OPTIMIZATION MODEL FOR MULTI-DEPOT VEHICLE ROUTING PROBLEM IN DISASTER MANAGEMENT

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Abstract. Vehicle Routing Problems (VRP) are part of many distribution systems that involve routes and scheduling vehicles through various points. This is a combinatorial optimization problem that requires the determination of the optimal route sequence that can be used by a fleet of vehicles to serve a set of customers, taking into account various operational constraints. One variant of VRP is a multi-depot, where the fleet or vehicle must service several depots, but each vehicle must continue to start and end at the same depot. This paper considers VRP with multi-depots to transport and distribute logistics in disaster conditions. The optimization model is proposed to meet the needs of people around the disaster area from transporting a logistics perspective.

1. INTRODUCTION

The problem of vehicle routes has become a lot of research material and previous writings. The vehicle route problem has been discussed and written since Dantzig and Ramser since 1959, Dantzig and Ramser have developed it in the Traveling Salesman (TSP) problem[1][4]. VRP is responsible for designing a series of optimal routes for vehicle fleets to serve a specific group of customers. The problem of vehicle routes or Vehicle Routing Problems
states that vehicles m are initially placed in depots to deliver separate quantities of goods to customers [1].

Determine the optimal route used by a group of vehicles when serving a group of users representing VRP problems. The purpose of VRP is to provide one service with a minimum vehicle route that originates and ends at the depot. One model of VRP is Multi Depot, where a fleet or vehicle must serve several depots, not just one depot with a particular vehicle, but each vehicle must continue to start and end at the same initial depot. Vehicle routing is one of the most influential things in the fields of transportation, distribution and logistics problems. Vehicle routing is related to transportation, distribution and logistics related to services in disasters or disaster management. Disasters are something that is close and close to human life, related disaster response and transportation activities usually include search and rescue, emergency medical care and fire fighting trips. This paper only covers explanations of multi depots and their relationship with disaster services, provides examples and related models related to disaster management services.

2. LITERATURE REVIEW

Multi Depot Vehicle Routing Problem (MDVRP), is the development of classic VRP, and is an NP-hard to determine the route for several vehicles from several depots to one customer and then return to the same depot. The purpose of this problem is to find a route for the vehicle so that all customers are served with a minimum cost of the total distance, without violating the capacity and time constraints of the vehicle[2][4].

Disaster Management and Transportation Disaster Management is defined as organization and resource management and has a role to handle all aspects of humanitarian emergencies, especially preparedness, response and recovery to reduce the impact of disasters. The United Nations defines disaster as a serious disruption to the functioning of the community or society. Disasters involve a wide range of human, material, economic or environmental impacts, which exceed the capacity of affected communities or communities to overcome the use of their own resources[3].

Disasters have a considerable effect on the transportation network, the function of emergency transportation networks can play an important role in the mitigation phase, especially in countries that sometimes suffer from sad experiences of total destruction of several developing cities. Transportation related disaster response activities usually include search and rescue, emergency medical care and fire fighting trips. In this paper, emergency
transportation network design problems are proposed to determine the optimal network for high-priority emergency response trips after a disaster. The need for transportation is largely due to the dependence of an efficient transportation network to provide accessibility and support safe and efficient movements of victims and goods. In addition, if the right pathway to be used by disaster relief forces is not planned, the activities of these groups can be stopped. Without a functional route, it is impossible to respond to the affected city.

Optimization and logistics Optimization is a process to achieve ideal or optimal results (effective value achieved, optimized problems are maximizing or minimizing some functions relative to several problems, representing various different choices to determine the best final solution. Optimization includes minimizing costs with maximum profit, minimal errors, optimal design, optimal management and variational principles. Optimization problems include:

1. Determining the shortest path from one place to another.
2. Determine the minimum number of workers to carry out a production process so that labor costs can be minimized and production results remain maximum.
3. Managing the vehicle lane so that all locations can be reached
4. Managing the routing of telephone cable networks so that the cost of wiring is not too large and not wasteful.

3. RESULT AND DISCUSSION

Logistics management for disaster management is known as humanitarian logistics or humanitarian logistics. Humanitarian logistics includes planning, implementing, and controlling the flow of humanitarian aid efficiently, saving costs and storing humanitarian assistance and related information, from the point of origin to the point of consumption for the purpose of reducing the suffering of disaster victims.

In connection with this function, multi depots aim to minimize travel costs while meeting constraints such as conditions and conditions on the way to disaster areas. Parameters and defining variables are:

- $A$: set resident to PoCs
- $V$: set from PoCs
- $E$: set from resident
- $P$: set from route
- $UnitN$: cost route
- $N_{max}$: cost route max $m$
- $d_{ij}$: range from $i$ and $j$
- $n_{ij}$: cost from $i$ and $j$
where:
\[ n_{ij} = \text{UnitN} \times d_{ij} \]

and
\[ x_{ijm} = \begin{cases} 
1, & \text{if arc } (i, j) \text{ set on } m \\
0, & \text{else}
\end{cases} \]

Based on the problem of vehicle routes, the following mathematical formula with the function \( Z(x) \) aims to minimize the total cost of travel using Equations:
\[
\min Z(x) = \sum_{i \in A} \sum_{j \in A} \sum_{m=1}^{P} n_{ij} x_{ijm} \quad (1)
\]

A set of structural constraints must be met to produce feasible problem solutions. Visit each resident once with one vehicle.
\[
\sum_{j \in A} \sum_{m=1}^{P} x_{jim} = 1, \forall i \in E \quad (2)
\]
\[
\sum_{j \in A} \sum_{m=1}^{P} x_{ijm} = 1, \forall i \in E \quad (3)
\]

Next Trip a vehicle that visits the patient must also leave the location of the resident. The vehicle route is closed at one of the depots.
\[
\sum_{j \in E} x_{ijm} = \sum_{j \in E} x_{jim}, 1 \leq m \leq P, i \in V \quad (4)
\]

Cost constraints: Vehicle travel costs (budget) cannot exceed.
\[
\sum_{i \in A} \sum_{j \in E} x_{ijm} n_{ij} \leq N^m_{\text{max}}, 1 \leq n \leq P \quad (5)
\]

Travel requirements: Each vehicle comes from the PoC back to where it was originally placed.
\[
\sum_{i \in V} \sum_{j \in E} x_{ijm} \leq N^m_{\text{max}}, 1 \leq n \leq P \quad (6)
\]

4. CONCLUSION

The results that must be obtained from the existing model are to minimize and maximize the journey of a logistics service for disaster areas without crossing the boundaries and those that have been created in the existing constraints.
REFERENCES


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