Dynamic single allocation hub location problem considering life cycle and reconstruction hubs

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Purpose: Hub location problems are getting more and more attention today due to their widespread application in designing product transportation systems and communication networks. In these systems, products (including data transmission, passenger transportation, freight forwarding and logistics, postal services, etc.) are shipped from multiple sources to multiple destinations. The performance of these systems can be improved by using hub points. In fact, instead of just deciding on a single period, a planning horizon with multiple time periods is considered. The necessity of doing this research is that decisions are made in each period according to the costs and flows of the same period. In the real world, facilities are usually depreciated after a certain period of time and must be closed or rebuilt if possible.

Design/methodology/approach: In this research, hubs reconstruction is allowed, meaning it can be reconstructed to reduce costs rather than startups, to operate for a specified lifetime and to cover network demands. It is also selected to operate hubs from different contractors. In this study, there are also several levels of capacity to set up that can be selected with respect to the demand of the period, which is both sufficient and cheaper to meet the demands. Genetic algorithm has been used to solve and evaluate the model performance.
In general, this study has attempted to provide comprehensive modeling for the multi-period hub location problem with multiple capacities. The investigated problem considered the hubs lifetime as well as the possibility of reconstruction at the end of lifetime. It has also been attempted to design the model to suit real-world conditions.

Findings: Investigations in this study showed that the proposed model is more efficient than the previous models in terms of coordination and compliance with real-world conditions. Further,the validity of the proposed model was also evaluated by performing a variety of sensitivity analyzes. Solving the various numerical examples by the genetic algorithm and comparing them with the exact method demonstrates the acceptable performance of the meta heuristic method.

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Research limitations/implications: For future research and improvement of proposed model the following recommendations are suggested:

- Consider different capacity levels for nodes so that the capacity of each node can be changed at different times depending on the problems conditions.
- Assume that the hubs can be closed before the expiration date depending on the problems conditions.
- Consider case studies in various industries and model development with conditions much closer to real situations, for example in the field of urban transport, perishable products, emergency services, and so on.
- Using uncertain programming such as probabilistic and fuzzy programming to predict and plan the model and its parameters in successive periods.
- Providing solution methods with better performance and solving larger problems in rational times. For example, heuristic methods can reduce the complexity of the problem and thus solve larger samples in shorter times, so they will be useful.

Practical implications: The main advantage of a multi-period problem over a single period problem is making the best decision in the time frame. In the single-period model, once the decision is made for all time periods, it is obvious that this decision will not be optimal because the parameters and conditions governing the problem are not the same over successive periods, so the result will not be global optimal. Another advantage is that the single-period model optimizes the cost of each period separately and it does not consider the relationship between the network structure of the nodes in different periods. Therefore, in this study, a multi-period model was proposed to obtain the global optimal solutions.

Originality/value: The main difference between this study and previous work is the following:

- Providing a hub location model in which it is possible to select a contractor for each hub set up.
- In this research, the hubs have a known lifespan and this lifespan is determined after the contractor selection.
- Providing a new model that enables the choice between reconstructing and closing at the end of each hub's life by considering network costs.

Keywords: Multiperiod Hub location problem, Dynamic demand, Multiple capacity, Hub lifecycle, Hub reconstructing, Genetic Algorithm