The Management Strategy Based on Uncertain Data of Supplies

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ABSTRACT
This paper proposes a combinatorial evaluation method for the effectiveness of supplies assessed on the basis of optimal route connections between warehouses and receivers (customers) with usage of rough sets theory in multidimensional approach. Effectiveness is evaluated as the difference between the value of orders and their implementation costs resulting from transportation. The uncertainty concerns the assortment and the level of orders. Among various order alternatives using the proposed methodology one can observe the most and least effective configuration. One can use it to support trade policy, create service areas adapting them to the location structure of supply, and receive nodes.

Keywords: distribution network, categorization, rough sets.

1. Introduction

Transportation problem in a deterministic version is, on the one hand, widely described [1,2,3], on the other hand, however, issues connected with full optimization are still not solved [4,5,11]. Therefore, our proposal regards the return to combinatorial methods based on permutation (variation). Processing time, even if it includes several minutes, is not an important indicator, because while planning a strategy or policy we operate off-line [6,9]. The combinatorial solution combines a classical transportation task, traveling salesman problem, Hamilton cycles, etc. A form of a final diagram allows us to select solutions with extreme values of effectiveness. This will permit us to create positive and negative areas of approximation for different structures of orders and to develop heuristics for the policy and strategy of orders and inventory, and even the location of warehouses. The opportunity to study the distribution of orders, stocks and warehouse locations, suggests the possibility of using rough sets theory in the multidimensional approach [17,12,15]. This also results in the possibility of building a reasoning mechanism [8,17,10,12]. The most convenient research organization relies on a successive increase of individual orders. For each product, we obtain the areas of approximation; next we can gradually increase the range of orders. The multidimensional inference is rather difficult and requires great discipline in the organization of the research. Hence, we observe the need for systematic and progressive changes in parameters [16]. The permutation approach should not discourage us, since as the final result, we obtain optimally organized transport route with loadings and deliveries. The main motivation of our investigation consists in searching for the guarantee of an optimal solution. The complexity of the research itself is connected with a strategy for choosing the set of data, and relating them to the real situation in a particular provider company (or a corresponding department) [7,13]. The proposed approach is the combination of a number of logistical problems, so that brings us closer to reality.

2. The permutation method for testing the route of supplies from warehouses to receivers

Sequences of procedures in the method implementation are as follows:

1. An introduction of data: customer orders, storage resources, distances from the warehouses, distances between warehouses and receivers, distances between warehouses, distances between the receivers, the priorities of receivers.

2. Generating the permutation element (receiver or warehouse).

3. Checking if loaded commodities (products) are sufficient for orders of the generated element, if it is the receiver, and unhandled receivers with a higher priority. If so, then unloading at the receiver and erasing from the waiting list should be performed. If not, return to step 2. If this is the warehouse then the loading is to be supplemented.

4. Saving the code of the generated element in the sequence of the supplier route and checking whether all orders were delivered. If not, return to step 2.

5. Correction of the shortest (the cheapest) line to provide orders.

6. Presentation of the shortest (the cheapest) route, loading and unloading with respect to warehouses and receivers.

The procedures presented in the above points are complex and require the use of multi-dimensional structures of intermediate results. In order to describe them, specified designations should be made:

S (*i; j*) – the resources of the *i*-th commodity in the *j*-th warehouse,
P(*i; k*) – the quantity of the *i*-th commodity order by the *k*-th receiver,
D(*a; b*) - the distance between elements (stores or receivers) *a* and *b*,
CM(*j*) – the codes of warehouses,
CR(*k*) – the codes of receivers,
PR(*k*) – the priorities of receivers,
V R(*k*) – the element of an order realization vector 1*;* 0 for the *k*-th receiver,
V C(*i*) – the element of a load vector 1*;* 0 of the *i*-th commodity,
ST(*i; j*) – the size of a delivery vehicle load by the *i*-th commodity in the *j*-th warehouse,
SM(*i; j*) – the supplies of the *i*-th commodity in the *j*-th warehouse,
DT(*t*) – the actual length of the route *t*,
FT(*t*) – the final length of the route *t*,
NT(*r; t*) – the *r*-th node (element: warehouse or recipient) of the route *t*,
MDT – the length of the shortest (the cheapest) route of all deliveries,
CMT – the number of the *MDT* route.

The strategy of the algorithm implementation consists of applying the verification rules of the current situation connected with the transfer of the delivery vehicle. Among the various selected elements we have to make a decision characteristic for the type of the next node of the route. And so if that is the recipient, who ordered a supply larger or equal to the capacity of the delivery vehicle, the heuristic hint will be to deliver products and refer to the warehouse to get further loading for the next delivery (fig.1a).

Figure1. a) The heuristics imposing complete loading and unloading at each time, b) the heuristics imposing the collection of the sum of supplies and their further realization, c)mixed heuristics that are further, consecutive loadings and deliveries and loadings and interspersed deliveries, where M-warehouse, R-receiver.

When supplies are small and portions of the load are incomplete we use the heuristics of collecting the commodities (goods) and recipient detour (fig.1b). Mostly, however, we use mixed heuristics (fig.1c). In this example, we make the loading in two consecutive warehouses, then the delivery to two recipients is conducted, and at the end further loading and delivery is performed. The permutation generator can be represented in the form of nested cycles, where each nesting excludes previous generations. That means we do not come back either to the warehouse, where we already were, or to the recipient, where ordered goods were delivered. This way we eliminate the part of the solutions that we consider to be ineffective. If the suspicion appears that the return to previously generated elements provides effective solutions, we can use the variation generator (with the