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SERVICE AREAS OF TRANSFORMATION CENTERS

Summary. Problem of material flow control by regional transformation centers, as well determination of their service sectors are significant tasks for generation and operation of macrologistical systems. Received results can be used by generation of expert system for material and informational flows control.

ЗОНЫ ОБСЛУЖИВАНИЯ ТРАНСФОРМАЦИОННЫХ ЦЕНТРОВ

Аннотация. Проблемы оптимизации управления материальными потоками региональными трансформационными центрами, идентификации их зон облуживания относятся к важным проблемам образования и функционирования макрологистических систем. Результатами можно воспользоваться для построения экспертной системы управления материальными и информационными потоками.

There are two main forms of logistical support for finished products distribution in up-to-date conditions. Other forms are different types of mentioned ones. Such methods usually foresee logistical approach to flow process control. Whereas we should mark that by logistic concept implementation at every level part of transit supply is being reduced and part of warehouse supply – increased. The more extension of logistics in micro- and macroeconomics the more development of such tendency. Warehouse form of material flow control becomes beneficial not only for consumers but for producers during marketing process. The reasons for that, provided by market relations development, are the following:

- ascertainment of market products, i.e. increase of finished products part produced under orders of specific buyers;
- warehousing, in some cases increase of number of enterprises interested in transit operations;
- hardened competitive struggle at distribution market, which leads to improvement of consumers service. In other words, production of high quality product with acceptable price and adjustment of after-sale services is no longer enough to gain advantages against competitors.

In this relation we shall indicate increase of transformation centers importance disposing integrated system for warehousing and processing in transport-warehousing systems, which are generated or are being generated. Based on mentioned above we can mark out relevance of service sectors differentiation as well as their disposition on logistical ground.

This task can be solved by two main ways: classical and heuristic methods. The first one is based on application of production-transportation problem algorithm in network or analytical form. The second one is characterized by application of theory of Inexact variables or Branch-and-bound method. It’s argumentation is provided below.

Let us assume that, we have:

i=1, n-products production;

j=1, r- transformation centers, provided by products warehouse and processing systems;

k=1, m-consumers;

X_{ij}; X_{ik} – products flow from i-enterprise to j-transformation center and from j- transformation center to k-consumer;

X_j – goods, which is kept and processed (statistical flow) at j- transformation center.

Additional values must be included:

C_j – cost for products warehouse and processing at j- transformation center;

P_i – amount of products sent to main line transport from i-enterprise;

C_{ij} and C_{ik} – cost for transportation of production unit from point i to j- transformation center and from j- transformation center to consuming point k.

Thereby, conceptual economic and mathematical model for solution of problem for products flows differentiation among transformation centers on logistical ground can be stated as follows:

$$R^* = \min_{xij;xjk} \sum_{ij} C_{ij} X_{ij} + \sum_{j} C_j X_j + \sum_{jk} C_{jk} X_{jk} \quad (1)$$

Herewith:

$$(X_{ij};\ X_{j\kappa}) \geq 0; \quad (2)$$

$$P = \sum_{j} X_{ij} \ , \quad (3)$$

$$Q_k = \sum_{k} X_{jk} \ , \quad (4)$$

$$X_j = \sum_{i} X_{ij} \ , \quad (5)$$

The main idea is to find such X_{ij}; X_{ik}, which can minimize exsecant keeping the restrictions (2, 3, 4). The exsecant reflects aggregate costs related to transportation and processing of goods in transformation center. Restrictions (3) and (4) represent conditions of goods production and consumption balances.

Conceptual model (1-4) has a range of modifications. In this form problem for effective goods flow distribution in transformation centers is being solved. If needed, some restrictions from revised facilities ability (as well as capacity of warehousing area) can be integrated in this model.

It looks the following way:

$$\sum_{i} X_{ij} \leq Q_j .$$

Besides, some restrictions related to transportation capacity of different transportation directions (ij), (jk) are possible.

Decision matrixes (1-4) X_{ij}; X_{ik} reflect not logistical services area of transformation centers (jk), (ij), but their results. They assist in effective material flow control within the framework of micrologic system in on0line operation.

When except material flow distribution we have to optimize disposition and number of regional transformation centers on logistical ground, in this case except production-transportation problem we need to solve combinatorial problem by handed enumeration of possibilities (1-5) or by dynamic programming method.

It’s worth to mention one more problem modification: parametric variables P_i Q_k as well as C_{ij}, C_{ik}, C_j can change as random variables. In such cases restrictions (3), (4) are recorded in verisimilar form, and for solving production-transportation problem stochastic programming method is used.

If imposition of service area of regional transformation center is stated in analytical form, in this case we have to except a range of significant tolerances, reducing accuracy of calculations: nonlinear problem (1-4) is replaced by linear problem, and verisimilar variables P_i, Q_j are taken as determinate ones.

By solving control and design problems with the help of inexact variables theory, where such linguistic variables as “high”, “not very high”, “low”, “properly”, “unsatisfactory” and others are used, decisions depend on subjectivity of a person making decision. In this relation in order to have a right for making decision with the help of inexact variables, responsible person must have an idea about the relevant features and characteristics, as well as be able to estimate objectively the structure of variables. If these conditions are kept, with the range of linguistic variables we can receive answers with full degree of certainty. Formal decision by inexact purposes and restrictions represent unstructured variable and can be considered as inexact formulated exsecant.

Let us assume that X represents variable of possibilities, characteristics or alternatives describing the considered object. In this case each object can receive relevant inexact variable A

$$\frac{x}{x} \in X \;\; ; \quad \mu_A(x) \in [0,1] \; ,$$

where $\mu_A(x)$ characterizes property containment level x b A

Considering that exponent of membership function is $\mu_A(x) \in [0,1]$, $x \in [0,1]$ the following condition comes in force:

$$S_{np}\mu_A(x)=1; \; x=X$$

Therefore it is obvious that exsecant and exsecant exponent is equal 1 to the maximum.
Incidental we will distinguish that exsecant and exponent of membership function has fundamental meaning inexact variables theory.

Exponent of membership function makes it possible by alternatives estimation change from linguistic variables to scalar estimate. It is very important.

Solving problems mentioned above two methods of scalar estimation of linguistic variables are used:

- valuation of linguistic variables are worked out by experts in actual figure on the interval [0,1];
- valuation of linguistic variables are worked out by analytical mathematics characterizing changes in membership function due to X property.

As criteria of opinion compliance of a person making decision with actual object characteristics appear separation value and inclusion value indexes - relation of inclusion of inexact variables. These indexes are formed by general study of membership function, characterizing estimate of object features.

Prime example of inexact variables theory application in logistics can be situation when there are two transformation centers on provided logistical ground. In this case characterization of problem consists in determination of their service sectors. Herein it is mentioned that goods transported by main line transport are interchangeable, i.e. goods can be supplied to any regional transformation center.

Decisive factor for consignor and receiver of goods in choosing this or that transformation center is availability stipulated by location factor. This factor can be formed by relation of distance between consignor/receiver of goods and transformation centers, time of delivery and delivery cost.

Below is a graphic picture of the problem, where it is needed to set limits of inexact variables A_1 and A_2 by two transformation centers reflected by consumers, location and time advantages of consignors and receivers of goods.

Experts advantages are set by the following membership function rungs (can be proposed other connections reflecting physics of the process):

$$\mu_{A1}(x) = \begin{cases} [1-(x_1 - x)]^{-1} \text{ for } x \le x_1 \, , & (6) \\ [1-(x - x_1)]^{-1} \text{ for } x \ge x_1 \, , & (7) \end{cases}$$

$$\mu_{A2}(x) = \begin{cases} [1\text{-}(x_2 - x)]^{-1} \text{ for } x \le x_2, & (8) \\ [1\text{-}(x - x_2)]^{-1} \text{ for } x \ge x_2. & (9) \end{cases}$$

Here x_1 and x_2 are given points location of transformation centers at service ground; x – current coordinate value of set of advantages A_1 and A_2, included in membership function.

Out of formulas (6, 7) by moving away of clients from transformation centers x_1 and x_2 deviations $(x\text{-}x_1)$ and $(x\text{-}x_2)$ are increasing, degree of membership function is decreasing and clients advantages relative to these canters is decreasing.

Fig. 1 represents connections $\mu_{A1}(x)$ and $\mu_{A2}(x)$. Here we can see that advantages equal to maximal grade of membership reach $S_{np}\mu_A(x)$=1 in proximity to regional transformation centers, when $x = \overline{x_1}$ and $x = \overline{x_2}$. The highest separation rung of transformation centers service areas in case under review is equal to $l_{max} = 1 - S_{np}\mu_{A1A2}(x)$ and cutoff should meet conditions $l_0 = S_{np}\mu_{A1A2}(x)$.

Connections $\mu_{A1}(x)$ and $\mu_{A2}(x)$

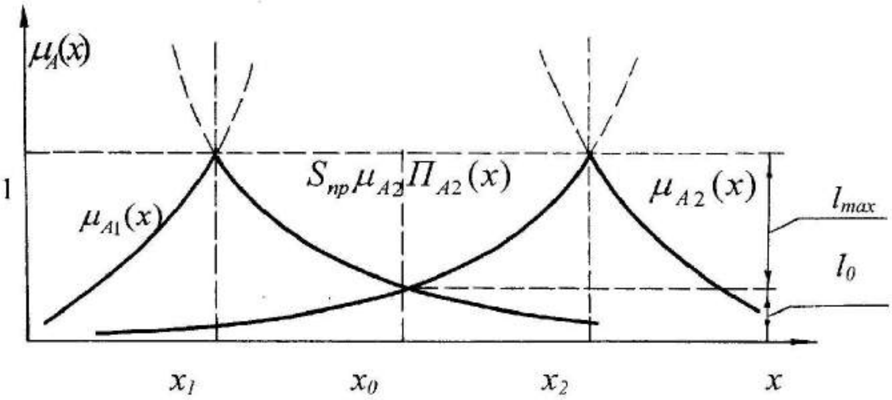

Fig. 1. Represents connections $\mu_{A1}(x)$ and $\mu_{A2}(x)$

Рис. 1. Представление соединений $\mu_{A1}(x)$ и $\mu_{A2}(x)$

Mark means intersection of subvariable A_1 and A_2, and $S_{np}\mu_{A1A2}(x)$ corresponds to ordinate maximum intersection in x_0 point.

Intersection of subvariable A_1 and A_2 are marked with degree of membership given in formulas (7, 8). Maximal separation value and cutoff reach in point, which means orientation area to regional transformation centers.

By solving equations (7) and (8) we can receive cutoff abscissa:

$$x_0 = \frac{x_1 + x_2}{z}.$$

Intuitively we could foresee x_0 value, because formulas (7) and (8) are symmetric in x_0.

With the help of known value we can determine cutoff by substitute it's value in (7) or (8):

$$l_0 = \frac{z}{z + x_1 + x_2}; \qquad l_{\max} = 1 - l_0 \frac{x_1 + x_2}{z + x_1 + x_2}.$$

Problem of material flow control by regional transformation centers, as well determination of their service sectors are significant tasks for generation and operation of macrologistical systems.

Received results can be used by generation of expert system for material and informational flows control.

Received 15.01.2008; accepted in revised form 13.07.2009