# Realization calculation model of matrixes of correspondence for transport network

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**Abstract**[1]

In article describes calculation model of matrixes of correspondence for transport network. Types of population movements and flow of movement of log are considered.

## 1. Introduction

Considering a problem of optimization for transport network of city need creation of complex mathematical model of the network including definition and the forecast of all parameters of functioning of the given network is necessary. One of such significant parameters is the set of matrixes of the correspondence of transport streams. The set of matrixes of the correspondence is not unequivocal owing to heterogeneity of movement of the population on destinations both various days of week and time intervals.

Now, keeps urgency a problem of working out of the simplified models allowing adequately to reproduce structure of difficult movement of urban population. In considered model display of structure of movement of the population by means of a matrix of correspondence A – the quantitative characteristic of movement of a transport stream on a network is supposed.

## 2. Kinds of movement of the population

All variety of movement made on a transport network, can be broken into different groups of movement by following criteria:

- On the purposes of movement $q_r$;
- For choice ways of movement $q_c$;
- On preference in a choice of ways of movement $q_w$.

The movement made on a transport network, on the purposes of movement is broken into groups, most important of which are:

- Movement between residences and places of the appendix of work (labor correspondence) $R_J$;
- Movement from residences to places of cultural and community service and back $R_C$;
- The movement made between places of appendices of work (business trips) $R_B$;
- The movement made between objects of consumer services $R_M$

For choice ways of movement share on foot $T_p$, automobile $T_v$ and by means of various kinds of public transport $T_s$ (the bus, a tram, a trolley bus, the underground).

To each group of movement there corresponds the stream of interdistrict correspondence which are fixed in the report of streams. As additive criteria used «the Generalized price» – criteria including different factors, such as movement time, comfort, payment and others.

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Classical scheme of modelling of the transport streams used often in a network of a city and containing four stage (four algorithms):

- An estimation of total amounts of arrival and departure from each area of a city (*Algorithm –> Trip generation*);
- Splitting on ways of movement (the pedestrian movement, movement with use of public transport, movement on the personal car, etc. (*Algorithm –> Modal split*);
- Definition of matrixes of the correspondence defining volume of movement between each pair of settlement areas of a city (*Algorithm –> Trip distribution);*
- Distribution of correspondence on a transport network means is definition of all ways chosen by participants of movement, and definition of quantity of movement on each way (*Algorithm –> Trip assignment*).

Result of the given scheme of modelling is the matrix of correspondence $A$, with volume of movement between each pair $(i, j)$ settlement areas of a city on each way. However for correct modelling of the real traffic it is necessary, to unite movement in chains $R_i$ where the chain is understood as sequence of movement ( $R_J$, $R_C$, $R_B$, $R_M$), where initial and final points coincide (for example: « house - work - cafe - work - shop - house»). Association of separate movement of matrixes of correspondence $A$ in chains allows to consider influence of such movement against each other. Models in which chains of movement are obviously considered, we will designate as $M_T$ «*tour-based*»

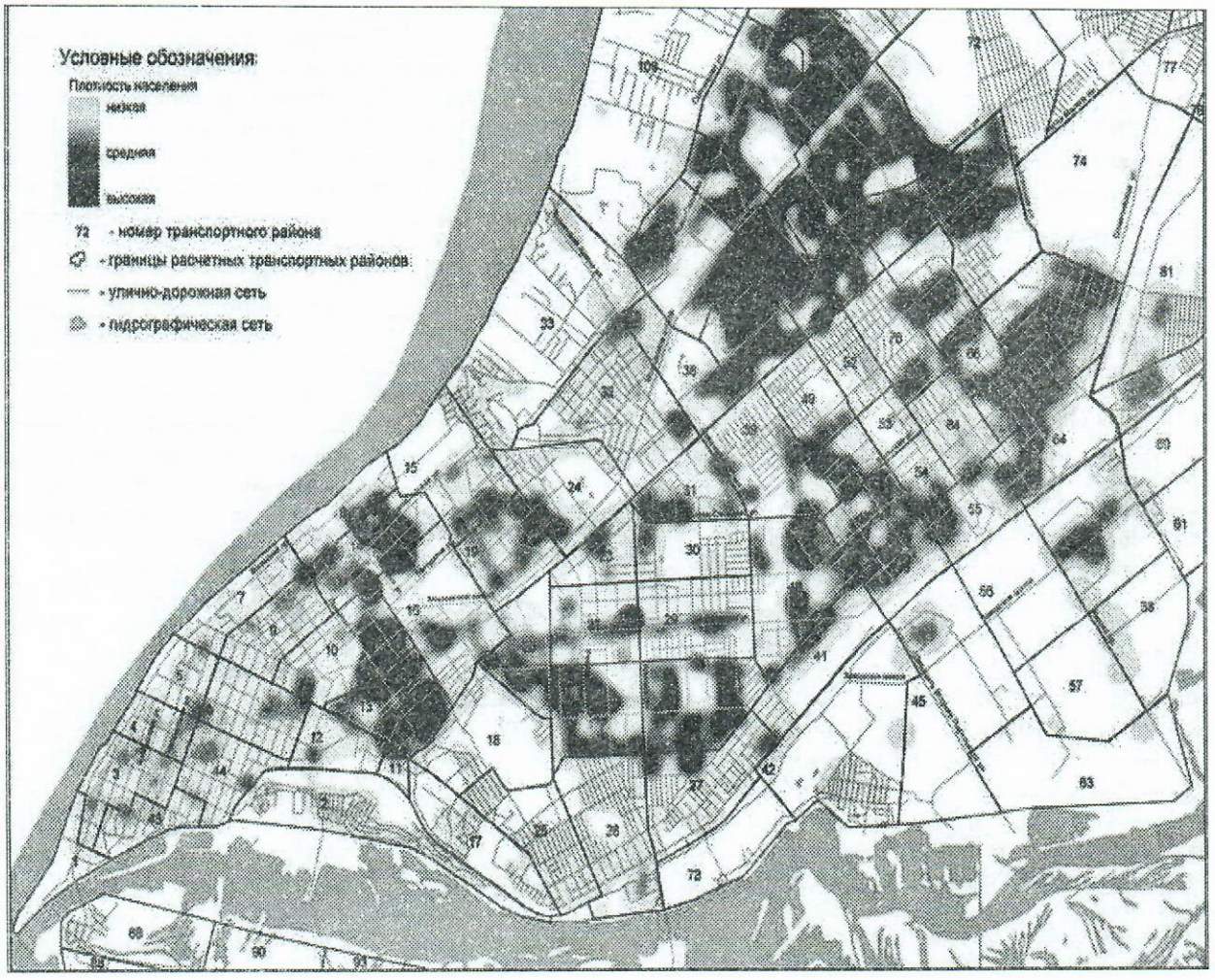


**Fig. 1. Definition of central offices of territory on intensity of links**

The gravitational model is developed by analogy with law connecting force of an attraction between two weights, located from each other on the set distance. The transport gravitational model defines dependence of intensity of stream $I_{ij}$ on full number of departures $Q$

from zone $i$ and numbers of arrivals $D$ in zone $j$ and expenses for movement between zones $i$ and $j$ - $c_{ij}$

$$I_{ij} = k\frac{Q_i D_j}{c_{ij}^2}, i = 1,\ldots,N, j = 1,\ldots,M \quad (1)$$

where $N$ - total of zones of departure,

$M$ - total of zones of arrival,

$k$ - constant

$c_{ij}$ - Can be considered, how distance between two zones $i$ and $j$, or as cost of passage of distance between zones.

The essential lack - has the equations at increase in set values $Q_i$ and $D_j$ twice, the number of trips will increase four times though actually it only will double. For elimination of the lack it is necessary to consider the following restrictions connected with balance of entrance and departure:

$$\sum_i^N I_{ij} = D_j, \forall i = 1,\ldots,N$$

$$\sum_j^M I_{ij} = Q_i, \forall j = 1,\ldots,M$$

$$I_{ij} \geq 0, \forall i = 1,\ldots,N, \forall j = 1,\ldots,M$$

The equation (2) means, that the total stream which left zone $i$ in zone $j$ should be equal stream which has arrived to zone $j$. Similarly for the equation (3). The total quantity of the left vehicles should correspond to total quantity arrived, that is fairly following condition:

$$\sum_i^N Q_i = \sum_j^N D_j \quad (5)$$

Streams should not be negative. Gravitational model (1) with restrictions (2) - (4) is the first modified gravitational model.

Now for calculation of correspondence instead of gravitational models are used entropic as gravitational models and their updating at formation of transport pairs $(i, j)$ do not consider individual preferences.

***Entropic*** model is based on the likelihood description of behavior of a vehicle. In this model the principle of a maximum of the weighed entropy of considered system is pursued. The principle consists that to real distribution of a stream to the networks, corresponding to self-organizing, distribution of streams satisfying to transport restrictions which can be received as a result of maximization of some entropic functions - the weighed entropy is put in the conformity, system depending on a condition.

The importance of this model in hypothesis formalization about equilibrium and independent behavior of elements of system at formation of its conditions. The most probable is that condition of system at which its uncertainty measured in size of entropy, is maximum.

Maximization of the weighed entropy means search of condition, which close on probability to real system at the account of individual preferences. Aprioristic individual preferences in entropic models can be set in the form of function of distribution of probability.

Example of entropic models:

$$\max_{I_{ij}} \sum_i^N \sum_j^M I_{ij} \ln \frac{\alpha_{ij}}{I_{ij}},$$

$$\sum_j^M I_{ij} = Q_i, \sum_i^N I_{ij} = D_j, I_{ij} \geq 0 \quad (6)$$

where $I_{ij}$ - distribution of the correspondence from zone $i$ in zone $j$ which is formed in system in the absence of restrictions;

$Q_i$ - Quantity of trips from a zone *i;*

$D_j$ - Quantity of trips to a zone *j*.

Sizes $\alpha_{ij}$ are defined, proceeding from functions of distribution of trips, for example, on time or convenience of messages.

(2)

In model ***of competing possibilities*** it is supposed, that the volume of correspondence between two areas is defined by quantity of the alternative centers along the line, that is quantity of alternative possibilities of visiting.

(3)

The model ***of the competing centers*** considers the greatest or least appeal of area, and is considered as generalization of gravitational model. The account of structure of system of areas is considered, areas are thus ranged under the status.

(4)

Now within the limits of working out of intellectual transport system of Samara, at modelling of a transport network of a city, it is used entropic model for calculation of matrixes of the correspondence, expanded taking into account heterogeneity of the types of transport used in one chain of trips. The modified model for a case of possibility of use by each individual one of six kinds of movement (foot, automobile and by means of public transport - the bus, a tram, a trolley bus, the underground railway ), is presented in a following kind:

$$\max_{I_{ij}^k} \sum_i^N \sum_j^M \sum_k^6 I_{ij}^k \ln \frac{\alpha_{ij}^k}{I_{ij}^k},$$

$$\sum_i^N \sum_j^M I_{ij}^k = Y^k, k = 1,6$$

$$\sum_j^M \sum_k^6 I_{ij}^k = Q_i, i = 1,\ldots,N$$

$$\sum_i^N \sum_k^6 I_{ij}^k = D_j, j = 1,\ldots,M$$

where $\alpha_{ij}^k$ - probability that the individual will go from zone $i$ to zone $j$ and will choose $k$ a type of transport.

$Y^k$ - Total quantity of trips on a network on $k$ a type of transport.

The matrixes of the correspondence constructed on resulted model, are used as entrance parameters at calculation of architecture of a transport network. However, this model of a matrix of the correspondence is still far from real streams of transport movings. The further researches of possibilities of updating of model for reception of matrixes of the correspondence approached to real characteristics of movement on a network are conducted.

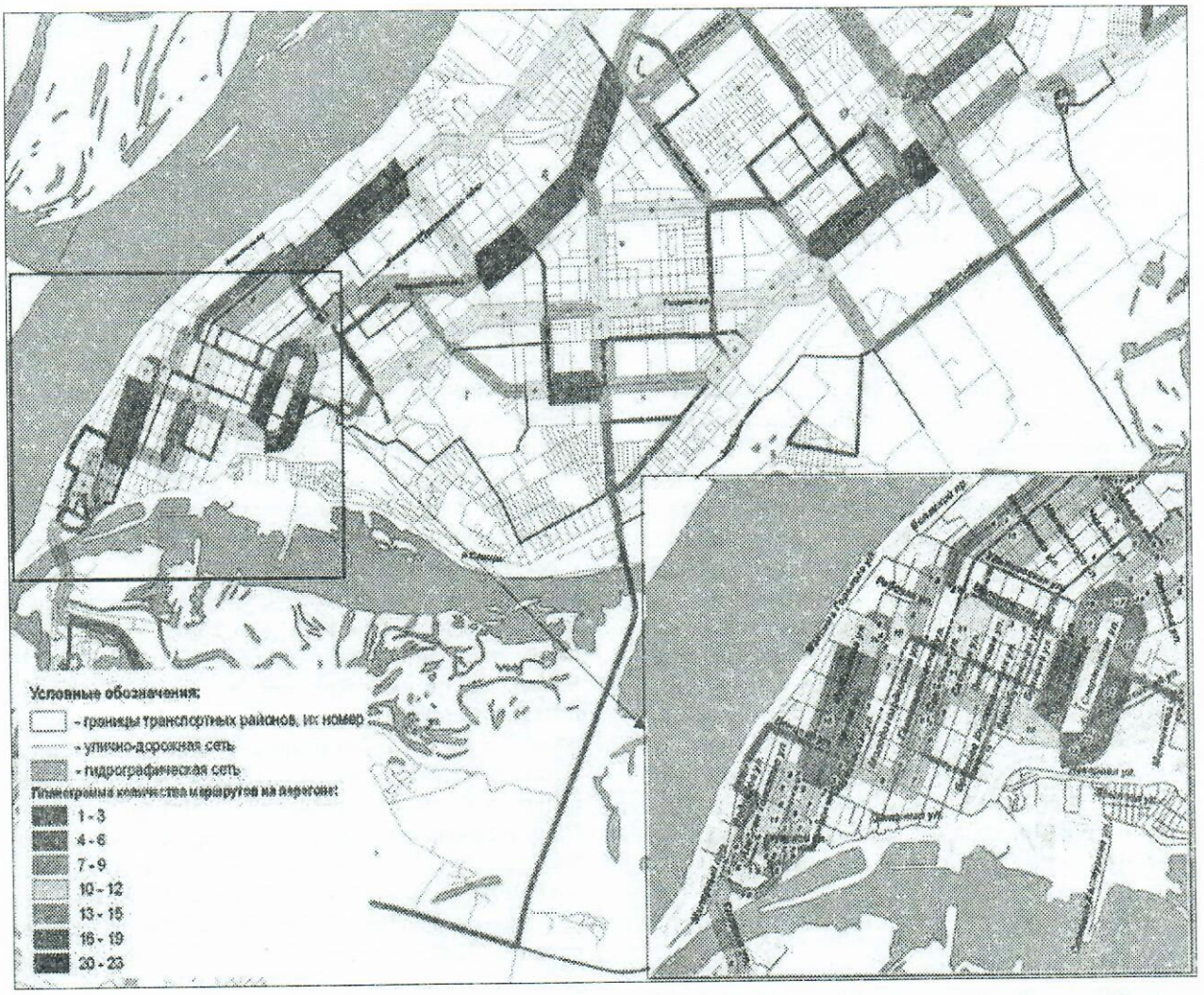


**Fig. 2. Planogram social network of commercial vehicles**

## References


1. Nurminski E., Shamray N. "Simulation of traffic flows on the basis of equilibrium theory" - Moscow: Scientific. Center of Sciences, 2009, 65 p.
2. Mikheeva, T.I., Saprykin O.N., Saprykina O.V. "Building architecture analytical tools of intellectual transport system based on the pattern" // Bulletin of Samara State. Technical. University. A series of "Engineering." Samara: Samara State Technical University, 2010, № 4 (27). S. 27-35.
3. Mikheeva, T.I. "Construction of mathematical models of objects of an street-road network of a city with usage of a geoinformation technology". *Information technology*. 2006; 1: 69–75.