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XIII Халықаралық ғылыми конференциясы

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The proceedings are the papers of students, undergraduates, doctoral students and young researchers on topical issues of natural and technical sciences and humanities.

В сборник вошли доклады студентов, магистрантов, докторантов и молодых ученых по актуальным вопросам естественно-технических и гуманитарных наук.

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OPTIMAL MODELS USED TO PROVIDE TRANSPORT SYSTEMS EFFICIENCY AND SAFETY

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The article under consideration presents methodology of construction of mathematical model enabling proper distribution of transport demand within the city territory. New territory assessment parameter is introduced – "city transport dependency". System of city transport infrastructure territorial and ecological development restraints is presented. Mathematical model of direct and dual problem of linear programming is presented. Assessment of practical importance of direct and dual problem modeling results is given.

In order to provide efficiency and complex safety of city transport system functioning it is required to address the challenges (i) on the level of transport planning and (ii) on the level of traffic management at particular sections of street-road network. Today, solving of such problems requires the use of forecast and simulation transport models whosegoalconsistsinassessmentofcertainactivitiesimpacton(i)performancetargetsoftransportsystema sawhole and (ii) its individual components (Lohse (1997)). It seems interesting to use instruments of mathematical modeling for assessment of traffic and environmental safety within city transport planning problems (Lukanin et al(1998)).

Thus, target of investigation may be defined as elaboration of algorithm of proper transport demand distribution as per types of transport and territories. Background of investigation is presented by burdens of transport systems development scenarios estimation. At present time, existing scenarios have no logical or formalized substantiation being the result of certain work performed by external experts, specialists or managers based on their experience and knowledge of the territory.

Object of this investigation – transport system; subject of investigation – satisfaction of transport demand and its distribution with reference to transport systems.

Problem of efficient transport system elaboration for the large city means problem of optimization. This problem is addressing efficient resources consumption in order to obtain maximum effect [Maslov (1970)]. In order to set up optimization problem, it is necessary to properly formulate thefollowing:

- set up (describe) thevariables;
- define the degree offreedom;
- formulate thetarget;
- formulate therestraints.

Variables (in our optimization problem) will be represented by scope of city population migration within the city territory performed in a variety of ways [Ortuzar and Willumsen (2001)]:

- onfoot;
- by publictransport;
- by personal vehicles(cars).

Each of the above ways will make contribution to the target function of the problem. And scope of contribution will vary. In our case, it will depend on the rate of correspondence implementation performed in this or that way (5 km/h, 18 km/h, 30 km/h). Respectively, each manner of migration will differently consume resources, spend and utilize the usable energy.

Setting up of optimal model implies a certain discretization of the sphere under investigation that is division of the city territory into transport zones. Let's divide the city into 10 transport zones. Transport zones represent four types of territories. Territories division should be done using the below principle:

1. City center (Zone *A-1*) (one zone).

This type of zones is characterized by considerable business activity.

2. Central regions adjoining the city center (Zone *B-2*) (fourzones).

This type of zones is characterized by high-altitude housing and versatile land use.

3. Outland districts (Zone *C-3*) (threezones).

This type of zones is characterized by own business and recreation centers. Challenge is conversion of the said areas into self-sufficient settlements and their autonomy.

4. Vast city areas with low density of population (low- storied houses) (Zone *D-4*) (two zones). In order to set up the model of optimization problem let's introduce the followingvariables:

X_{rs1} – number of persons moving within the area under investigation in "*s*" manner on foot; X_{rs2} – number of persons moving within the area under investigation by public transport in "*s*" manner; moving within the area under investigation by personal transport in "*s*" manner;

S – number of route passing types in area under investigation (S □1,2,3).

While moulding the optimal model it is important to take into account the way of correspondence passing through area under consideration: transit; entrance/exit; correspondence inside the area. Let's illustrate it by Fig. 1.

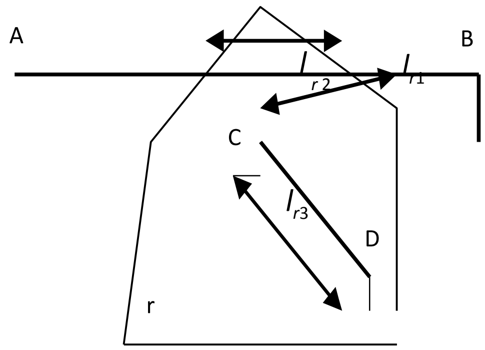

Figure 1 - Area of investigation r. Trip configurations (routes)

Routes connecting the centers of transport regions are passing through the area under investigation: A, B, C, D. Three types (S □1,2,3) of route passage through area under investigation are possible: 1st type ($A – B$); 2nd type ($B– C$); 3rd type ($C – D$).

Number of areas under investigation defines the number of degrees of freedom and, accordingly, the problem dimension.

In this definition, the problem of solving the mathematical model will consist in selecting the best set of values of all the 90 variables.

For each of the transport zones we will seek for efficient satisfaction of people transport demands providing for the city as a whole a minimum of the target function – time of correspondence implementation.

In order to construct the target function, it is required to set up the transport systems operational parameters and to calculate the scope of migration kilometers for each zone.

In this problem definition, the objective target of transport system functioning will be: minimum time-weighted average for transport correspondence implementation by all road users within 24 hours.

In capacity of constraint set superposing the target function let's use six types of constraints:

- constraints regarding migration demands in areas underinvestigation;
- constraints regarding length of existing street-roadnetwork;
- constraints regarding contaminantsemissions;
- constraints regarding road accidence occurrencerisk;
- constraints regarding available vehiclestock;

• constraints regarding noisepollution.

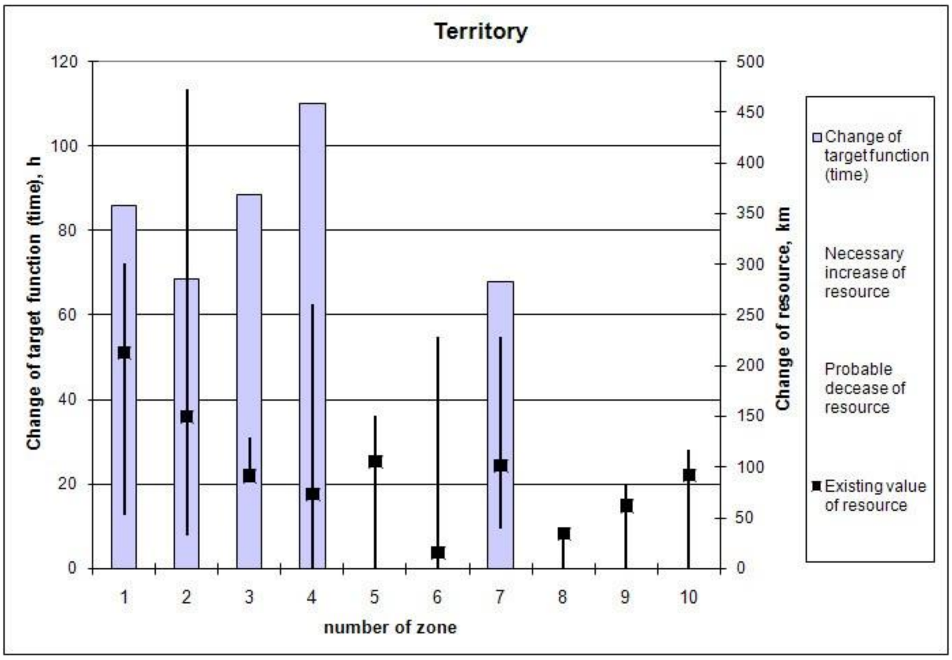

Figure 2 - Exchange diagram of dual model's solution presented in the form of functioning city transport system. Resource – territory

Black dots represent available resource reserve, i.e. in our case – length of street-road network in each transport zone.Barsarerepresentingthevalueofrespectivevariableofthedualproblemineconomicterms“shadowprice”of the resource measured in target function's units of measure i.e. showing how the target function will change at variationofreserveoftherespectiveresourcebyoneunit.Thinblacklinesrepresentrangeofstabilityofthesolution.Inourcaseitischangeofresourcereserve(lengthofthezone'sstreet-roadnetwork).

For instance, solution of the dual model for the city of Perm shows that most efficient (from the viewpoint of reduction of total time of transport correspondences implementation) will city street-road network improvement activities to be fulfilled in zone 4. Each new kilometer commissioned in the said zone wilreduce total diurnal time ofcorrespondenceimplementationinthecityby110hourswhilelimitsofnewroadscommissioninginthiszoneshall not exceed 50km.

Thus,knowingsuchevaluationofeachofresourceconsumedaswellasfinancialresourcesavailableatthedisposal of community it is possible to elaborate the economically substantiated program of activities aiming to improve efficiency of city transportsystem.

Recently the STSDsys (Scenario of transport system development) module was developed. It is a software implementation of the aforementioned algorithm. Use of such algorithms is a prospective approach allowing to improve process of managerial solutions development and implementation in the sphere of transport planning and traffic organization [Yakimov and Arepjeva (2016)]. Software implementation of these algorithms (being used as individual software tools and models) should (in the near future) bring optimal models into line of software products on an equal basis with forecast and simulation transport models.

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ОСОБЕННОСТИ ПРОЕКТИРОВАНИЯ СОВРЕМЕННЫХ СКЛАДОВ

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В транспортной системе большое распространение получили комплекс многопрофильныхскладов для хранения зерна и других товаров, а также склады с автоматическими стеллажными кранами-штабелерами, поскольку они занимают небольшие площади и имеют высокую производительность.

Современные складские системы с технологической точки хранения принципиально отличаются от традиционных хранилищ (рис.1), где применяются международные стандарты и новые методики проектирования, пред-полагающие комплексное выполнение ряда взаимосвязанных шагов в определенном порядке:

- постановка обусловленной логистическими требованиями общей концептуальной задачи;
- общее концептуальное проектирование;
- создание комплексного технического задания (ТЗ) на проектирование складов;
- эскизное проектирование;
- рабочее проектирование.

Рисунок 1 -Современные складские системы

Исходя из необходимости следования многошаговой стратегии, проектирование складского комплекса разделены на четыре этапа. Ниже приведен поэтапный состав проекта логистических складов