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TECHNIQUE OPTIMIZATION THE LOCATION OF SOME NETWORKS OF SERVICE INSTITUTIONS

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Abstract– Mathematical models, algorithms and programs for optimizing the location of some networks of service institutions have been investigated and developed, both in urban development and in rural areas, i.e. a toolkit for optimization for organizing a network of objects and service institutions (taking into account the existing planning structure of development).

Key words– Service objects (SO), service institutions (SI), power, optimal solution, service areas (SA), single-level and multi-level, mathematical models (MM), outpatient clinics and polyclinics, multidisciplinary hospitals, schools, methods, algorithms, programs.

I INTRODUCTION

Improving the planning of the sectors of the public service should be guided by the long-term aims of social development of society, and the network of service institutions should be based on a long-term scientifically grounded concept of systems of populated areas and the location of the country's productive forces. All this necessitates scientific forecasting of the system of public service institutions, such as a network of health care institutions, individual vehicles, a network of schools, etc., which performs the most important problem of further socio-economic development of our society.

The socio-economic zoning of the republic, based on which various settlement systems are distinguished, made it necessary to fundamentally new approaches to the formation of a network of service facilities and institutions, and to improve the methods of their territorial planning.

Any complex systems that include collectives of people, information management systems are considered by many as a universal tool that guarantees a modern level and high quality of management. Serious attention is paid to the accelerated development of industrial and civil construction in the CIS, since not only the growth of national wealth depends on its effectiveness, but also the solution of many socio-economic issues. These industries provide both the reproduction of fixed assets in all sectors of the production and non-production areas, and their own development.

Everyone knows that the high value of the agricultural lands surrounding the cities of Central Asia is due to its high productivity, exceeding, for example, 15-25 times the analogous indicators of Belarus and the Baltic states.

The sprawl of urban areas leads to additional capital and operating costs due to:

- lengthening of transport and engineering communications;
- increasing the rolling stock of public transport;
- growing loss of time of the population for transport movements;
- compensation due to the withdrawal of additional agriculturally valuable lands, etc.

An alternative to this process is, firstly, an increase in the density of development (construction of high-rise buildings, an increase in the capacity of objects of cultural and public services, etc.). Secondly, the rejection of the construction of single-storey garages (creating zones in residential buildings that are unfavorable from the sanitary-hygienic and criminogenic points of view, not representing architectural and aesthetic value), occupying significant areas of micro districts (more than 5% of the area of the micro district) and the construction of multi-storey garages.

In the context of the scientific and technological revolution and progress in the field of construction production, the scope of activities of an architect and urban planner is becoming more complex and expanding. Methods of architectural design and solving urban planning problems require

the improvement of the feasibility study of design problems, allowing to analyze complex urban planning problems as a whole, to ensure the strengthening of the complexity and target orientation of design and planning decisions.

For the construction of research objects, it is necessary to develop projects for organizing their networks, providing for the solution of the following interrelated problems:

- determination of the minimum required number of objects;
- optimization of their location on the territory of the city, residential buildings;
- identification of service areas and the capacity of each of them,
- moreover, taking into account a complex of serious limitations and factors (described further in the work).

The solution of the set problems is largely associated with the use of mathematical methods and CAD, which in turn increases the quality and validity of design decisions, reduces the time and labor intensity of projects. All this determines the significance and relevance of the study.

The aim of the study are formalization, mathematical modeling and creation of a system for optimizing the planning and location of a number of networks of service institutions (SI) in rural areas and cities of the Republic. The mathematical and software support of the system has developed to solve a wide range of problems for organizing an SI - analysis of existing SI networks, their reconstruction, development and design of a new network.

This aim made it necessary to solve the following problems:

- analysis of mathematical models for the location of institutions and facilities from various groups of the service institutions;
- classification of problems solved when organizing networks of service institutions;
- development of a concept for the implementation of the problems of optimizing the network of the city's SI
- development of synthesis algorithms for options for organizing networks of the investigated service objects;
- experimental testing of algorithms for the implementation of problems, using the developed and existing software tools, on specific examples of organizing a network of educational institutions in order to confirm the basic theoretical prerequisites and the effectiveness of the proposed approach.

The scientific novelty of the research consists in the creation of a toolkit for generating options for organizing a network of educational institutions in the development of a city or in rural settlements, taking into account the existing planning structure of development; in the formalization of problems and the development of a new concept for the implementation of the stated problems, the creation of effective algorithms using as an optimizer the method of determining the smallest externally stable set of a graph, the method of random search for the global extremum of multi-parametric multi-criteria functions, as well as multi-criteria evaluation of the generated variants of SI networks to identify the best one.

As you know, the service industry is broadly divided into five main groups: administrative and public, cultural and educational and entertainment, health and fitness and physical culture and sports, retail and household and mass recreation.

The structure and composition of institutions and enterprises of the public service network is determined by the specifics of this type of service, the requirements for the development of the system as a whole, the specific features of the life of the local population, the size and architectural and planning structure of populated areas.

The networks of service establishments, according to the specifics of their functioning, are divided into:

- one-tier service;
- tiered service.

Peer-to-peer service networks include a wide class of institutions and service facilities. For example, in healthcare - pharmacies, ambulances, specialized hospitals, maintenance facilities - gas distribution stations and gas distribution points, boiler houses, temporary buildings and structures on a construction site, buildings and structures of railway stations, multi-storey car parks, trade enterprises, etc.

Multilevel service networks include the following institutions: outpatient clinics and polyclinics, multidisciplinary hospitals, rural schools, etc.

Although the design of networks of service establishments solves the same type of problems, but due to the need to take into account the specifics and functioning, it is not possible to reduce them to one or a number of mathematical models.

On the basis of studying the processes of functioning of the studied networks of educational establishments (multilevel outpatient-polyclinic and school networks in rural areas; single-level - a network of multi-storey garages for individual vehicles, a network of fuel stations [1], a network of innovative type pharmacies - "Univerpharm" [2]), a mathematical apparatus is proposed generation of options for organizing networks of the SI, which is implemented by a triune problem (determination of the optimal number, loca-

tions, service areas and capacity of the SI at each service level), typical for this class of problems. Although it differs depending on the considered SI (the algorithm for determining the smallest externally stable set of a graph, the simplex method of linear programming, a random search algorithm, the method of potentials, etc.), in all cases, the pivotal algorithm is the algorithm for determining the smallest externally stable set of a graph [1][3][4][2], a modification of which was developed for this class of problems.

In the general case, the problem of locating the network of the SI is reduced to the following: it is necessary to determine their optimal number at each service level, service area and capacity (bandwidth and location).

II The mathematical formulation

of problems in this class is reduced to the following.

Many settlements (micro districts) are set $\{a1,a2,\dots an\} = A$, many residents in these $\{q1,q2,\dots,qn\} = Q$, road network with distances between nodes [L]mn, possible locations of service objects $\{m1,m2,\dots,mn\} = M$, number of settlements n. It is necessary to determine the number of service objects ξ, location of these objects xi*yi*, service areas by each object

$$\{a_1,a_2,\dots an\} = A, A_1 \subset A,$$

$$\{a_m+1,a_m+2,\dots,a_k\} = A_2, A_2 \subset A,$$

$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$

$$\{a_s+1,a_s+2,\dots,a_n\} = A_\xi, A_\xi \subset A,$$

service objects capacity (OO) – W_i.

The criterion is Φ=f(A, Q, M, V, L), where V – the need for this type of service. That is, the problem is usually multicriteria. So, when designing an outpatient-polyclinic network, the criteria are:

- capital expenditures for the construction of outpatient clinics and polyclinics of all service levels, taking into account equipment;
- total annual path of the population to visit polyclinics of all service levels;
- annual cost of maintaining the staff of polyclinics.

The problems limitations are as follows:

$$P_{min} \le P_i \le P_{max};$$

$$A_j = \begin{cases} 1, & \text{if the microdistrict is entered in the Service Zone,} \\ 0, & \text{otherwise.} \end{cases}$$

$$L_{ji} \le R, \text{and others,}$$

where P_{min} and P_{max} — minimum and maximum allowable capacity of SI; L_{ji} – distance from j -th micro district to i -th SI, R — allowable service radius.

III Problem solutions.

Problems have been formalized, mathematical models, algorithms and software have been developed that allow interactively generate options for organizing a two-level school network in rural areas, both with high and low population density [3].

The structure was developed and the database of the system was filled, which is the basis for the generation of school and outpatient-polyclinic networks in rural areas. It collects and systematizes materials on modern projects of schools, outpatient clinics and clinics (capacities, capital costs for their construction, annual operating costs for staff, equipment cost, etc.), a digital model of the road network of a rural area, tariffs for transportation of the population by buses, standards for the number of visits by the population per year to outpatient clinics and polyclinics of all service levels, demographic structure of the population, SNiP standards, etc.

A mathematical model, algorithms and software for generating a multilevel outpatient network in a rural area have been developed. One of the criteria for the considered multi-level network is the socio-economic criterion - the annual volume of population movements to polyclinics of all service levels, the algorithm of which is proposed in [4].

IV Conclusion

The developed tool for multi-level multi criteria evaluation of indicators of options for organizing networks of educational institutions and determining the best of them, including: evaluation of a set of indicators of options according to a number of optimality criteria (Wald, Hurwitz, Laplace, Savage criteria) with the involvement of qualimetry methods to evaluate the quality indicators; evaluation of indicators of options by an additive criterion, which is one of the methods of convolution of a vector criterion; evaluation of options for a number of integral ratings [3] has shown its high efficiency.

In the studied SI networks, the problem of optimization of the “Univerpharm” nertwork of stores stands out in particular [2]. Here, for economic reasons, the population in the service area of the store must live at least a predetermined number of people. Therefore, their required number is determined by the population of the city (town). They need to be optimally located on the area of an existing city, which creates a number of algorithmic and computational problems.

The main theoretical prerequisites of the research, the efficiency and technological rationality of the developed software are confirmed by the results of the problems imple-

mented on the materials of the 2 regions of the Republic of Karakalpakstan, implementation acts and copyright certificates of the Intellectual Property Agency of the Republic of Uzbekistan. The results of the study are the basis of the object-oriented instrumental system of the designer of the networks of the SI.

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