UZBEKISTAN 2030 STRATEGY OF DIGITAL TECHNOLOGIES IN E-COMMERCE

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ANNOTATION

To calculate the cost values (20), it is also required to specify the shape of the territory occupied by the city (the area of integration D), the distribution of vehicles or subscribers in this territory (their surface density w(x)), averaged parameters characterizing the difference between the lengths of paths from the shortest Euclidean distances (the function of the form factor F(x)). The ability to trace the dependence of costs on these factors shows the usefulness of the asymptotic approach.

First of all, consider the same type of expressions for L_c, $L_н$, L_0.

Obviously, the ratio of these values to the number of paths between PO N^2 makes sense of the average lengths of paths:

$$l_c = L_c/N^2;\ l_н = L_н/N^2;\ l_0 = L_0/N^2; \quad (32)$$

From the above formulas it can be seen that the placement of software on the territory of the city is uniform when zoning with permanent areas and uneven in other cases, when the software is concentrated in areas with increased vehicle (subscribers). The degree of this concentration is different for optimal zoning and for zoning with a constant capacity. Indeed, from the above expressions V(x) it can be seen that with an increase in the density of W(x), for example, by 10 times, the area of Np areas decreases in the first case by $10^{2/3} \approx 4.64$ times, and in the second case - by 10 times. Accordingly, in the high–density zone, where the majority of PO is concentrated, the connecting paths in the first case will be reduced by approximately $(10^{2/3})^{1/2} = 10^{1/3} \approx 2.15$ times, and in the second case - by $10^{1/2} \approx 3.16$ times.

From these considerations, it can be seen that for any city where the density of W(x) has a small value in the center and decreases to the periphery, the smallest total length of connecting paths is provided by zoning with constant capacities of

PO, in the longest length of these paths – zoning with constant areas of station areas.

The optimal (along the length of the paths) zoning occupies an average position. The conclusion can be easily confirmed by calculating the integral expressions L_c^1, L_p^1, L_0^1 for specific G and W(x), the difference in options depends on the specific characteristics of cities.

Let's start comparing the lengths of subscriber paths with L_c and L_a, defined by formulas (24) and (25). When replacing F(x) with the average value (see above), their ratio is equal to

$$\alpha = L_c / L_H = \int_\Gamma W(x)^{1/2} ds \,/\, \left(\int_\Gamma W(x) ds\right)^{1/2} \left(\int_\Gamma ds\right)^{1/2} \qquad (33)$$

This expression can be evaluated using the Bunyakovsky–Schwartz integral inequality [6]:

$$\int_\Gamma f(x)\, ds \leq \left(\int_\Gamma ds\right)^{1/2} \left(\int_\Gamma f^2(x)\, ds\right)^{1/2}$$

Assuming in this inequality that are valid for all functions for which there are integrals $f(x) = (W(x))^{1/2}$ we get $\alpha \leq 1$, i.e. the length of the path when zoning with constant software capacities is always no longer than when zoning with constant areas of districts.In this case, equality is achieved only when the density is constant throughout the city, W(x) = const, when both zoning options coincide.

To compare options with a minimum length of paths and with a constant RO capacity, it is advisable to make an expression of the "gain" of optimal zoning (also for a certain shape coefficient):

$$g = (L_c - L_0) / L_0 = \int_\Gamma (W(x))^{1/2} ds \left(\int_\Gamma W(x) ds\right)^{1/2} / \left(\int_\Gamma (W(x))^{2/3}\, ds\right)^{3/2} \qquad (34)$$

To study this expression to the maximum, we should find the function W(x) corresponding to the largest value of the functional (34). However, the use of standard methods of calculus of variations shows that this problem has no solution in the class of smooth functions – the gain increases indefinitely with the approximation of W(x) to the Dirac delta function [7]. To get around this difficulty, we will determine the maximum (34) with a fixed ratio of the largest and smallest values on the territory of the city:

$$g = W_{мах} / W_{мин} = W_{м} / W_{m} \qquad (35)$$

It is not difficult to verify that in this case the limit of the extremum n is reached if W(x) is equal in each or W_v or W_m. Thus, the problem under consideration leads to a "two-level" model of the city.

Suppose that $W(x) = W_m$ on the part of the city with area S and $W(x) = W_v$ on the part with area $S_v = S\text{-}S_m$. then (35) takes the form:

$$g = ((\sqrt{W}м\ Sм + \sqrt{W}m\ S_m)\sqrt{W_M S_M + W_M S_M}) / (W_M^{2/3} S_M + W_m^{2/3} S_m)^{3/2} \qquad (36)$$

Let 's introduce the notation:

$$S_M / S_m = \beta, \qquad x = q^{1/6}$$

Formula (36) takes the form:

$$g = \{[(1+\beta x^3)(1+\beta x^6)^{-1/2}] / (1+\beta x^4)^{3/2}\} - 1 \qquad (37)$$

Let's choose the area ratio so that g is maximal. To do this , calculate the derivative:

$$\partial g/\partial\beta = [(g x^3 (x-1))/2(1+\beta x^4)(1+\beta x^6)(1+\beta x^3)]\ [(x-1)(x+2)-x^4(2x^2- x+1)\beta]$$

Equating this expression to zero, we find:

$$\beta = \beta_0 = [(x-1)(x+2)] / x^4(2x^2- x+1)$$

The derivative $\partial g/\partial\beta$ at a stationary point will change the sign from plus to minus for all values of x, so that the stationary point is the maximum. Substituting $\beta = \beta 0$ in (37), we obtain the calculated formula:

$$g_{мах} = [2(x^3 + x-1)/ x(3x^2- 1)]\sqrt{(x^4 + x^3- x+1)/(3x^2-1)} \qquad (38)$$

The results of calculations of the largest gain are shown in Table 1.

The greatest gain is g_{max} and g_{kr} Table 1

g	3.333	10	33,33	100	333,3
β	0,1100	0,0910	0,0515	0,0274	0,0129
$g_{мах}$	0,0103	0,049	0,1250	0,2280	0,3790
$g_{кr}$	0,0049	0,0160	0,0320	0,0470	0,0600

The results obtained are approximated with satisfactory accuracy by a simple formula:

$$g_{мах} = 0,385(g^{1/6} - 1) + 0,405\,(g^{-1/6} - 1) \qquad (39)$$

It can be seen from the table that the gain values for other functions W(x), although with a given uneven distribution g(32), the gain turns out to be somewhat less. For example, for the territory of a city in the shape of a circle and the density $W(r) = e^{-kr}$, $r^2 = x^2 + y^2$, you can get the formula:

$$g = g_{кр} = (4\sqrt{6} / 9)[(q^{1/2} - 1)(q - 1)^{1/2} / (q^{2/3}-1)^{3/2}] \qquad (40)$$

The results of the calculation using this formula are also shown in Table 1.

The obtained very insignificant values of the gain should be additionally adjusted taking into account the fact that for connecting paths, it is more advantageous to build a network with constant RO capacities. The losses in the length of these paths for the considered cases have the same order of magnitude as the gains indicated in Table.3.1.

Conclusion. The issues of the theory of zoning and modeling "in general" on the placement of post offices in cities and other territories are considered. The obtained results provide a theoretical basis for further research of this complex problem.

Calculations show that due to the low sensitivity of the optimal zoning gain from small errors in determining the position of service centers and the boundaries of service areas, it is recommended to use a relatively simple asymptotic approach to solve the problem.

As a result of the calculation, it was found that theoretically optimal is zoning with the same total or average length of all internal routes of subscribers for all zones (generalization of the criterion of I.P.Zhdanov).

Zoning with the same number of subscribers in all zones is only a few percent units inferior to optimal zoning. A more detailed analysis showed that it is rational to use such zoning in most practical cases.

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