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# SIMULATION OF MANAGEMENT AND ORGANIZATION OF HEALTH

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# МОДЕЛЮВАННЯ УПРАВЛІННЯ ТА ОРГАНІЗАЦІЇ ОХОРОНИ ЗДОРОВ'Я

***Setting the problem***. For providing economic development first of all it is necessary to have a well-established and well-functioning health system, since the competitiveness and productivity of the state depends on overall level of population health at both the macro- and at the micro level.

Multicomponent administrative divisions, uneven level of health in the regions of Ukraine, the mismatch of resources and staff of health to the real needs of the population, that is resulted in a low level of health of certain groups, requires fundamental changes in the economy and management of the health care area.

***Analysis of recent research and publications..*** The works of many scientists, economists and practitioners are dedicated to the problems of regional health care system as a component of social sphere. In particular, a significant contribution to the development of the subject is introduced in works [1-3]. Also, the socio-economic aspects of health care at the regional level are considered in the works [4-7].

Despite the large volume of published studies describing the health sector problems, there is need for caring out the state complex activities based on the formed strategic objectives that would take into account regional differences in socio-demographic, financial, economic, environmental and other factors.

***Setting the objective.*** The tasks of the research are giving a qualitative assessment of the health level in the regions of Ukraine as well as a formation of regional development strategies of health, developing a three-level cascade model of management and organization of health care on the basis of economic and mathematical models.

The research object is the complex of the economic-mathematical methods and models that allow to carry out the analysis of the main indicators of the health.

***The main material of the research.*** Functioning of the health sector is an integral part of internal and external activities of the state. For effective management of health care at the state level, it must to be considered the following factors as medical and human resources and financial capacity, medical resources, the quality of medical care, health service quality, demographic expectations and environmental condition.

Management of health care must to be seen as a complex process that requires the participation and interaction of a large number of structural units and subsystems of the industry and shall take into account the specific problems in each level.

To achieve the objectives, reflect the objectives and instruments of health care there was developed three-level cascade model of management and organization of health care, based on the use of economic-mathematical methods and modeling and makes it possible to analyze the efficiency of field management at the national and regional level as a well as facility management level (pic. 1).

The above system is a set of levels of healthcare management. The state level of healthcare management includes strategies to improve the industry as well as establishing the socio-demographic and economic balance of the regions.

In order to minimize the costs of providing services in the medical field, at the level of regional management, there is decided a problem of optimal allocation of health facilities.

One of the key points forming a rational organization of health care is the efficient management of medical institutions, including the simulation of the performance of the health facilities, optimization of management and organization in structural health departments.
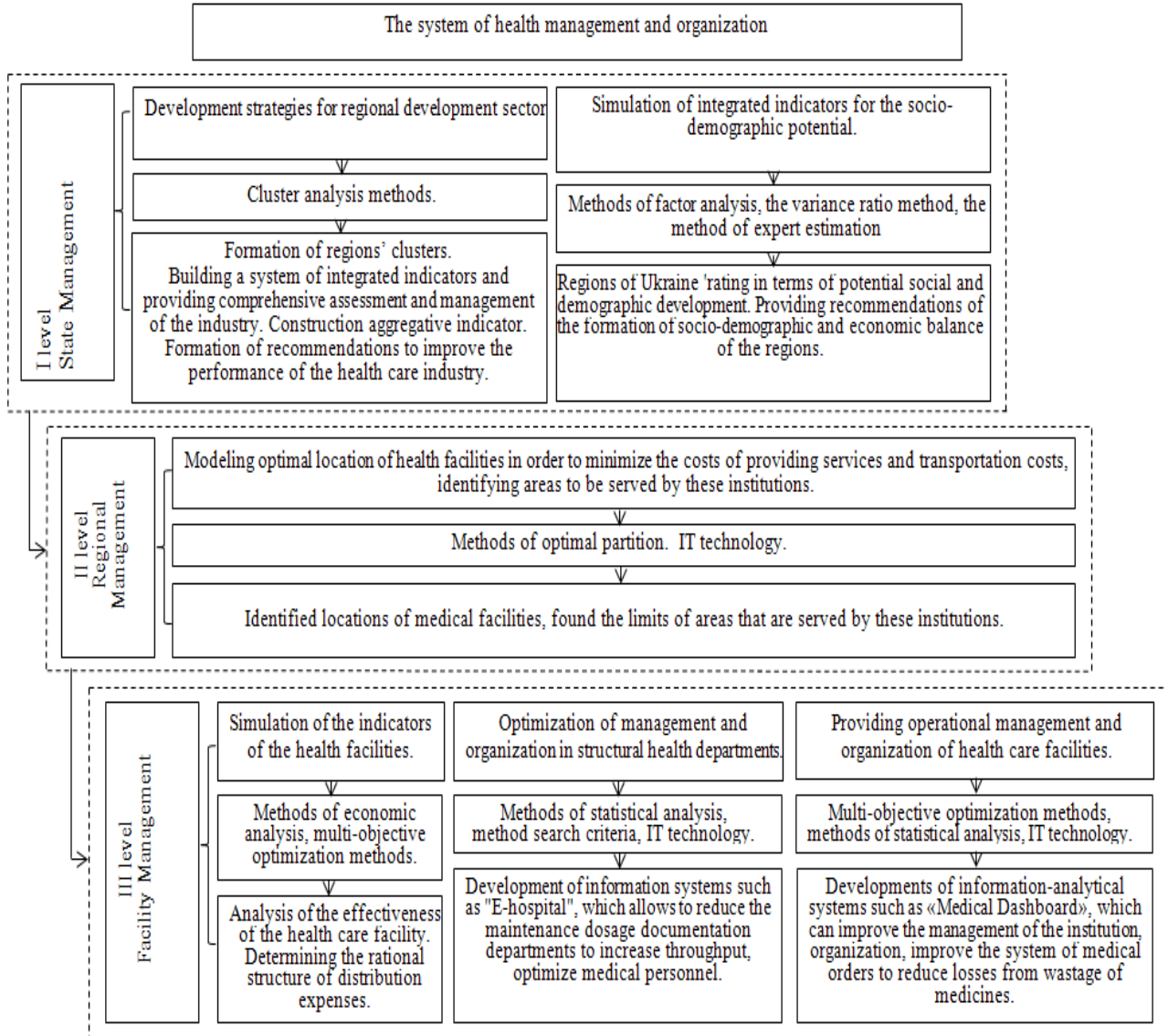


**Fig. 1Three-level cascade model of management and organization of health**
*Note: developed by the author.*

Formation and management of the health at the national level may include: the formation of clusters of regions, analysis of the association of regions in clusters, building integrated performance indicators of the health sector, the construction of model for assessing the health care level for each cluster, formation strategies, a set of measures and recommendations to improve the performance of each cluster.

The model of estimating the health level is:

$$HCI_m = \sum_{i=1}^{z} \left( \alpha_i \frac{\sum\limits_{j \in D_m} Y_{ij}}{l_m} \right), \ m=1,2,3,$$ (1)

where $HCI_m$ – the aggregate criterion for assessing the state of health m-th cluster;

$Y_{ij}$ – value of the *i*-th integral index of *j*- th object;

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$D_m$ – indices set of objects belonging to the *m*-th cluster;
$l_m$ – number of objects in the m- th cluster;
z – number of integral parameters, z = 7.

The research used statistical indicators of the functioning of the health sector in 2011 the Centre for Medical Statistics of the Ministry of Health of Ukraine [8].

Value of the health level for the first cluster HCI=59%, the second - 51% and for the third - 45%. That indicates that any cluster development of the health sector does not correspond to high level. To improve the level of health, developed a strategy on which is formed a set of measures and practical advice.

For the regions of the first cluster is proposed to apply the intensive development strategy that will improve medical and staff as well as financial potential. For regions of the second cluster is recommended the strategy of improvement the demographic situation. For regions that are in the third cluster is necessary to apply the strategy of exit from the crisis, which will eliminate the existing regional.

To investigate the efficiency of health care in the Ukraine's regions, there was made a model of the socio- demographic development potential. That made possible to construct generalized index of the social and demographic development potential of regions based on the values of integral indicators there was built rating and determined socio-demographic development condition in the regions of Ukraine. In constructing generalized index, integral indicators weights $w_i$ were determined by three methods: a modified method of principal components, dispersion method and method of expert assessments. Values of the generalized index of socio-demographic development potential Z was calculated using the formula:

$$Z = \sum_{i=1}^{m} w_i \tilde{Y}_i,$$ (2)

where $w_i$ – weight coefficient of *j-th* unified feature $\tilde{Y}_i$.

 Model equation of the generalized index of social and demographic development potential in Ukraine's regions, which received by the modified main components of Z $^{(I)}$:

$$Z^{(I)} = 0,011 + 0,249 + 0,07 + 0,195 + 0,402 + 0,135.$$ (3)

Model equation by the second method Z $^{(II)}$ is follow:

$$Z^{(II)} = 0,085 + 0,215 + 0,076 + 0,109 + 0,300 + 0,216.$$ (4)

Model equation Z $^{(III)}$ by the method of expert ratings:

$$Z^{(III)} = 0,014 + 0,201 + 0,073 + 0,176 + 0,375 + 0,161.$$ (5)

On the basis of the generalized index values there was conducted a ranking of regional socio-demographic development potential $Z^{(I)}$, $Z^{(II)}$, $Z^{(III)}$, the results of which are presented in pic. 1.
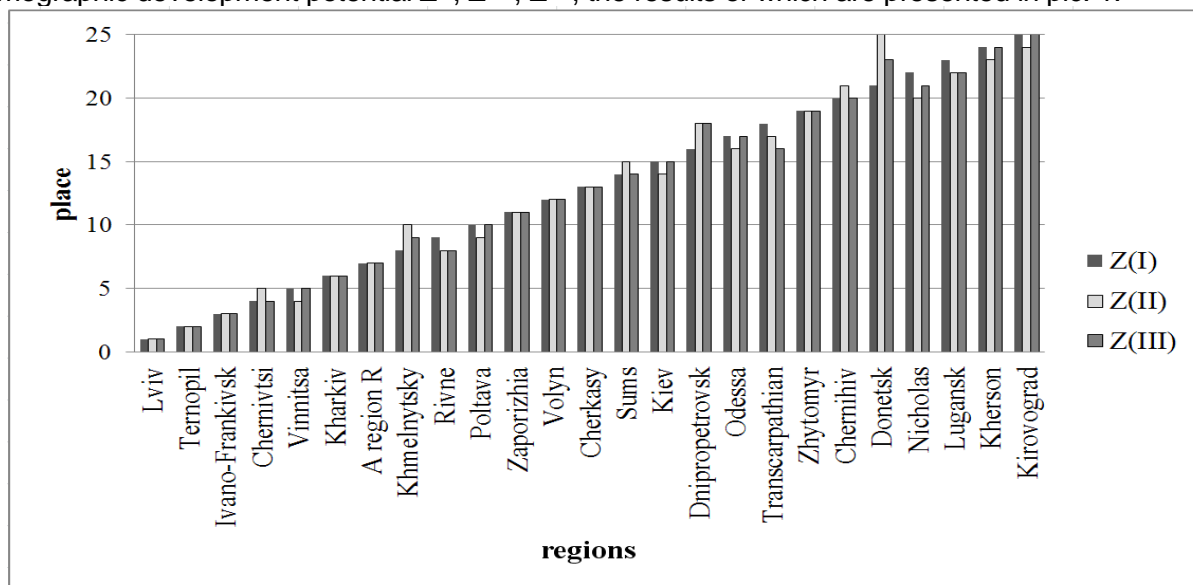


**Fig. 1. Distribution of Ukraine's regions by a generalized index of social and demographic development potential**
*Note: developed by the author.*

The analysis of socio-demographic development potential of Ukraine's regions based on the constructed generalized index showed that west regions have the highest socio-demographic development potential. That is because the index of demographic expectations has the highest weight coefficient value for all the methods that were used in the analysis. Industrialized regions have the lowest life potential where financial potential is the highest, but the worst health indicators, which can be explained by high influence of environmental pollution.

To strengthen the management decision-making in the health sector at the regional level, the problem is developed and the optimal allocation of health facilities with defined areas of service and built their mathematical models. For the task of the medical institutions of the definition of the place of their location, and the boundaries of areas to be served by them, the model has the form:

$$\int_{\Omega_i} \rho^j(x,y,t)dxdy \leq b_i^j, \; i = 1,\ldots,N, \; j = 1,2\ldots M, \; t \in [0,T], \tag{6}$$

where $\rho^j(x,y)$ – the need for the *j*-th service at (x,y) at time $t \in [0, T]$;

$T$ – time period for which the known dynamics of the services if it is not known, then lay $\rho j (x, y, t) = \rho^j(x,y,t) = \rho^j(x,y)$;

$b_i^j$ – maximum number of *j*-th services provided of *i*-th institution;

$M$ – number of services;

$N$ – number of centers.

The effectiveness of the management and organization of health care depends on efficient planning funding and optimal allocation of costs to the hospital. Also, it is important to monitor key performance indicators of medical institutions activity.

To determine the optimal allocation of expenses by using multi-objective optimization methods, it is made the model estimates the performance of the health care institutions:

$$\varphi(S_j) = \sum_i^n \eta_i f_i(\hat{S}_j) \to max, \tag{7}$$

where $\eta_i$ – coefficient of relative importance of the *i*-th local criteria;

$f_i(\hat{S}_j)$ – normalized value of the *i*-th local optimality criterion in normalized form for a possible option expenses.

**_Conclusions from the study._** As a result of research there was found sufficiently strong territorial disparities of health and socio-demographic status of the regions that is expressed both in medical resources, medical and staff potential and disparities in financial support, demographic expectations and ecological status.

The estimation of health, based on the obtained values of the aggregated criteria for the first cluster $HCl_1$ = 59%, for the second – $HCl_2$ = 51% and for the third – $HCl_3$ = 45% indicates that none of the clusters has high level of health.

That in turn requires the maintenance of a more efficient funds allocation for health, taking into account each region's characteristics and maintain more rational state policy using appropriate tools and mechanisms for the formation of the regional socio-demographic and economic balance.

According to a study presented three-level cascade model allows us to form a holistic health management, assessing the status and degree of development of the industry at all levels of its operation, and to optimize medical and economic processes on the basis of rational organization.

The use of economic-mathematical models in a comprehensive analysis of health sector development enables to form rational approaches to solution the strategic goals and improve the functioning system as a whole. That will facilitate the creation of equal conditions of access to appropriate quality health care, improvement of medical standards and socio-demographic expectations.

Thus improving the existing system of health care provision needs to formulate a comprehensive management and organization of health care at all levels of its operation.

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