System of quality indicators and the methodology of evaluation of the housing and communal service of the population

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Abstract. Developed a set-theoretic model of the problem of assessing the quality of housing and communal services population, which allows to determine the necessary components and characteristics involved in the formulation of the problem, forming the input data. For resolving the problem of redundancy of indicators to assess the quality of a procedure was developed to identify a minimum set of indicators. A procedure of the analysis of cognitive maps, including recommendations on elimination of redundant indicators.

1 Introduction

Now in the Russian Federation much attention is paid to reforming of the housing and communal services (HCS) which is carried out taking into account the wide acquired experience in the solution of problems of the housing-and-municipal service (HAMS) of the population. Social stability in regions depends on quality and uninterrupted rendering of services of the housing and communal services enterprises.

One of indicators of quality of HMO of the population is satisfaction of residents. This assessment possesses subjectivity and uncertainty of the mechanism of interpretation as not always there is a possibility of the accounting of the factors making it and estimates of their influence on satisfaction in general.

Regulation of process of formation of indicators of quality at the federal level doesn't yield successful results, from 17 target indicators and indicators established by the Federal Dwelling program, planned values are designated on 5 positions, and on 9 values aren't presented to force of inconsistency of data at all.

In the field of HMO of the population and an assessment of quality the Russian and foreign scientists were engaged in researches: I.N. Ryzhenko, D. Dzhuran, I.I. Masur, L.E. Basovsky, V. Deming, K. Isikava, A. Feygenbaum, etc.

The problem of development of the system of indicators of quality, model and technique of an assessment of quality of HMO of the population and development corresponding to this task algorithmic and the software is actual.

Housing-and-municipal organization (HMO)

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2 Main part

For complex semistructured problems and tasks in service of houses the following features are characteristic: not always it is possible to formulate a problem or a task in service of a house precisely or accurately; it is impossible to tell, what decision is correct or false, but it is possible to tell what decisions are the best or the worst in service of houses.

In actual practice the managing organization and the chairman of condominium constantly faces need of decision-making and in the conditions of semi structured, and weak and formalizable tasks, i.e. in the conditions of uncertainty when information is vague, and it is difficult to make comparison of various options of behavior

In the course of decision-making in modern conditions of the market of housing and communal services, the person the making decision (PMD), as a rule, meets the following difficulties [1]:

1. The acute shortage of time that influences carrying out detailed and comprehensive investigations of process of HMO of the population is observed;
2. There is no the reliable structured information about (HMO)(only the list of works in the contract and performance terms) that compels to use intuitive, indistinct or unreliable information about management process;

Set of the parameters of quality of service of a house and their value expected by owners, satisfying to their inquiries, will also make the value of service in DHU.

Now there is the following problem in management of houses – formation of a set of indicators for an assessment of quality of service in houses. If to estimate all system in general at the created set of indicators which was previously estimated by the principle of functional completeness as the solving range of problems in this activity, then of expense monetary and temporary can be too high. Excess expenditure aren't necessary if there is an opportunity to solve problems step by step. For this purpose it is necessary to allocate groups of situations and to designate a set of indicators, as will be the solution of a problem of estimation in management of houses.

The problem of the redundancy of indicators of the assessment of quality increasing time for carrying out monitoring and raising expenses is solved. The procedure of identification of the minimum adequate set of indicators of quality of DHU of the population using the cognitive technology based on representation of knowledge of a problem by experts in the form of a cognitive map [2,3] is for this purpose developed:

a) The expert forms the cognitive map containing types of works on service of a house representable in the form of a basic set of indicators of $RP_{main} = \{rp_1, rp_2, \dots\}$ – m of concepts of a cognitive map. On a cognitive map the direction of the cause and effect relations between concepts are designated by shooters. Further for the numbered concepts of r_{pi} , $i=1, rp$ we will define extent of influence of concepts at each other and we will construct a cognitive map. Influence of a concept on a concept is estimated in a sign form, where "+" – existence, "-" – lack of influence. For an assessment of communications between characteristics of types of works and their interference expressed to the rp_i , variable the following scheme of estimation is entered: : $rr_{pi} = rr_{pj}$ when characteristics of i -go and j -go of a type of works are identical; $rr_{pi} = -rr_{pj}$, when characteristics of a konfliktna; $rr_{pi} = 1 - rr_{pj}$, when characteristics complementary; $rr_{pi} \neq rr_{pj}$, in all other cases.

Among a set of indicators the separate indicators having the status of constants and being constants are revealed, for all others the principle of variability of influence works, and they are variables. The conditions dictated by standards and state standard specifications to carrying out measurements for engineering networks, to service of the territory, contract works belong to similar obligatory parameters of a task.

Creation of a cognitive map with a set of indicators of quality of housing-and-municipal service of the population requires definition of the relations between concepts (fig. 1). We

will define vector criterion function on a set of all admissible decisions and we will present in a general view:

$$F(rp) = (F_1(rp), F_2(rp), ..., F_N(rp)) \tag{1}$$

$$\text{where } F(rp) \rightarrow extr, rp = \overline{1, m}. \tag{2}$$

Fig. 1. Structure of a cognitive map with a set of indicators.

b) $MAT=\{mat(rp_i, rp_j)\}_{2m \times 2m}$, which elements define interferences of concepts is formed. Are defined a set of positive and negative couples of elements (rp_{ij}, rp_{ij}) and a matrix of MAT of interference of concepts. Procedure of transitive short circuit determines coordination of the relations of concepts ($MAT= MAT\ 1+ +MAT\ 2+...$).

c) The group of system indicators of a cognitive map, among which consonance, a dissonance impact of concepts on system in general and at each other pays off. It is necessary to define influence of concepts among themselves, influence of a concept on system in general and to define:

- 1. Consonance of influence of a concept of rp_i on rp_j concept;
- 2. Consonance of influence of i -go of a concept on system;
- 3. Dissonance of influence of a concept of rp_i on rp_j concept;
- 4. Dissonance of influence of i -go of a concept on system;
- 5. Impact of a concept of rp_i on rp_j concept;
- 6. Impact of i -go of a concept on system.

We form the table for values of group of system indicators for concepts (Table 1).
Values of system indicators

Table 1. Values of system indicators.

<div>influence concept</div>	consonance	dissonance	influence
Concept1	C_1	D_1	VZ_1
Concept2	C_2	D_1	VZ_2
....	...	...	...
Concept <i>i</i>	C_m	D_m	VZ_m

d) The found system characteristics allow to define on an initial set of concepts of RPmain the relation of a linear order for selection of a set of smaller power of RPmin and

elimination of information redundancy: $: |RP_{min}| < |RP_{main}|$. If we present each concept as the vector defined on a set of the received system characteristics, on an initial set of concepts of RP_{main} it is possible to separate Pareto's great number that also is by segmentation of concepts.

The subset of $RP_{main} \setminus RP_{min}$ consists of the rejected concepts, which influence on system insignificantly. The exception is made by the constants of a cognitive map declared earlier in point a.

We will present results of the cognitive analysis in fig. 2 and in fig. 3.

Fig. 2. the Cognitive analysis with hierarchical structure.

Fig. 3 the Cognitive analysis with a set of indicators

Groups of experts were allocated:

1. Residents of apartment houses;
2. Engineering group.

After carrying out poll with the first and second groups of experts processing of results is carried out. Further it is necessary to enter the indicators received during inspection of engineering systems, accounting reports, etc. At an assessment of opinions of experts questionnaires, very conveniently are often used, it is possible to distribute and after to process data. The purpose of processing is obtaining the generalized data. As a result of processing the solution is formed.

Existence, both numerical data, and substantial statements of experts results in need of application of qualitative and quantitative methods of processing of results of group expert estimation where the specific weight of these methods significantly depends on a class of the problems in management of apartment houses solved by expert estimation.

3 The integrated indicator

Depending on the nature of indicators of quality of housing-and-municipal service of the population and an objective of estimation there are two versions of the solution of formation of the integrated indicator: selective method and aggregation of information. The first option provides refusal of population in favor of selection, the second – replaces all selection with several numbers (characteristics) where statistical characteristics are distinguished both for population, and for selection. A set of admissible values of signs in DHU of both a qualitative, and quantitative look are characterized by type of a scale in which they change. Are allocated three main used like scales:

- 1. nominal or scale of names;
- 2. the serial;
- 3. quantitative (interval, scale of the relations and absolute scale).

For definition of a weight indicator all concepts of rpi are ranged by experts in a significance value where each expert ranges components on their importance.

4 Time interval

Determination of value of parameter T. This parameter T is applied to definition of a time interval in the course of an assessment of quality of housing-and-municipal service of the population. Possibly some options:

- 1. $T=<int1,int2,...intn>$ for determination of frequency of a solution in compliance with the schedule where frequency of carrying out research for identification of changes in an assessment of quality of service of a house is defined;
- 2. $T=t_{now}-t_{isl}$ an assessment of quality of service on a certain, in advance set time interval.

5 Structure of a task

For definition of structure of a problem of estimation of quality of housing-and-municipal service of the population the set of types of works of $RP=<rp1,rp2,...>$. For the solution of an objective $<Zl>$ it is necessary to conduct research on a set of indicators and to solve a problem (fig. 4).

Fig. 4 Solved problems of an assessment of quality of management of a house.

Tasks can be divided on: planned (monitoring, standard), casual (arising at the request of residents), the technique of carrying out monitoring of quality of DHU of the population allowing to formalize a problem of estimation of quality of DHU of the population, containing three stages [4, 5, 6] is developed:

- 1. At the first stage knowledge of experts and a method of collection of information is formed, and also the set of indicators according to the set problem of an assessment of quality of DHU of the population is formed. Groups of experts which included residents of houses and engineering group are allocated.

For the solution of a question of alignment of the expert estimates having various order of measurements it is offered to enter scaling of all indicators in the form of a numerical assessment on an interval $[0,1]$. For interpretation of the obtained data the verbal and numerical scale of Harrington is used.

All concepts of rpi were ranged by experts in the level of their importance, each i -mu to a concept of rpi there corresponds its weight of $w(rpi)$, and $\sum_{i=1}^T w(rpi_i) = 1$.

For drawing up system of scales for the purpose of creation of a rating of components each expert carried out ranging of components on decrease of their importance: $rpk > \dots > rpl > \dots > rpr$, where $k \neq l \neq r$ – indexes of components.

The weight of concepts of $w(rpi)$ or in advance are appointed experts, or, in the conditions of incomplete information, are ranged on decrease of their preferences with use of a formula of Fishburne. For formation of system of scales for the purpose of creation of a rating of components each expert carried out ranging of components on decrease of their importance. Initial the weight of components were determined by a formula $w(rpi_i) = \frac{2(m-i+1)}{m(m+1)}$, where m – quantity of concepts.

The described way allowed to order components on degree of their importance taking into account opinion of all experts.

2. At the second stage there is an aggregation of indicators of quality of DHU of the population and interpretation of the obtained data. The resultant indicator of quality of DHU of the population is formed depending on structure of an objective. In the presence of hierarchical structure of indicators of an assessment of quality the resultant indicator estimating achievement of the global purpose of hierarchy of $w(rp1)$ is used.

In the presence of an unstructured set of indicators of an assessment of quality of $RP = \langle rp1, rp2, \dots, rps \rangle$, reflecting its separate properties, apply integrated or vector criteria. The integrated criterion is calculated on a formula: $U = \sum_{i=1}^s c_i \cdot w(rp^i)$, where s – quantity of indicators, c_i – the parameter of ponderability, $w(rp^i)$ – rated i -go value of private criterion, $w(rp^i) \in [0,1]$.

3. At the third stage there is an analysis of the obtained data for formation by the person making the decision (PMD) of actions for improvement of quality of DHU of the population. Relevance of an assessment of quality depends on frequency of its carrying out, for example, for identification of seasonal indicators when service is actual. The analysis is carried out on the basis of comparison of the estimates of quality executed or for various objects, or to various timepoints. In the latter case depending on an objective monitoring of a set of indicators of quality of DHU $RP_t = (rp1, \dots, rpn)$ has to record a condition of quality in a timepoint of carrying out measurements of t and define change of a state towards improvement, or deteriorations for one period of measurements. The analysis of the received estimates shows when influence of an indicator of quality on system is positive. It is also possible to record the values of indicators characterizing normal or satisfactory conditions on the basis of which, defining the direction of a deviation to initiate possible managing directors of influence [7, 8].

The developed technique formation of various vectors of conditions of quality of $RP_t = \langle rp_t^1, rp_t^2, \dots, rp_t^n \rangle$ $RP_{t+1} = \langle rp_{t+1}^1, rp_{t+1}^2, \dots, rp_{t+1}^n \rangle$, They differ in time of carrying out measurements of t .

Defining each vector as alternative from a set of the generated alternatives, it is possible to make the analysis of a set of alternatives, comparing current state of RP_t :

- with a condition of RP_{t-1} , recorded before carrying out the operating influences;
- $RP_{t-1}, RP_{t-2}, \dots, RP_{t-p}$ – group of the states measured for p of the previous periods;
- with the state characterizing a standard or "ideal" condition of quality of RPID.

So for two possible conditions of quality of $RP_t = \langle rp_t^1, rp_t^2, \dots, rp_t^n \rangle$ and $RP_{t+1} = \langle rp_{t+1}^1, rp_{t+1}^2, \dots, rp_{t+1}^n \rangle$, is possible to enter function of distance of $\rho(RP_t, RP_{t+1})$, using various metrics:

– Euclidean metrics of $\rho(RP_t, RP_{t+1}) = (\sum_{i=1}^n (rp_{t+1}^i - rp_t^i)^2)^{1/2}$;

– uniform metrics of $\rho(RP_t, RP_{t+1}) = |\sum_{i=1}^n (rp_{t+1}^i - rp_t^i)|$.

If $\rho(RP_t, RP_{t+1}) < \Delta$, where Δ it is beforehand set, a deviation isn't essential and this site isn't problem. Otherwise additional research of a site for identification of the possible reasons of deviations is required.

It is also possible to compare conditions of uniform objects of the measurements taken in t timepoint. For example, to compare quality of cleaning for several houses.

Using a method of an ideal point, on the basis of the entered functions of distance, it is possible to determine degree of proximity of current state of quality of RP_t with standard RPID: $\min_{t=1, \dots, n} \rho(RP_t, RP^{ID})$.

Frame representation. The knowledge base containing frames for formation of the cause and effect scenario is developed for management, collecting, storage, search and delivery of knowledge of solution of problems of DHU by managing organization. Knowledge of procedures is offered to be stored in a type of the simple frames or functional frames containing simple frames. Some characteristic types are distinguished from them:

1. FrK – the conflictness frame describing deviation situations from the normal modes: the reasons leading to their emergence, ways of detection of atypical situations and ways of their localization;

2. FrProd – production frame describing the relationships of cause and effect necessary for achievement of the end result – the purpose of management;

3. FrStr – the frame of structure describing structure of concepts and indicators by which this process in object of management and the end result of impact on it by the system is described.

For replenishment of the knowledge base the process of formation of frames, an assessment of indicators, formations of the operating influences attached to a problem of identification of the reason of decline in quality of utilities is offered. Slots of frames are: value of an indicator, the reason, a consequence, regularity that reveals the factors influencing emergence of an emergency. On the basis of the knowledge base the optimum set of actions for decrease in risk of accidents and their consequences is defined [9, 10].

The offered technique of an assessment of quality of housing-and-municipal service of the population was approved on managing organization. By comparison of the used technique of an assessment of quality of housing-and-municipal service of the population to the offered technique of an assessment the following tendencies were revealed: reduction of time for carrying out research for 60%, expenses inspection of a house was reduced by 50%.

6 Conclusions

The set-theoretic model of a problem of an assessment of quality of DHU of the population allowing to define necessary components, and characteristics participating in a problem definition, formation of entrance data is developed. The procedure of identification of the minimum set of indicators using the sign cognitive maps constructed by experts was developed for solution of the problem of redundancy of indicators of an assessment of quality. The procedure of the analysis of cognitive maps including recommendations about elimination of excess indicators on the basis of the ordered set of concepts of a cognitive map which is again created linear is developed. The technique of carrying out monitoring of quality of DHU of the population which main stage is the analysis of current state of the

quality expressed in a vector or scalar look is formulated. The group of methods of comparison of the come into fortune with retrospective, or standard states is offered. The efficiency from introduction of the developed technique of an assessment of quality of housing-and-municipal service of the population which is shown in reduction of time for carrying out monitoring and decrease in costs of inspection is defined.

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