Peculiar features of the monitoring system for housing and utility complexes renovation

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Abstract. A monitoring system is a special system ensuring monitoring, control and assessment of in-service wear of elements of housing and utility complexes (HUC), determining their compliance with the areas of human life safety in different environments taking into account environmental, economic and other requirements. The main purpose of the monitoring system is to determine and provide for parameters and their permissible combinations during the renovation of HUC facilities under the analysis.

1. Introduction

Numerous studies of the development of the Actual World show that it is integral and its integrity is formed and developed, adjusted and interconnected according to the laws of nature, the composition and mechanisms of which ensure the improvement of their system work. If we consider the work of Earth as an agent of the Solar System, then scientists note that over the past 2.5 billion years it has kept its mass within 98\% due to the development of its internal structures based on information-genetic and noosphere-intelligent systems. A person who participates in the development of these processes exchanges resources by only 20-30\%. It is clear from this that man-society is in the zone of risks and self-destruction. Consequently, great contradictions persist between the activities of Earth and a man (according to A. Tymon, A. Tarasov, A. Stephen Honing, D. Uyler, physiocratic fathers of theoretical economics, F. Aquinsky, F. Romada, M. Moiseev and many others). The mankind on Earth has been developing following strategic multi-stranded flows of natural resources exchange through their closed cycles. These flows are formed under the influence of the following two self-regulating systems:

1) The information-genetic environment is used by nature to provide a complete closed cycle of resource exchange. In this case, information is manifested for all the elements of infrastructures necessary to create the integrity of both astro-regions and agency formations.

2) The noospheric intelligent environment is formed by nature through the development of consciousness and the ability to effectively complicate. In the spheres of development of biological and sociobiological formations, their consistency should cover all stages of the development of strategic multi-legged energetic integral systems based on intelligence, creativity, consciousness.

So, M. Keynes, when studying the laws of nature, came to the following conclusion: “The master-economist must possess a rare combination of gifts .... He must be mathematician, historian, statesman, philosopher - in some degree. He must understand symbols and speak in words. He must contemplate the particular, in terms of the general, and touch abstract and concrete in the same flight of thought. He must study the present in the light of the past for the purposes of the future”\textsuperscript{1}.

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The General Assembly of the United Nations often pays attention to this approach towards the selection and assessment of human activity in nature today, the search for effective ways of sustainable human development in nature. So, for example, this problem was mentioned by the President of the Russian Federation V. Putin: “It should be about creating fundamentally new nature-like technologies that would not be harmful to the outside world, but would exist in harmony with it and would allow to restore the balance between the biosphere and the technosphere violated by man. It is indeed a planetwide challenge. I am convinced that to respond to it, a person has sufficient intellectual potential”.

In this regard, V. Vernadsky wrote: “Environmental literacy requires systemic thinking in terms of the relationships between people and processes. Systemic problems rely on truths that were tested and proven many times. This is, first of all, an attitude towards the world around us, which does not contradict the principles of scientific search reflecting on the repeatedly verified and confirmed truth. This is the basis of the noospheric nature of consciousness, intelligence.

But even in our time the assessment of the effectiveness of human activity is often not taken into account in closed cycles of resource exchange in nature. This can be seen from the tactical countermeasures of activity in the natural environment according to some used countermeasures, i.e. replacement of the strategy of closed cycles with the tactics of their elements.

1) Market economy tactics:
   Despite the scientific discovery of the principles of the nature economics, the mutual relations between informational genetic and noosphere-intelligent vectors of system development are implemented according to individual factors of production of goods, provision of services, cycles of strategic vectors of human activity systems development and activities of nature for the joint exchange of resources in closed cycles [1-2]. A market economy is based on the principles of freedom of entrepreneurship and selection, distribution of resources, exchange and consumption of goods and services, supply and demand, universality of profits and costs.

2) Price tactics
   Price indicators are reflected in money and bonds according to the "commodity-money-commodity" scheme. The tactics of partial accounting of effects by individual blocks of sustainable human development in nature, etc [3]. As noted above, resources exchange under conditions of sustainable human development in nature amount up to 98%. In a tactical market economy this effect is within the exchange of resources equal to 20-30% of their use.

   In this regard F. Romada came to the following conclusion: "No one will deny the fact that only radical changes in the relationship between a man and nature will allow us to avoid the fate of the Dinosaurs".

2. Materials and Methods
The peculiarities of the monitoring system for housing and utility complexes renovation include a special information and analytical system for the observance, monitoring and assessment of the quality of renovation that meets the forecasts of environment changes to improve its quality at minimum costs (Figure1) [4]:
Monitoring during the renovation of housing and utility complexes requires the use of scientific, methodological and rational methods of its assessment (Table 1). In the process of monitoring, modernizing and improving the state of housing and utility complexes, special attention should be paid to the scientific and technical description of the goals and methods of increasing the efficiency [5].

The monitoring system of the housing and utility complexes includes the solution of tasks in the following main areas:

- Determination of the scope of repair and restoration works.
- Economic feasibility of complexes self-preservation.
- Analysis of faults and failures of buildings and elements.
- Research and forecasting of the service life of structures.
- Calculation of works on the repair of elements of housing and utility complexes.
- Building preservation strategy.
- Repair and technological repair of buildings.
- Effectiveness of ensuring the safety of elements of housing and utility complexes.
- System of monitoring of social environment in-service wear.
- Database creation [6].

In the theoretical foundations and regularities of the backbone monitoring of housing and utility complexes it is recommended to determine minimum values and restrictions related to the main resources and procedures:

1) Forecasting over time of flows of production of all types of building resources.
2) Determination of minimum values of steps to advance the preservation of building structures.
3) Optimal combination of economic use and wear of building structures.
4) Optimizing effects over time [7-8].

In the course of operation of housing and utility complexes two types of wear risks can be distinguished: socio-economic ($A_1$) and technical ($A_2$) risks.

The total risk in this case will be equal to the sum $S_i = A_{1i} + A_{2i}$, i.e. as the sum of wear risk curves (technical risks ($A_1$) and socio-economic risks ($A_2$)) [9].

Figure 1. System for the monitoring of housing and utility complexes in-service wear taking into account the maximum costs.
Table 1. Scientific methods that are part of the monitoring system for housing and utility complexes.

| Method name                                              | Types of monitoring                                                                                                                                                                                                 |
|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitoring of housing and utility complexes               | Observation - perception of construction and technical expert review objects in order to study their purposeful development over time                                                                                   |
|                                                          | Description - indication of distinctive features and changes in the parameters of the object under the influence of material and reliable evidence of its integrity preservation                                              |
|                                                          | Comparison - comparison of properties and features of individual objects with variable parameters                                                                                                               |
|                                                          | Experimental observation - study of the parameters of an object by means of active targeted actions when comparing its properties, characteristics of actions, etc.                                                                 |
|                                                          | Modelling is carried out by replacing the original object with the corresponding model, which is created as an analogue (in the form of devices, systems, phenomena, processes)                           |
| Mathematical models for the monitoring of housing and utility complexes | Cybernetics is the science of the theory of mathematical description of the state of monitoring                                                                                                                          |
| Cybernetic monitoring methods                            | New information technologies based on the search for comparisons and automatic data processing by means of computer modelling                                                                                        |
| Morphological analysis of monitoring                     | Comparison of the parameters of changes in the properties of an object (shapes, sizes, deformations of structural elements, parts of a whole) and defects on the surface and in the volume that arise during the manufacture and interaction of objects |

Figure 2. Nature of changes in the components of the acceptable risk.
If $S_2$ is the total wear, then the total risk area will be equal to:

$$E_2 = A \frac{T_1 T_2}{T_1} \left( \frac{T_1 T_2}{T_1 + (T_2 - T_1)} \right) = A \frac{T_1 + (T_2 - T_1)}{T_1} + A \frac{T_2}{T_1}$$

(1)

As it can be seen from the model, effects $E_i$ will decrease due to additional costs $A_1$ and, on the contrary, increase due to costs $A_2$.

Organizational and economic management and development of housing and utility complexes is a structure of aggregate principles and methods of purposeful impact on the quality of the results of their operation taking into account the interval between repairs and the state of the surrounding operating environments using a monitoring system for renovation objects (Figure 3) [10 - 11]:

**Figure 3.** The diagram of comparison of theoretical (2) and statistical (1) values when assessing the distribution of $A_1$ and the probability of failure-free operation of $B_1$ when monitoring the operation of the housing and utility complex in the human environment: Architectural and planning solutions, Service life of housing and utility complex facilities Economic levels of productive activity, Ecological levels of human environment development [12].

Asymmetry and probability $P_i$ values of the forecasted processes are determined based on the areas of combination of theoretical values (2) and forecasted (statistical) values during the distribution of $A_i$ and kurtoses (for example, failures) $E$ [13].
3. Result section
Monitoring systems are usually divided according to the following criteria:
- Division of the housing and utilities infrastructure into regions and areas.
- Development of operating conditions for housing and utility complex facilities [14].

To reflect the total effects of theoretical and statistical values of monitoring systems, it is advisable to use:
- Mathematical expectation of failure-free operation of the housing and utility complexes:
  \[ \overline{X} = \frac{\sum_{i=1}^{n} x_i}{n} \]  
- Root-mean-square deviation:
  \[ \sigma_X = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \overline{X})^2}{n}} \]  
- Indicators of asymmetry and kurtosis:
  \[ I_x = \frac{\sum_{i=1}^{n} (x_i - \overline{X})^3}{n \sigma_X^3} \]  
  \[ E_2 = \frac{\sum_{i=1}^{n} (x_i - \overline{X})^4}{n \sigma_X^4} - 3 \]  
- Coefficient of variation [15]:
  \[ V_X = \frac{\sigma_X}{\overline{X}} \]  
- Measures of deviation of theoretical and statistical distribution values. According to K. Pirsan, who proved the correspondence of theoretical and statistical values when analysing their totality:
  \[ X^2 = \sum_{i=1}^{n} \left( \frac{P_{ci} + P_{pi}}{P_{T1}} \right)^2 \]  

4. Conclusions
1. Nowadays we can say with confidence that a man and society are agents of the Actual World, which achieve the maximum accumulation of the energy of nature, including on Earth, in the "space and time" system. P. Kuznetsov wrote: "The evolution of living nature is dominated by processes that lead to an increase in free energy, which is true for all forms of life".
2. The construction of the activity of a man, society, civilizations should proceed from the systemic principles of natural self-preservation: ecology, energy, biosphere, noosphere, creativity, intelligence. L. Bertalanffy noted: “What is past is prologue”. A system is a set of interacting elements being in relationship with each other and their natural environment.
3. In order to achieve sustainable human development in nature through closed cycles of resource exchange, it is proposed to perform the following activities:
   - It is advisable to create an International Chamber of Experts on Sustainable Human Development in Nature.
   - Develop a theoretical basis for training experts in sustainable human development in nature.
   - Provide for a training program for experts.
   - Conduct a systematic analysis of monitoring of the activities of countries and regions with respect to sustainable human development in nature through closed cycles of resource exchange.

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