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Management and safety of the roofs the buildings of the historical buildings of the city of Odessa (Ukraine)

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Abstract. Any general process of managing an immovable object of a historical building consists of the individual management of interdependent processes: organizational, labor, information and others. It is proposed to create in the city of Odesa the "Corporate scientific and technical complex of urban planning and energy reconstruction "*CSTC T-PPR*" as an innovative organizational structure that in practice uses the accumulated scientific and technical potential for the reconstruction of historical buildings. buildings of the city of Odesa according to energy efficiency standards. The calculation of the predicted average service life of roofing made of metal tiles for decorating parts of some buildings of the historical buildings of the city of Odesa that are being reconstructed, 1820...1920, was performed. The received result much less than standard service life for the given kind of a metal tile (T_{st} = 20 years); T_{av} = 141,2 months ≈ 12 years depend on a considerable quantity of random factors, including from quality of civil and erection works.

Keywords: Management quality assessment, management expertise, operation of buildings, roofs, organizational structure, a complex of urban planning and energy reconstruction, an immovable object of a historical building.

1. Introduction

The housing stock of the city of Odessa is quite diverse [1, 2]. Such diversity is due to the change over time of such characteristics and parameters as purpose, architectural and planning decision, configuration in the plan, availability of engineering networks, number of floors, location of the building on the site, and others. All these signs have undergone significant changes over time due to the development of capacities and capabilities of the construction base, functional requirements, construction traditions and trends [3, 4].

An economic criterion for the preservation and modernization of an existing building is a comparison of the construction of old buildings with new ones that have similar town-planning, technical, and architectural-planning characteristics (area of location, degree of improvement, capitalization, number of floors, etc.). In this regard, for the economic assessment of each old building, it is necessary to take into account the general mode of reconstruction in the given territory, that is, the density and reliability of the building, its functional and historical and cultural [1, 2].

The value of the historical environment and territory in the central part of Odessa imposes a number of restrictions on the location, size, configuration, architectural solution of the building, the technology of the work, which leads to a 1,5...2 times increase in the price of new construction and, accordingly, increases the economic expediency of preservation and modernization of old buildings [1, 2, 5, 6].

Therefore, it is proposed to create in the city of Odesa the "Corporate scientific and technical complex town-planning power reconstruction "*CSTC T-PPR*", as an innovative organizational structure that uses in practice the accumulated scientific and technical potential for the reconstruction of the buildings of the historical development of Odesa according to energy efficiency standards with the involvement of foreign experience [1, 2]. The criterion for preserving and modernizing an existing building is a comparison of the construction of old buildings with new ones that have similar town-planning, technical, and architectural-planning characteristics. As an economic criterion when determining the general regime of reconstruction, the efficiency of the use of the territory is taken into account. The final technical and economic analysis is based on cost documentation and comparison with analog reconstruction projects [7].

2. Analysis of recent research and publications

Reconstruction is a continuous process that varies in each city depending on the former growth and modern requirements [1, 3, 8-11]. This determines the significance of the city as a historical phenomenon in which different eras are intertwined [3,4,12]. The main tasks of reconstruction include extending the service life of buildings, as well as eliminating physical and moral wear and tear, improving living conditions [3], equipping residential buildings with modern engineering equipment [10], and improving operational characteristics [9, 13, 14], increasing energy efficiency [15] and architectural expressiveness [1, 3, 4, 16].

The economic assessment of the progress of work is the basis of the assessment of construction management [2, 7, 16-20]. Management expertise is defined as a study of the quality of the management process and making a motivated conclusion about it, which is used for the purpose of further influencing both the management object and (or) the management subject [18]. The main purpose of management expertise is to assess the quality of the management system as a whole, that is, the entire set of elements, namely: the subject and the management object, connected by information flows circulating between them.The pragmatic goal of management expertise is to increase the efficiency and quality of real estate management at all stages of its life cycle. The conclusion of the quality of the management process should either confirm trust in the subject of management (accredit him), or express distrust of him (not accredit). Therefore, the subject of management examination is the analysis of the quality of management.

The determining factor of any process in general and the management process in particular is time [18]. That is, the study of any process means the dynamic fixation of its essential characteristics over time [7, 16, 19]. The set of dynamic characteristics of the management object is conventionally defined as a management trajectory [21]. The planning trajectory of management is based on the actual determination of the initial state of the object of management and the expected forecast of its state in the future.In the general case, that is, under the influence of unaccounted environmental influences, there will be a discrepancy, or, in other words, divergence, between the planning state of the management object and its actual characteristics. The magnitude of the discrepancy between the actual state and the planned state is, on the one hand, the basis for a conclusion on the quality of management, and on the other hand, the basis for making the appropriate management decision. A systematic approach that focuses on a comprehensive assessment of all essential characteristics of the management object is important for management expertise.

The tasks facing management expertise follow from the analysis of general management functions. Regulatory influences due to such general functions as planning, organization and regulation are transmitted directly from the subject to the object of management. Information about the state of the control object is transmitted via feedback (control function).

Description of the development of the construction project is an informationally complex process, because it depends on a large number of characteristics affecting it [7, 16, 17, 19, 21]. Therefore, at the planning stage, a modeling methodology is used, which predicts the change of not all, but only part of the process characteristics [21]. Any model cannot be completely identical to the original, especially since in the considered situation the original can only appear in the future. In general, the considered control models are homomorphic, because the ambiguity of their display, unlike isomorphic models, acts only in one direction. It follows that the model of the management process can more or less unambiguously determine the future properties of the original, but the regression (return or projection) of the properties of the original to the initial characteristics can have multiple interpretations. However, despite the fundamental proximity of models of management processes, they (albeit often qualitatively) allow to systematically describe management objects and plan management decisions on this basis.

Thus, through the modeling methodology, the management entity performs general management functions. Therefore, the main goal of management expertise is the task of analyzing models:

- construction planning as a management process;
- organization of its resource support;
- process implementation control;
- regulation, as a process of direct influence on the object of management.

As a rule, the modeling of management processes allows for their certain multivariation [18, 22]. However, in practical terms, one of the possible models is used for a specific situation, which must satisfy the following most important requirements:

- maximizing the adequacy (relevance) of the original;
- adaptation (adjustment) to changing conditions, i.e. its reliability over time;
- effectiveness both in achieving the goal and in terms of costs associated with its use.

3. Inclusion of the historical center of Odessa in the UNESCO list

The cultural heritage of the city of Odessa is an integral part of the cultural heritage of Ukraine and the world cultural heritage. The historical center of the city of Odessa has preserved a unique planning structure with world-famous architectural ensembles and monuments of cultural heritage of local and national importance and has a high value as a whole. There are 1,354 monuments and objects of cultural heritage on the territory of the city of Odessa, including 42 monuments of national importance, of which 1,012 objects are located in the Central historical area of the city of Odessa, including 977 buildings-memorials elements of architecture and urban planning, history of national and local importance [6]. A significant number of objects in the historical center are unique monuments of history, urban planning and architecture, monumental art of national and local importance, many of which are a kind of visiting card of the city. Preservation of valuable authentic historical buildings, especially in the core of the historic center of Odessa, where a significant number of monuments and objects of cultural heritage of a wide stylistic range are located, plays an important role in increasing the investment and tourist attractiveness of Odessa, has a great influence on the further development of the city.

The long-term exploitation of the infrastructure of the city economy and the lack of a responsible approach to its timely maintenance over the previous decades led to the unsatisfactory state of many historical buildings in the central part of the city, which, in turn, causes the threat of losing the integrity of the perception of the historical environment in the Central Historical Area of the city, and also carries the threat of facade elements collapsing. Solving problems related to the preservation of historical buildings, maintenance, repair and restoration of objects is a necessary and permanent task, which is closely related to solving the problems of reforming and developing the city's housing and communal economy. It is necessary to carry out current repair and restoration works of monuments of architecture, history, and monumental art in a timely manner, as well as to constantly maintain them in a proper technical and aesthetic condition. Further implementation of measures to preserve historical buildings, continuation of repair and restoration works and capital repairs of facades and roofs of buildings, most of which are monuments, can normalize the problem of deterioration of their technical condition every year.

Due to the threats that have loomed over the city since the beginning of the russian aggression, the World Heritage Committee resorted to the emergency procedure provided for by the Operational Directive for the Implementation of the World Heritage Convention, at an emergency meeting in Paris on Wednesday (January 25, 2023) decided to inclusion of the historical center of Odessa in the World Heritage List. This decision recognizes the outstanding universal value of the site and the duty of all mankind to protect it. The historic center of Odesa is also included in the List of World Heritage in Danger, which gives it access to increased technical and financial international assistance, which Ukraine can request to ensure the protection of the site and, if necessary, help in its restoration [5]. Streets, buildings and other objects that have signs of multiculturalism were added to the main list. In particular, this is the ensemble of Primorsky Boulevard, Teatralna Square, Deribasivska, Gogol. Odesa Sea Trade Port was also included in the List [6]. Inclusion in the main UNESCO List is, first of all, the preservation of our historical heritage, but it is also an impetus for the development of tourism, because the city will be included in the world tourist routes, and this, in turn, will have a positive effect on the economic indicator.

4. Modeling the quality management of the roofs of immovable objects of the historical buildings of the city

4.1. The purpose of the study

It is proposed to create the "Corporate scientific and technical complex of urban planning and energy reconstruction "*CSTC T-PPR*" as an innovative organizational structure that uses in practice the accumulated scientific and technical potential for the reconstruction of historical buildings according to energy efficiency standards with the involvement of foreign experience and to investigate the methodology of the projected average life of roofing coverage of immovable objects of historical buildings of the city of Odessa.

4.2. Research methods

Modeling the function of the quality of management by the predicted service life, the method of least squares, as well as universal methods of statistical modeling.

4.3. Modeling of the predicted average service life of the roofing

In connection with the inclusion of the historical center of Odessa in the UNESCO World Heritage List, it is necessary to make calculations of the projected average service life of structural components and the building as a whole. To obtain these data, the operational departments of the “Corporate Scientific and Technical Complex for Urban Reconstruction of the Power Industry "*CSTC T-PPR*" should create a scientifically sound collection of information about shortcomings and failures of projects, about their development within the established time frame.

And buildings as a whole are judged on the operational characteristics of building components for their reliability. The main reliability indicators: the failure rate parameter $\lambda(t)$, the reliability probability $P(t)$ and the probability density $f(t)$ are determined, grouping statistical data on failures by time base. For an initial assessment of the reliability parameters, statistics on the need for repair of components can be used, since the need for repair is usually the result of failures.

The primary operational organizations, based on the inspection results, keep records of the need for repairs of building structures and engineering equipment. Mathematical processing of this statistical material makes it possible to obtain quantitative indicators of operating time parameters: $\lambda(t)$, $P(t)$, $f(t)$.

To determine the percentage of failures of certain structural elements, it is necessary: to determine the volume of operational failures and their development over time (the countdown starts from the year of manufacture or the year of the last overhaul); calculate availability parameters;

f(t) = the saved up amounts of works / total amount of works; (1)

λ(t) = volume repairs for a year / total amount of works; (2)

$P(t) = 1 – f(t)$ (3)

In 2020…2022 the finished parts of some historical buildings of Odessa built in 1820…1920 were reconstructed. The roof of these tin buildings was replaced with metal tiles [1].

Let's perform the calculation of the predicted average lifespan of a metal tile roofing (using the least squares method). 23,870 m^2 of metal tile roofing was examined in 10 historical buildings. From the analysis of defective metal sheets, it was calculated that failures were observed in these buildings: after 12 months on an area of 168 m^2; after 24 months’ additional failures were registered on an area of 240 m^2; after 36 months the same for 310 m^2; after 48 months – by 388 m^2; after 60 months – by 455 m^2; and after 72 months – by 515 m^2. Using this data, the frequency of roof failures can be determined at six points over time:

$F(t) = n_o/N,$ (4)

where N – quantity all surveyed elements;

n_o – quantity the given-up elements by the moment t.

On value $F(t)$ it is defined statistical probability non-failure operation $P(t)$ and corresponding to it quintile normal distribution on also it is made out in the tabular form (tab. 1).

Frequency refusals *F(t)*:
In 12 months: 168/23870 = 0,007;
In 24 months: 0,007 + 240/23870 = 0,017;
In 36 months: 0,017 + 310/23870 = 0,030;
In 48 months: 0,030 + 388/23870 = 0,046:
In 60 months: 0,046 + 455/23870 = 0,065;
In 72 months: 0,065 + 515/23870 = 0,087.

Table 1. Definition quintile

№ points	Time *t*, month	Frequency refusals *F(t)*	Probability non-failure operation $P(t) = 1 - f(t)$	Quintile, u_i
1	12	0,007	0,993	2,457263
2	24	0,017	0,983	2,120072
3	36	0,030	0,970	1,880794
4	48	0,046	0,954	1,6871868
5	60	0,065	0,935	1,5152825
6	72	0,087	0,913	1,3600501

The concrete value service life registered while in service, can be presented as [2]:

$$t_i = T_{av} - u_i\sigma \quad (5)$$

where T_{av} – average service life an element;
σ – average quadratic a deviation.
Proceeding from it, we will write down system of the equations:
$12 = T_{av} - 2,46\ \sigma;$
$24 = T_{av} - 2,12\ \sigma;$
$36 = T_{av} - 1,88\ \sigma;$
$48 = T_{av} - 1,69\ \sigma;$
$60 = T_{av} - 1,52\ \sigma;$
$72 = T_{av} - 1,36\ \sigma;$
Let's combine the equations term by term: $252 = 6T_{av} - 11,02\ \sigma$,
Whence $T_{av} = (252 + 11,02\ \sigma)/6$, month
Following a way the least squares, we multiply each member the made equations on corresponding quintile.
We receive new system the equations:
$29,49 = 2,46T_{av} - 6,05\ \sigma;$
$50,88 = 2,12T_{av} - 4,5\ \sigma;$
$67,71 = 1,88T_{av} - 3,53\ \sigma;$
$80,99 = 1,69T_{av} - 2,86\ \sigma;$
$90,92 = 1,52T_{av} - 2,31\ \sigma;$
$97,92 = 1,36T_{av} - 1,85\ \sigma;$
Let's combine the equations term by term: $417,91 = 11,03T_{av} - 21,1\ \sigma;$
Let's substitute value T_{av} in the equation and we will define a root-mean-square deviation:
$417,91 = 11,03\ ((252 + 11,02\ \sigma)/6) - 21,1\ \sigma;$
$417,91 = 463,26 + 20,26\ \sigma - 21,1\ \sigma;$
$0,84\ \sigma = 45,35; \rightarrow \sigma = 54$ months.
Let's define average service life a roofing covering from a metal tile:
$T_{av} = (252 + 11,02 \times 54)/6 = 141,2$ months ≈ *12* years.

5. Conclusions

(1) It is proposed to create the “Corporate Scientific and Technical Complex of Urban Planning Energy Reconstruction "*CSTC T-PPR*" as an innovative organizational structure that will use the accumulated scientific and technical potential for the reconstruction of historical buildings in practice according to the standards. energy efficiency.

(2) The presented model for assessing the quality of management is appropriate, since it is based on the modern concept of assessing the effectiveness of investment projects. This model basically has the property of adaptability. However, for an optimal effect, time must be taken into account. And finally, the model is effective because it allows you to dynamically evaluate the result of management activities and make sufficiently detailed forecasts for the development of the management process.

(3) Calculation of the predicted average service life of metal roofs for the finishing parts of some reconstructed buildings of the historical development of Odessa in 1820...1920 was carried out. The result obtained is well below the standard lifespan for this type of metal tile (T_{norm} = 20 years); The average life of the element $T_{av} = 141,2$ months ≈ *12* years depends on a variety of random factors including the quality of construction and installation work.

6. Future research

Relying on our own work on the architectural and constructive solutions of the attic floors of residential and public buildings of historical buildings in Odessa, taking into account the priority of reconstruction of attic spaces without changing the type of roof to preserve the architecture of the historical buildings of Odessa, as well as the possibility of using existing load-bearing roof structures with their satisfactory technical state, as a rational (optimal) type of mansard floor, in the future, the type with the spatial organization of the mezzanine floor at the two-level development of the upper floor of the base building (in the form of external walls) with external drainage should be investigated. Access to such an attic floor is carried out from the premises (requires the installation of additional vertical communications). This option is also possible with the formation of a separate floor on the same level.

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