Scheduling of Processes and Results of the Reorganization of Construction Objects Building Constructions, and Their Internal Rooms

R R Kazaryan¹, V A Khvan¹

¹ Department of Technology and Organization of Construction Operations, Moscow State University of Civil Engineering (National Research University), 26 Yaroslavskoe shosse, Moscow, 129337, Russia

Email: vitalykhvan95@gmail.com

Abstract. Systematization of scientific research and their elements imply that the purpose of scientific research is comprehensive study of an object, process or the phenomenon, their structure, communications and the relations on the basis of the principles again found or known to science and methods of knowledge, and also obtaining and implementation in practice of a construction reorganization of objects buildings high-rise constructions and their internal rooms of results of a research of technogenic impacts, useful to the person, and the new methods of the organization of a labor activity and its elements corresponding to these results. Feasibility and need of modeling of technogenic impacts as important element of management of a construction reorganization of objects for the purpose of providing competitiveness of the proposed organizational technology solutions, it is caused by a variety of reasons: ● fixed increase of scales, complexity and interrelations in systems that leads to increase of complexity of objects of management; ● increase in uncertainty in knowledge of real-life technogenic impacts because of intentional or accidental misstatement of information; ● dynamics of change of political decisions or economic country situation, legal and legal base of activities; ● change of patterns of ownership and increase in responsibility of the owner for results of activities; ● moral and physical aging of an active part of business assets and housing; ● change of the status of the person in system when often it is considered not as the determining component and as an account resource. These reasons increase relevance of forecasting of technogenic impacts, planning of methods of their accounting and management of them for the purpose of achievement of necessary level of competitiveness of the proposed organizational technology solutions of a reorganization of objects.

1. Introduction

Scientific and technological progress, as well as increasing requirements in the volume and complexity for the functioning of the domestic construction industry, determines the current trends in construction science [1,2,3,4,5]:

● Development of competitive new technologies and improvement of existing ones, organizational forms and structures, methods and means of production of works on new construction and reconstruction of existing buildings and structures of civil and industrial use;

● Theoretical and experimental studies of the technological processes efficiency for the erection and reorganization of construction objects;
Identification of modern patterns and trends through modeling and optimization of organizational and technological building solutions;
Development of new methods and improvement of existing methods of organizational and technological design of new construction and reconstruction of previously erected buildings and structures;
Increasing the managing efficiency of the organizational and technological design of the reorganization processes, and its subsequent implementation.

The quality of the erection or construction reorganization of the facility starts, mainly, at the pre-project stage. Therefore, it is important at this stage to have a maximally concretized image of a new or re-arranged object and ways of real achievement of the required quality, timing of implementation and the degree of conformity to the level of modern consumer properties.

At the end of the last century, our country formulated the problem of developing an integrated model (a virtual building object) that collectively reflects the necessary qualities of the future object. Such a model was proposed to be organized as a structure of indicators, criteria for their evaluation and the interrelationships of all components in a set of characteristics of a building object. The actual development of virtual models of re-built and newly constructed construction projects was started only at the beginning of the 21st century by the construction industry. The model of the virtual building object has to ‘accompany’ the building object throughout its life cycle, but at the pre-project stage it is the most relevant [4,5,6].

2. Materials and Methods
The purpose of the scientific research and virtual modeling of a building object and erecting or rearranging construction industry is a comprehensive study of the object, process or phenomenon, their structure, connections and relations on the basis of newly discovered or scientifically known principles and methods of cognition. The result of such a study is the receipt and introduction of new methods of organizing labor activity and its elements into the practice of construction industry [4].

The tasks of virtual modeling include:
- Analysis of existing domestic and foreign developments of virtual models for the erection or construction of facilities;
- Analysis of existing domestic and foreign methods of organizational and technological design of erection or constructional reorganization of buildings and structures;
- Study of the characteristics of control systems for the erection and construction of buildings and structures;
- Modeling of the objective function (criterion) of management at the pre-project stage of erection and construction of buildings and structures;
- Development of organizational structures and technologies of construction industry in relation to the selected object-representative of erected or rearranged buildings and structures;
- The formation of a methodology for the development of elements of technical, technological and organizational support for the management of the erection or constructional reorganization of buildings and structures, taking into account certain technogenic impacts.

The indirect or direct impact influencing a natural system, which is inherent in technology, as an artificial system (which is the result of human thought activity, then realized in its productive activity), is called technogenic. This impact inevitably leads to changes in the parameters of human functioning and his environment. Such changes are registered organoleptically (using sensory organs of the person, i.e. sight, hearing, touch, smelling, etc.) or revealed in the process of instrumental diagnostics or computer monitoring.

Expediency and the need to model technogenic impacts as an important element in the management of the building reconstruction of facilities in order to ensure the competitiveness of the proposed organizational and technological solutions are due to a number of reasons:
- Constant increase in the scale, complexity and interrelationships in the systems, which leads to an increase in the complexity of the control objects themselves;
- Increased uncertainty in the knowledge of actual technogenic impacts due to intentional or accidental distortion of information;
- Dynamics of changes in political decisions or economic situation in the country, legal and law framework of activities;
- Changes in ownership patterns and increased responsibility of the owner for the results of operations;
- Moral and physical aging of the active part of production assets and housing;
- A change in the status of a person in the system, when often he is viewed not as a determining component, but as an expendable resource.

These reasons increase the urgency of predicting technogenic impacts, planning methods for their accounting and management with the aim of achieving the required level of competitiveness of proposed organizational and technological solutions for the reorganization of facilities [3,4,5].

3. Results

Concepts and definitions related to the field of technogenic impacts modeling are not established; they are in the stage of formation; therefore, there are different versions of the definitions of the same concept [1-6].

Simulation of hard-to-formalize and expertly estimated control factors for building reconstruction of objects is performed for a fixed set of objects that are compared in pairs in terms of their preference (desirability, importance, etc.); and the results of the comparison are written as a matrix of paired comparisons $A = \{a_{ij}\}_{n \times n}$, reflecting the emerging binary ‘preference / indifference’ relation on the $X$ set. Elements of the $A$ matrix are imposed with additional calibration constraints (power-lawful calibration using inverse-symmetric matrices in the Bern-Brook-Burkov object ordering model, based on the hierarchy analysis method, etc.), clearly linking in pairs symmetric $a_i$ and $a_j$ elements.

The solution of the problem is a process of gradual setting of priorities, that is, numerical estimates of the importance (weight) of the element along the whole set of assessments that are consistently attributed to the elements of the hierarchy in a particular situation. All elements of a certain level $k$ of a simple hierarchy of criteria, factors, solutions or alternatives affect any element of the level $(k=1)$ and through them affect elements of higher levels of the hierarchy. The measure of this influence is shown by the priorities of the elements that are quantitatively estimated by the experts’ assessments that pair and match the elements of one level in points, filling the square ‘matrix of assessments’. Assessments placed in $A$ matrix are considered ‘perfect’, and the matrix itself is ‘consistent’ if for all values of $i, j$ and $k$ the condition $a_{ik} = a_{ij} \times a_{jk}$ is valid. For any ‘triad’ (three-point logics) of perfect assessments, the law of logical consequence (transitivity) acts: if $C$ follows from $B$, and $D$ follows from $C$, then $D$ must follow from $B$.

If

$$w_{ij} = (w_i / w_j) \times O$$

for all $i$ and $j$, then all assessments are perfect and the matrix is consistent. Then

$$Aw = \sum_j (a_{ij} \times W_j) = (n-wi) = nw,$$

where $w = (w_i)$ is the $n$-dimensional significance (weights) vector, $\lambda_{\text{max}} = n$ is the Frobenius number, i.e. the highest modulus of the simple eigenvalue, and $w$ is corresponding to it the unique eigenvector of the $A$ matrix (up to a constant factor).

For any matrix, its trace (the sum of the diagonal elements) is equal to the sum of the eigenvalues $\sum_{ij} = \text{Sp} A = \sum a_i$ (in the left sum each $a_i$ is taken taking considering its multiplicity). Therefore, for any inversely symmetric matrix $\sum_{ij} = n$, and for the matched matrix all $e$ eigenvalues, except for the Frobenius number, are zero (since $e$ rank is one).

Another problem is the sufficiency and completeness of the quality assessment of activity in functional systems for the erection and constructional reorganization of facilities. Kurt Godel’s incompleteness theorems state that in theory the attempt to ‘describe’ (formalize and evaluate) a
system (as a set of elements that are in relationships and connections with each other) from within completely and consistently at the same time is doomed to failure.

There are true, but unprovable, judgments and controversial questions, the answers to which are required to be sought outside the system under investigation. In practice, the ‘descriptions’ of the structure, interrelations and technologies of the system’s activities that regulate the level of the quality of its functioning are the result of an arrangement on the limitations organized by the methods of ‘consensus’ (consensus, unanimity of participants in the discussion when adopting the ‘description’ as a whole) or ‘imposed consensus’, similar to the administrative-command rationing.

In the infography, the procedure for organizing such a ‘description’ is simulated by a triad (three points) as a compromise between three interrelated concepts. Most often, the ‘need-opportunity-sufficiency, NOS’ and ‘sufficiency-completeness-redundancy, SCR’ triads are used.

The system ‘man-technology-environment, MTE’ models functional systems of construction industry, forms their internal ‘descriptions’ as a compromise of these triads, demonstrates a sufficiently high level of quality of functioning. Therefore, the question of the relationship between the concepts of ‘sufficiency’ and ‘completeness’ of the MTE system descriptions is relevant, as well as the construction of a basic infographic model on which these two concepts can be distinguished [1-3].

In order for the local MTE system could be unambiguously formalized and evaluated, it must be considered as a subsystem of a larger construction production system (metasystem). The system can be on an intrasystem level: stable, steady (self-sufficient); not stable, not steady; on a non-systemic (suprasystem) level completely formalized, partially formalized.

4. Discussion
Diagnostic models are the models of technogenic influences, the research and use of which provide information on the causes of the identified problems. Using such diagnostic models, by analogy with dynamic infographic models of monitoring the parameters of the system and its components, dynamic series (sequences in time) of the predicted retrospective values of the parameters of technogenic impacts are constructed.

Visual displays of such dynamic series (infographic models) are known as ‘trends’.

Forecasts of possible man-caused impacts and their results with regard to the functioning of the system as a whole or its individual components allow, with their evidentiary reliability, to minimize the time and money spent on the choice and justification of the most competitive organizational and technological solutions for building reconstruction of facilities (including a person, as an element of the labor construction process and the priority component of the system).

Such forecasts are distinguished by:

- Depth level (methods of functional, structural or parametric prediction, as well as complex methods);
- type of information (expert, functional-logical, structural, mathematical, complex forecasting or forecasting based on engineering diagnostics and intellectual monitoring of the system);
- The period of ‘anticipation’ (operational, short-term, medium-term, far-term and long-term forecasts).

Each of these systematizations implies a separate approach to the choice of a method for predicting technogenic impacts in the system.

When analyzing the possibility of technogenic impacts in the process of building reconstruction of the objects in terms of the degree of the conditions certainty, the following types of modeling methods are distinguished:

- Ones with deterministic (certain) conditions;
- Ones with random conditions having one of the known probability distributions;
- Ones with uncertain conditions, in which a reasonable opponent counteracts (intentional technogenic impact).

Processes of organization and technology of interaction of system components that act as elements of the labor process of construction industry, which have been sufficiently studied, can be
mathematically modeled and implemented, given the often encountered limitation: the possible intentional distortion of information [2-6].

The complexity of solving the problem of predicting the effect of technogenic impacts in the process of building reconstruction of facilities on the competitiveness of the proposed variants of reorganization raises the need for a phased consideration of the factors contributing to the achievement of the necessary level of competitiveness, which include:

- Ensuring the reliability of the ‘man-technology-environment, MTE’ system;
- The use of a comprehensive innovative approach to the reorganization of facilities;
- Prioritization of system components;
- Development of information technology for engineering diagnostics of habitat, including fixation and mapping of technogenic impacts in the reconstructed buildings;
- Development of mathematical and infographic models of the impact of technogenic factors and changes in human functioning in the system.

The most significant influence is rendered by:

- Increasing the variety of modeling methods generated by the growing number and complexity of objects and practical tasks of building reconstruction (currently there are more than one hundred methods, and acquaintance with them by searching takes time that the engineer may not have in the new business environment);
- Increasing ‘mobility’ (dynamics) of the market environment.

To ensure multi-criteria scheduling for the use of the organization resources of the reorganization of construction projects, it is necessary:

- To form a systematic approach to the scheduling of construction industry, taking into account the influence of external and internal factors of construction industry, the entire possible set of resources involved and based on the cybernetic management model;
- To systematize the types of calendar ‘plan-schedules, PS’ used and methods of scheduling;
- To substantiate the basic principles of constructing dynamic models of construction industry, taking into account the simulation of the parameters of the construction system: the expedient use of a favorable period of the year and the minimization of real working time resources.

In the process of such optimization, the PS developer or specialist, who performs the function of monitoring the progress of the planned PS of construction and installation works, binds the real parameters of the reorganization to the normalized values of normative documents.

The process of formation of object calendar PS is divided into several successively executed stages. They are:

- Collection, processing and analysis of raw data in the form of regulatory parameters and constraints;
- Making decisions on the degree of detail and the results of assessing the reliability of the parameters;
- Formation and calculation of variants of object scheduling on a normalized scale;
- Adjustment by transferring the object calendar PS from the normalized to the real time and the resources used scale;
- Multi-level optimization by the most significant criteria and resources by calculation and / or expert methods;
- Final formation of the project calendar PS taking into account all the above-mentioned stages and taking it as the basic optimal deterministic one.

The most important requirement of a complex calendar PS is the inadmissibility of work stoppage (freezing of any of the construction objects considered in it); this is due not only to the inevitably arising violations of technology and the organization of construction production, but also to economic losses.

These violations and losses are leveled out in different ways, identifying and implementing:
Different dependencies between the timeframes for the production of CIW and the required resources of working time, as well as between the duration and cost of restrictions;

- Making decisions on the degree of detail and the results of assessing the reliability of the parameters;
- Forming and calculating variants of object scheduling on a normalized scale;
- Making adjustments by transferring the object calendar PS from the normalized to the real time scale and the resources used;
- Performing multi-level optimization of the most significant criteria and resources by calculation and / or expert methods;
- Finally forming the project calendar PS taking into account all the above-mentioned stages and adopting it as the basic optimal deterministic planning document.

The periods of deployment of subsequent construction and installation works (CIW) in real time and used resources scale are determined by linking the normalized values to the calendar time, taking into account their effect on the actual duration of the construction work.

Dependences between the calendar terms of CIW production and the necessary resources of working time, between the duration and the cost of CIW allow us to formulate two optimization tasks that require defining the scheduling parameters. They are:

- Production of construction and installation work, under which the cost of work is minimal;
- The construction industry, in which the minimum resources for the implementation of construction and installation work, will be achieved.

5. Conclusions

For scheduling, the utility of various permutations consists in the formation of flows with minimal reserves (breaks); these reserves can also be used to reduce the number of contractors. Algorithm for the formation of PS, based on the solution of inconsistent time and resource constraints by the method of uncertain resource coefficients, allows optimizing the number of CIW performers and allows reducing the risk of untimely performance of CIW. As a result of the studies conducted, the exponential distribution of random work durations is justified, which not only reflects the untimeliness of the CIW implementation, but also makes it possible to obtain an array of random durations based on a single statistical parameter, which is the average untimely performance of the work.

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