Modelling of organizational and technological parameters of the informational model of municipal infrastructure facilities subject to reorganization

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Abstract. This article describes constructing methods of an information reorganization facility model based on parametric mathematical methods. The principles of reorganization parameter selection at the stage of municipal infrastructure facility pre-operation are described. The algorithm of information model building of facilities reorganization, as well as information model of organization processes of reorganization are being shown.

Introduction

The main goal of using the information modelling technology at the stage of facility reorganization is to collect data and documentation including all the resources and project solutions from the previous stages of the building lifecycle. According to this technology, information model in the process of building reconstruction is available for the analysis, and then for introduction of reasonable modifications [1].

A significant number of facilities in the municipal environment system are project-oriented, with the possibility to use the advantages of their parameterization [2-4]. Consequently, having undergone slight changes, they can be reused in similar projects involving historical sites reconstruction. Currently, most of the simulation information models of historical sites are created for the purposes of one project. It is necessary to extend the existing modelling technology using modern approaches and technologies (including software) to create more realistic and informative models [5].

Organizational and technological parameters of the information model of municipal infrastructure reorganization facilities will be the models of functional necessity in the facility reorganization, constructional wear, organizational and technological processes. The goal of an ideal reconstruction informational model is a workflow automation for reconstruction (or other types of remodelling) of buildings and constructions. This approach will allow to estimate explicit costs, as well as time and labour costs for buildings reconstruction as early as at the stage of facility pre-operation (figure 1) [6,7].

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Functional modelling of municipal infrastructure reorganization facilities allows to determine facility parameters and represent them in a form of the informational model, which reflects the processes of selecting the required organizational and process parameter. Mathematical modelling includes three interconnected stages: preparation of mathematical description of a facility under study (physical, regime, physicochemical and structural parameters); selection of a method of solving the mathematical descriptions equation system, and its implementation in a form of simulation program; compliance establishing (model adequacy to the facility) [8].

Creation of generalized building information model based on BIM-technology at the planning stage of a building lifecycle is the main tool to increase the efficiency of the organisational process of reconstruction (municipal environment reorganization). While creating the functional model of municipal infrastructure reorganization facility, it is possible to prepare a work description of the created system and analyse actuality of the upcoming improvements, modifications, amount of the necessary costs of all types of resources, as well as to most accurately coordinate work of subsystems. One of the common methods of solving this problem is a parametric design (or just parameterization) based on a model creation using parameters of model elements and correlation between these parameters [1, 6, 9].

All software systems involved in particular projects have their own model variants. To store the parameters of model elements, a database of geometric parameters of facilities; physical parameters of facilities; assigned (allocated) parameters of facilities should be formed. The parametric model of a building integrates three-dimensional model and elements behaviour model (edit history). All the construction documents are formed based on such informational model [10]. The model documentation is updated automatically when the smallest changes are being introduced. The agreed model modification reminds of the table cells change, the values in which are assigned by formulas. The formulas allow automating the calculations, and parametric modelling systems of the buildings automate the building documents acquisition.

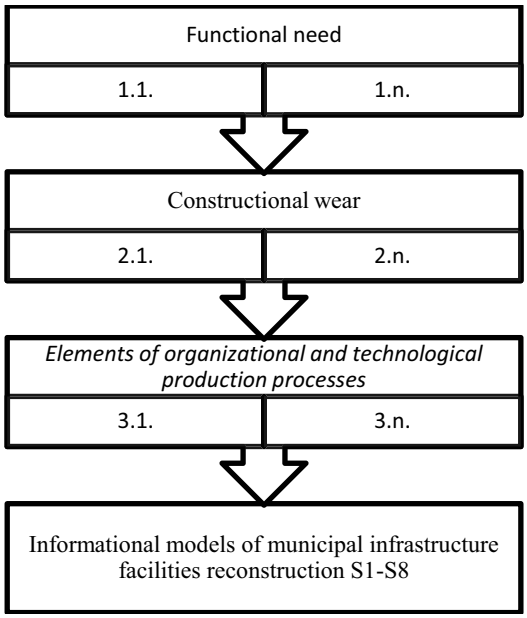

Fig.1. Algorithm of building the informational model of facilities reorganization

In the process of hierarchic parameterization (parameterization based on scheme history), "scheme tree" is formed for all the model elements with their decomposition into elements (a group of elements – element). Variational, or dimensional, parameterization is based on sketching (with application to the facilities of a sketch of different parametric correlations) and application by the user of restrictions in the form of equation systems determining connections between the parameters [11].

Mathematical model of parametric design of generalized building information model is determined by: *Ni* elements set and {*D1, …, Dn*} set of design decisions.

$$Ni = (E, P, Vr, C, R, Pr, cf), \text{ where} \quad (1)$$

E – is a set of structure elements {*e1, …, en*};
P – is a set of parameters {*p1, …, pn*};
Vr – is a parameter values set {*V1, …, Vn*}, where *V*i={*vi1,…, vin*} is each parameter value set;
C – is a value constraints set {*c1, …, cn*};
R – is a set of requirements for {*r1,… , rn*} model;
Pr – is a set of preferences {*Pri,…, Prj*};
cf – is a global cost function.

Ei structure element determines a primitive element of the design model. The *pi* parameter is a characteristic of the *i* structure element. Each parameter is connected with the range of *vi* values predetermined by a set of values assigned in *pi*. There are *m* possible values for the parameter and *n* parameters. The total amount of the design space is *N* = *m**n. The values of functionally dependent parameters are uniquely determined by functional dependencies or requirements. Functionally independent parameters are called the key ones, and their values are determined by degrees of freedom in the design process, i.e. the actual size of the design space [12].

For each specific type of reorganization, informational model (Figure 2) of organizational processes, functional requirements and the level of constructional wear is formed [13].

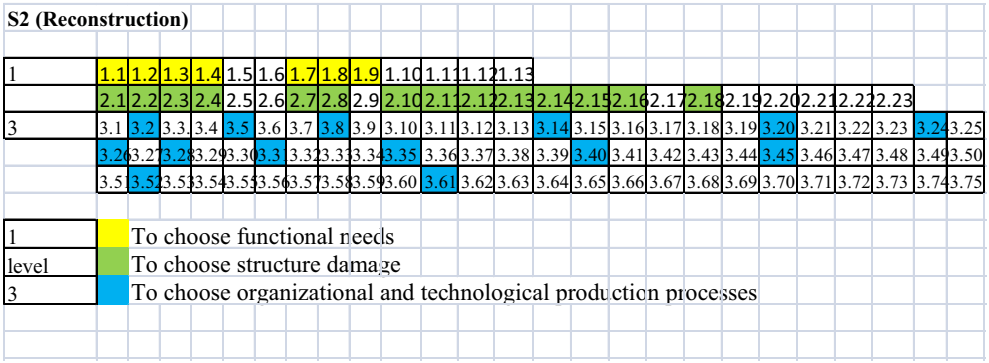

Fig.2. Informational model of reconstruction organizational processes

Conclusion

BIM-Manager enters the required modification parameters to the building information model, determines the hit ratio of the selected parameters with the results received on

levels. He gets chains – modules for each of the reorganization types, which allows preparing documents for achieving the objectives and needs of the modifications made.

Informational model of municipal infrastructure reorganization facilities based on BIM-technology includes all project lifecycle phases (taking into account operation process and possible building reconstruction) [14]. That is why the main task of BIM-Manager is to develop a working automated system with proven efficiency, which is required in the process of operation of a building and its systems. Such automated system should be based on the information received at the previous stages of the building lifecycle [15].

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