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Complementary assets in the methodology of implementation unified information model of the city environment project life cycle

Andrey Volkov[a], Olga Kuzina[a]* ,

[a]*Moscow State University of Civil Engineering (National Research University), 26 Yaroslavskoye Shosse, Moscow, 129337, Russia*

Abstract

This article contain comprehensive data of completing the functional, complementary unified information model, based on the technology of building information modelling for creation city environment through the whole lifecycle of the building. Each stage of lifecycle contains its own functional information as a part of unify complementary information model. Complementary unified information model for the executive stage of engineering to complete the documentation are also describe. Complementary unified information model for the stage of facility management presented within the model of life support systems including processes of utility management.

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Keywords: functional inforamation model; complementary assets; city environment; facility management; utility management; parameterization; systems of indicators; automated system

Introduction

To create city environment for stable development in the nearest future we should understand that the most appropriative way is to collect and then implement information from different levels: physical, engineering, legal, economical, and ecological. In such approach, this scope of information could be applied effective, fast, clear and could be rather easy for users.

* Corresponding author. Tel.:+7-916-841-2869.
E-mail address: kuzinaon@mgsu.ru

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For such requirements, there is suitable software and methods of data representing. Building information modelling (BIM) is a process of creating the unified model (UM) involving different complementary assets.

Complementary assets are architecture, structure, MEP, technological, organizational and economical models. Assets are complementary to each other when an increase in one asset increases the investment effect of the other. Complementary assets are mutually enhance effectiveness (Figure 1).

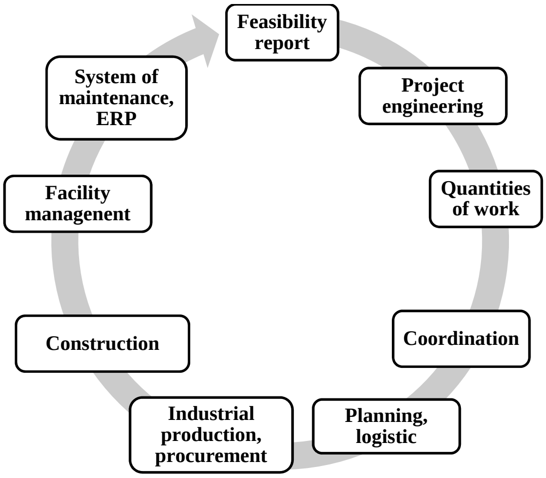

Figure 1. Complementary unified information model for the whole life circle.

In other words, the complementary assets need developing together as it is in unified model.

If the model created by the designer, and then refined throughout the project, then it has a chance to become a "real" model. In this model all specifications will be included, the operation and instructions for operation and maintenance, and warranty information to the stage of facility management in the future. It also allows the owner to assess the cost-effectiveness of any proposed changes.

1. Complementary unified information model

For the perfect model, the operation manager should collect data for information model through the all stages of the project life cycle.

Planning stage:

- Investment planning
- Financing modelling
- Business-planning

Executing stage:

- Process management
- Engineering (including calendar planning)
- Procurement
- Construction
- Object commissioning
- Operation

Clothing stage:

- Redevelopment
- Decommissioning.

1.1.Planning level.

Planning process consists of the processes carried out to determine the total content of the works, conduct and clarify goals and develop an action sequence required to achieve these goals. During the planning process project management plan and project documentation must be developing. The complex nature of project management creates a feedback chain for further analysis. Additional planning may be required upon receipt and interpretation of more information or characteristics of the project. Significant changes occurring throughout the project life cycle, leads to the need to revisit one or more of the planning processes and, possibly, to the initiate of processes. This consistent detailed project management plan is often called «rolling wave planning», indicating that planning and documentation - recurring and ongoing process.

The main purpose of planning is the integration of all project participants to perform a set of works, ensuring the achievement of the project results. Planning is a set of actions, providing for the objectives and parameters of the interaction between work and organization of parties, the allocation of resources and the choice of other organizational, technological and economic solutions that ensure the achievement of the project objectives.

1.2. Executing level

At the executive stage manager should consider all the processes from the complementary unified model (Figure 2).

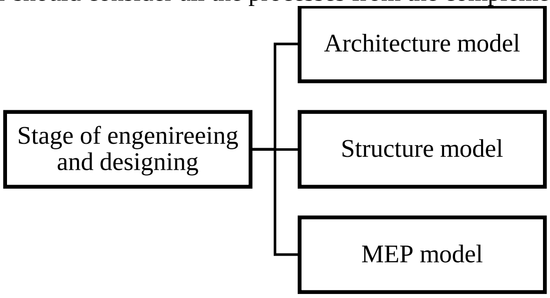

Figure 2. Complementary unified information model for the executive stage of engineering to complete the documentation

After the forming the engineering model the designer (or BIM manager) should collect and add organizational, technological, economical information in the unified model of building [1].

The most sophisticated stage – is the stage of facility management. During the construction phase, it is necessary to control the processes of construction and development of executive documentation.

At the end of construction management company should establish information and electronic data bank for the current object, based on the technical documentation or Complementary unified information model based on Building Information Modeling technology, which will contain input data, and system of appointments (systems of indicators) [2].

1.3. Facility management level

During the life cycle moderator (facility manager) must add quantitative and qualitative changes in the systems of the object. Terms and forms of data application should be fixing by standard documentation. The sensors transmit and record data on the operation of the building, so that the building information model can evaluate the energy efficiency, track costs throughout the life cycle and optimize them.

The main objective of the specialist from laboratory of modeling and integration of intelligent building engineering is simulation, testing of safety scenarios and power saving algorithms of each life-support systems of the future building both in standard and in alarming situations (flooding, fire, broken links, no operator's workstation in the workplace, unauthorized access to the system, etc.)[3].

In the process of simulation Building Management Systems (BMS) is designed and its subordinate life-support systems (Figure 3).

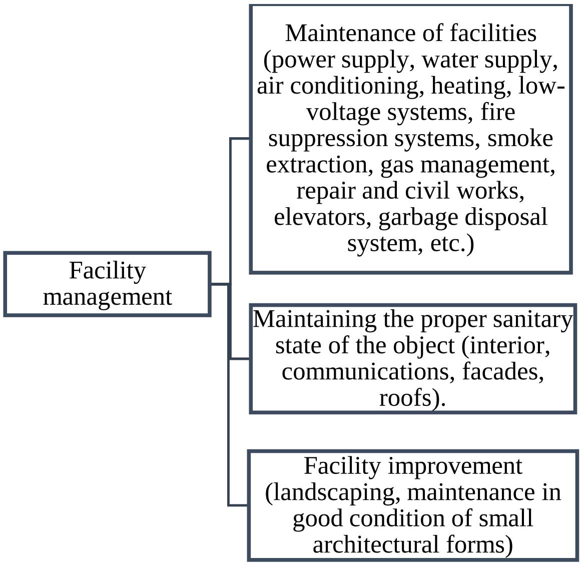

Figure 3. Complementary unified information model for the stage of facility management

The operation company clarify its requirements for technical, operational and performance characteristics of each building life-support systems. After completion of the model, during engineering and construction stages, the operation manager receives the technical design of equipment and integrated building life support systems that optimally meets all the requirements of the environment, energy efficiency, safety and ergonomics of intelligent building, as well as the cost of its operation and maintenance [4].

The most important issues are faced on the BIM manager are mapping of the inherent logics and algorithms, automated model updating.

2. Utility management integration into complementary unified information model (Figure 4)

To improve the quality of life in a whole it is necessary to input in the unified information model data of indicators of each utility system of building (heating, ventilation, air conditioning, security control, access control, fire alarm and fighting, tracking of people and equipment, power supply control system, indoor and outdoor lighting, guaranteed power supply). Process of operating and management facilities and utilities includes monitoring of utilities, security and automation of network operation, registration of accidents, calculation of energy, change the current settings, automated systems management [5].

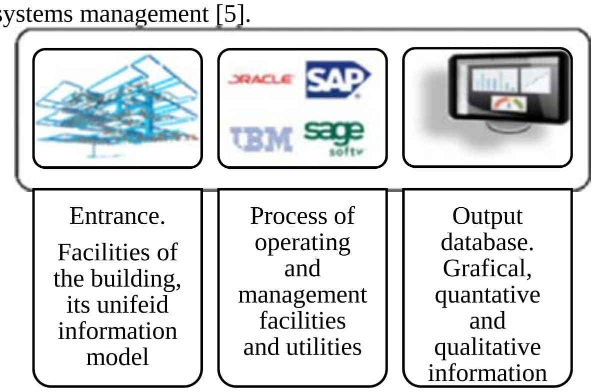

Figure 4. Complementary unified information model of utility system during the facility management stage.

Complementary unified information model in facility management should base on project one, but content data for further operating, for the next stage of lifecycle [6].

3. Parameterization in modelling process

Parametric design (or parameterization) bases on the creation of the model using the parameters of the model elements and relationships between these parameters. All software systems, involved in a particular project, have specific models with particular options. For the purpose of elements storage, projected model parameters database contains: geometric object parameters (size, volume, etc.); physical object parameters (mass, the material physical constants, etc.); assigned (appointed) object parameters (name, cross-section, marking, codes, etc.). A parametric building model integrates three-dimensional model (geometry and data) and model of elements behavior (edit history). The entire working documentation completed on that base. All changes update automatically. Consistent change model resembles the change table cells whose values given by the formulas. Formulas allow us to automate the calculation and parametric modeling systems of buildings automate obtaining construction documents. A mathematical model of parametric design generic building information model, defined by plurality of components Ni and plenty of design decisions models.

$$Ni = \left\{ Ei; Pi; Ri; Di; Ci \right\},$$

where Ei - set of structure elements $\left\{ E_{1.....i} \right\}$; Pi - set of parameters $\left\{ P_{1...i} \right\}$; Ri - set of requirements and restrictions for the model $\left\{ R_{1....i} \right\}$; Di - set of preferences $\left\{ D_{1....i} \right\}$; Ci - cost function. Structure element defines a primitive element of the design model. The parameters reflect the value of element. Each parameter is associated with a range of values. The values of parameters identified by functional requirements and restrictions. Desire or preferences of the customer or the whole system are also reflected in an equation. Parameterization principles of modern software allows information model be invariant to change the format of different software systems.

Key advantages to apply information modelling in approach of complementary assets as a unified information model:

- To see and understand the whole model from different aspects;
- To reduce the number of errors in the design decisions, errors due to poor coordination between builders and designers;
- To choose the best possible design options from alternative;
- Wide range of possibilities for analysis and simulation;
- To use operational model based on project one;
- To control the cost of construction by directly considering all the changes;
- To work on complex projects;
- To support decision-making during all the stages through the life circle [7].

Complementary unified model, based on BIM, are involved in all phases of project lifecycle, including maintenance and reconstruction. Therefore, the main purpose of BIM managers is to create working automated system with clarify effectiveness to provide further operating life of a building and its systems. That system should take information database, which has collected during the previous lifecycle stages. And the huge subject is to connect software possibilities to provide unified database [8].

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