Integration of Operation and Maintenance Information Model with Company's Existing Information Systems

N Knyazeva[1],

[1]PhD, Department of Information Systems, Moscow State University of Civil Engineering, 26, Yaroslavskoye Shosse, Moscow 129337, Russia

E-mail: nknyazeva@mgsu.ru

Abstract. Continuous development of information technologies opens new possibilities to increase efficiency of business activities of enterprises. However, introduction of IT innovations into construction with its principles of production process developed over the years needs to be done with appropriate integration in mind. Identifying approaches and integration platforms is the main task during introduction of information modeling into operation and maintenance activities of capital construction projects. Based on analysts' analysis, cumulative loss due to unintegrated data (cost of interoperability) was discovered to be the biggest on the stage of operation and maintenance and amounted for 2.5% of total costs. Current approach with automation of local tasks leads to increased financial burden on operator and owner of the building. The trend towards implementation of information modeling in the construction industry (BIM) helps to solve this problem. BIM allows to create a centralized graphically equipped database, from which it is possible to isolate information on a single component without losing any other components. The ever-increasing complexity of buildings and amount of maintenance information necessary to ensure the proper operation of the upkeep services requires continuous access to the updated and complete model of the building by maintenance staff.

1. Problem statement

The modern history of facility management dates back to the 1990s. when alongside with increasing technical equipment of workplaces and aspiration to overcome the energy crisis of 1970's many companies took the path on lowering upkeep costs and outsourcing related services to operation and maintenance companies. With further development, information systems with an ever-growing and more complicated functionality began to be actively introduced into the facility management services.

Low degree of integration that characterizes investment and construction activities in general and operation and maintenance of facilities and structures in particular, at present time creates additional costs related to aggregation and processing of information.

Difficulties with BIM implementation in construction are discussed in a big number of analytical reports and research. Including one of the large-scale surveys on the use of information modeling throughout the life cycle of the capital construction project showed that about 70% of developed models are not transferred to facility management services due to lack of uniform standards and techniques, as well as professional unpreparedness of operating organizations.

Substantial progress with this issue was done in power industry complex, where information models hold integral part to ensure security during operation and maintenance of constructed facility.

The information collected over entire period of the BIM model development is useful for facility management services, but for its competent use, it must be integrated or compatible with information systems used at the company, for example Computerized Maintenance Management System (CMMS), electronic document management system (EDM), Energy Management System (EMS) and building automation system (BAS). Different companies favor different systems, necessary data is fragmented between them, and often inputted manually by operation and maintenance staff. Information model makes it easier and faster to get initial data, and also expands the range of possibilities through visualization tools and etc.

2. Relevance of the study

Analysis of the current level of integration of operation and maintenance information model with company's existing information systems

If we talk about integration process, without any specifics, we can see Maxim Smirnov's review on different integration environments, techniques and levels of maturity of approaches to the development of integration solutions. [1]

Chinese authors from Huazhong University of Science and Technology cover issues with integration of the information model at all stages of the life cycle and propose their own structure for integration, which provides unified platform for data management and integrity. [2] However, operation and maintenance stage is covered superficially. Proposition is to group information on the operation and maintenance stage into three categories: general information, information about the project, and information about management of the project.

BIM scenario term can be seen in foreign literature, it has been deeply researched in University of Pennsylvania, as part of the work on recommendations for the implementation of BIM projects. The so called "BIM use" is based on decomposition of BIM technology into separate processes for solving individual applied tasks arising during the life cycle of capital construction project. It is detalization and sequential chaining of BIM scenarios used on the operation and maintenance stage that allows us to achieve the highest level of integration of operation and maintenance information model with company's existing information systems.

An interesting recent study by specialists from Peter the Great St.Petersburg Polytechnic University relies on the classification of scenarios by categories: aggregation, formation, analysis, exchange and implementation. [3] Operation and maintenance stage is mentioned in the last category in the subcategory Management of details. For further hierarchy placement 5 disciplines from investment and development project are outlined and BIM scenarios on each discipline and each category are considered. [4]

3. Article purpose formation

Purpose of the research – to consider the possibilities for integration of BIM model with existing information systems of facility management services based on research of BIM scenarios in different categories and subcategories.

4. Key findings

Before selecting a facility management company, a task and workload contour are defined, operating technical specifications are established and flow diagram for operation are developed. Alongside with construction design and as built documentation operation and maintenance department receives cumulative information model, which in future used as electronic technical certificate of the facility. During maintenance, it is important to document the work, and to fill in service reports.

Key indicators for effective work of operation and maintenance services during their work using information model are:

- lower operating costs based on accounting for consumed resources and optimized planning for resources consumption;
- higher control and management level due to automation of business processes.

Information that is aggregated and stored in BIM is rather difficult to process in in its original form for the needs of operation and maintenance companies, for this reason we need to comprehensively work out the issue of data transfer from the information model to CAFM.

Corrections to the methodology described in article [4] are proposed in the list of disciplines for the investment and development project. Since operation and maintenance activities do not imply issue of design documentation, it is logical to select disciplines from OmniClass classification (table 1).

Table 1. OmniClass classification.

Item №	Name of the discipline	OmniClass number	Description
1	**Facility Use Disciplines**	**33-55 00 00**	**Continued maintenance, operation and use of a building, structure, or site following the completion of construction.**
1.1	Real Estate	33-55 14 00	Buying selling or renting of property.
1.2	Facility Owner	33-55 21 00	Ownership of property and facilitating all expenses associated with all aspects of procurement, design, construction, and facility use.
1.3	Facility Operations	33-55 24 00	Providing a combination of support services within a client's facilities, such as janitorial, maintenance, trash disposal, guard and security, mail routing, reception, laundry, and related services to support operations within facilities.
1.4	Facility Restoration Services	33-55 36 00	Cleaning, maintaining and repairing of damage to parts of building due to age, weather, or materials deterioration.

Among the stages of the investment-development project in the framework of this paper (table 2), it is appropriate to consider the following:

Table 2. Stages of investment-development project.

Item №	Name of the stage	Code	Stage description
1	Operational commissioning	09	Evaluation of completed work through testing, inspection and commissioning (including all equipment) to ensure compliance with design criteria, efficiency in accordance with applicable codes and standards. Transfer of post-completion documentation from design and construction team to the management group of facility user, also demonstrations, training and instructions.
2	Operation	10	At this stage, the user or lessee occupies a usable floor area, manages facility systems, uses and maintains it, including repair works.

Next let's look at the categories and sub-categories of BIM-scenarios (table 3). The proposition is to consider subcategory Process simulation in the category Data Analysis on stage 10 Operation to be researched area, as in practice, tools for simulation modelling of emergency situations, crowd flow evacuation etc. are used.

Table 3. Categories and sub-categories of BIM-scenarios.

Let's look at BIM scenario examples at the operation and maintenance stage using Trade and Office Center as an example (table 4).

In 10-01-03-FOw scenario ELT method is used in cases when data check and correction is required to wo work with different reference data with big amount of transactional data that does not have frequent inflow.

Integration, described in scenario 10-05-03-FRS is theoretically applicable and can be used as main one for all scenarios on condition of at least 3 used systems/applications, at least 5 users. However, information about its implementation during work with software complexes for informational modelling and in work of facility management services in Russia was not found. Typically, companies involved in operation and maintenance activities are small and their usage of this approach is very limited.

Foreign companies, in Australia and Great Britain in particular, chose ESB application in combination with open formats for implementation of information modeling technologies.

Possibility for integration in scenario 10-05-04-FOp with SCADA creates additional resources for increasing security of people in the buildings.

Cloud services open big opportunities for facility management services, key advantages of which are accessibility, mobility, economy, manufacturability and reliability.

For each BIM scenario it is important to determine sources of operational data and to check completeness of data with COBie format, using built-in verification systems in CAFM, or by using COBie QC Checking Tool. When using open standard IFC as exchange format, we can make checks in specialized complexes for quality control of the model, such as Solibri.

Table 4. BIM scenario examples for Trade and Office Center.

BIM scenario code	BIM scenario description	Tools examples	Options for integration with the information model
10-01-01-RE	Changes in database for leased premises	MS Excel, MS Access, QS: Tenant database, Customer Accounting (configuration Managing company)	SQL-query into ArchiCad information model for premises (with the necessary parameters such as area, location, etc.), transfer of generated database in XML document format or providing access to the project from external programs using ODBC driver.
10-01-03-FOw	Checking the coolant flow rate in heating systems for billing renters to pay utility bills.	System for accounting of heat consumption INDIV AMR with visual aggregation of readings.	ETL method - source data is extracted from various sources, resulting data is converted to the target format, processed data is loaded into specific data storage.
10-05-03-FRS	Accounting for maintenance equipment for organization of repair works.	1C	Integration with 1C based on ESB data bus
10-05-04-FOp	Fire safety system monitoring	OnGuard Fire&Intrusion	Access to the project from external programs using ODBC driver. Integration with SCADA
10-05-04-FRS	Health monitoring for important building structures	ZETLab	The information is extracted using IFC format and placed in COBie format.

5. Conclusions

Main task of operation and maintenance information model: documentation of operation and maintenance process of the facility on digital double of the facility and to provide with full information different services of Investor, Customer, facility management company (services) and user. CAFM systems allow to solve tasks on automation of operation and maintenance. Integration of automation systems for operation and maintenance with information models of the building allows to provide maintenance staff not only with automation tools, but with visual representation of information about the building. Joint usage of information models and CAFM systems in future allow to lower maintenance costs and increased efficiency of facility management services. BIM and FM bundle can be realized through single informational space and with regulated by BIM scenarios access to it. It is important to only include data that is necessary for performance of production functions to avoid extra costs when creating operation and maintenance information model.

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