BIM IN FACILITY MANAGEMENT AND MAINTENANCE: THE CASE OF KAISA LIBRARY OF HELSINKI UNIVERSITY

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One of the promises of building information modelling is that it will be used during the whole life cycle of a building. However, there are very few studies of the actual uses of BIM and other information systems by facility management and maintenance personnel. The purpose of this study is to clarify the daily tasks of the maintenance personnel, the types of software used in maintenance and how the information is handed on to maintenance. Key persons involved in the maintenance of Kaisa Library, main library of Helsinki University, were interviewed and a member of the maintenance personnel was observed in his work. Results show that an electrical maintenance manual is an essential part of maintenance personnel's work. University as an owner has been active in developing and interconnecting FM and maintenance tools it has implemented. However, building information models were not linked to these systems. The representatives of facility management found a partial, stepwise integration based on selective communication between the FM and maintenance systems already developed a way forward. They did not find the advantages of BIM implementation evident enough to legitimate the investments in the implementation.

Keywords: building information modelling, facility management, maintenance.

INTRODUCTION

The central goal for the development of a product model and later BIM in the 2000s was that all the information of the building created during the design and construction process would be available during the whole lifecycle of the building. For instance, a forerunner of building information modelling in Finland, the RATAS project, defined its goal in 1988 as follows (Enkovaara & al. 1988, 15) "The kernel of the RATAS systems is a product model for structuring all data on a specific building, for the use of design, production and maintenance." This goal has included the promise that the owners and facility managers can use BIM as a powerful tool for carrying out management operations more efficiently. On the other hand, it is recognized that thus far, the industry has mainly used BIM in design and construction and that its use in Facility Management (FM) and operation is still in its infancy (Eastman & a. 2011, 170)

In the 2000s, it has been pointed out that 85 % of the lifecycle costs of a facility occur after construction is completed. Moreover, approximately 20 billion dollars are annually lost in the US alone due to inadequate information access and

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interoperability issues during operation an maintenance phases (Newton 2004). It is argued that the use of BIM in FM will significantly help to prevent these losses (Azhar & al. 2012, 21).

Paradoxically, it seems that the owners and facility managers, however, have not thus far been motivated to implement BIM or invest in the creation of interoperability between design and construction models and maintenance software systems. An evident reason for this is that property owners and facility managers do not see sufficient benefits to be gained or positive return in investment of the BIM implementation (Kiviniemi 2013). The BIM literature has reacted to this situation in three ways. First, it has been underlined that positive examples of the implementation have to be reported to enhance the implementation in FM and maintenance. Eastman & al. (2011) present two cases in the BIM Handbook, Maryland General Hospital and Cost Guard Facility. In the Cost Guard facility Planning Case (Eastman & al. 2011, 168) “the project team realized a 98% time savings by using information models to populate and edit the facility management database.” Also other authors find the savings in the data handover in the establishment maintenance information systems as an argument for the BIM implementation (Becerik-Gerber 2012). It can be doubted, however, whether the savings in the information handover are a sufficient reason to attract the interest of property owners in the implementation of BIM. Knowledge of more substantial and fundamental BIM-related benefits related to the operation during the building lifecycle may be needed for them to take the initiative.

The second approach dealing with the possible uses of BIM in FM and maintenance is to interview specialists and ask them to forecast what would be the forthcoming areas of BIM use in FM. This takes place by interviews, questionnaires and focus group discussions. This approach produces an expert view of possible or imagined uses of BIM. For example, Becerik-Gerber and her colleagues (2012, 434) found in their study ten areas of the application of BIM. The most frequently mentioned among them were: locating building components, maintaining real time data access, visualization and marketing, and checking maintainability.

The third approach comprises attempts of defining the data structures, conceptual diagrams and technologies that would allow the integration of design and construction models with maintenance software systems. The suggested solutions by which to achieve this include defining the necessary information needed in FM models, creating BIM servers, and outlining FM object repositories etc. These technologically oriented projects create technological conditions for the integration of the systems but do not as such provide motives for the implementation. Also the difficulties of integration, such as unclear responsibilities in the creation of as-built models, problems created by the variety of software used or insufficient supply of complementary tools in different phase of project are mentioned.

The approaches characterized above all assume the point of view of extending BIM from design and construction to FM and maintenance. However, the activities and needs of the owners and facility managers have not been extensively studied. Neither the uses nor challenges of the FM software systems currently in use have been duly reported. In this paper, we aim at contributing to the discussion of the implementation of BIM in FM by studying the relationship between design modelling and the uses of maintenance software in a Finnish project, the construction of Kaisa Library, the central library of Helsinki University. We will interview ten central stakeholders of the project and ask them to report the information tools used in FM and maintenance as well as their opinions on the future uses of BIM and the problems of its implementation. We will also find out the daily tasks of a caretaker to see, whether there are possible uses for BIM in his work. Shadowing method is used to solve this. Before analysing the Kaisa Library case, we first characterize the state-of-the-art use of BIM in FM and maintenance in Finland.

HISTORY OF BIM IN FINLAND

First projects to create foundation for the use of product models in construction in Finland started already in the late 1980s. Subsequently, several national projects have been carried out. The so-called HUT600 project in 2002 was a pilot in which models were used in design (Hänninen et al., 2010). In 2002 the ProIT–project was launched, with the aim of create a common practice for modeling. As a result, common product modeling instructions were published. (Kiviniemi, 2006) At 2007 Senate Properties published their own BIM requirements, which served as a basis for the Common BIM requirements 2012.

The Common BIM requirements (Yleiset tietomallivaatimukset, YTV) present the requirements for modelling and using BIM in a construction process. Finnish real estate owners, developers, construction companies and software vendors created the requirements. One of the series concentrates on using BIM in facility management. It points out that building information modelling is a relatively new concept in facility management and practices are still under construction. Because of that, the Common BIM requirements for facility management mostly introduce opportunities and alternatives rather than requirements.

Our research group studied several life-cycle projects carried out in central Finland in 2011. In an interview, a property manager in charge of a life-cycle project strongly stated that a maintenance manual is an essential tool in facility management and maintenance.

"It is an unbeatable tool for a property owner today. It's an absolute precondition for being able to do my job properly… The maintenance manual is a tool for a maintenance company. It's a tool for the management of a maintenance company. It's a tool for a property manager. It's a supervisory tool for a property owner. He will be able to see what's going on all the time. For the users, in this regard it is a tool, because all service requests are made using it." (property manager)

Correspondingly, the property manager did not find good reasons for implementing BIM in maintenance. One reason for this was the risk of incorrect information related to using BIM in maintenance. An as-built model has to be done correctly and maintained through the life cycle of a building. The model has to be reliable and if it fails (even) once, its value is compromised. As far as we can evaluate, this statement reflects well the state of Finnish construction industry.

"The problem is that when the modeling is done; it must correspond to the real product. If it doesn't, the point of modeling goes down the drain right away. And that's the challenge, for example when in the construction site they have done some installations that deviate from the plans and models, so how to correct these deviations in the drawings and models. If, even once, somebody would like to use the models but he notices that it's not correct, the models will then be forgotten and they say that let's do it like we have done before. And that is, in my opinion, the biggest fear in modeling: who will maintain, and who is capable of maintaining the models

through the life cycle of a building. It has to be maintained all the time.” (property manager)

KAISA LIBRARY: GOAL OF THE MODELLING AND DATA HANDOVER

Our research’s site, Kaisa Library, is the central library of University of Helsinki now with room for 1 500 000 books, 5000 customer, and 150 employees. The design phase started in 2008, renovation and construction started at spring 2010. The building was completed two years later and opened in autumn 2012.

It was required in the design contract that the architect and designers use modelling in preliminary drawings. After that, modelling was optional. The goal of modelling was to get useful data for priced bill of quantities and to secure enough space for HVAC routings. The contractor also used IFC-models for crosschecking the architect and engineers’ designs.

The architect made nearly 300 drawings and planning documents, of which most were 2D line drawings. However, the architect used the model for making floor plans, indoor wall drawings, and stair and elevator charts as well as a base of those 2D line drawings. Electrification engineers modelled the preliminary drawings. They modelled the cable routings, but all installation solutions are not in the model. HVAC engineers modelled the main routings in the right height. HVAC-engineers delivered 2D drawings that were from the model but all changes during the construction phase were made in those 2D drawings only (using drawing symbols and numeric information). The structural engineer used modelling. The main drawings for construction were from the model as such or with minor changes. Reinforcements were not modelled.

The data handover in the project was realized in two ways. First, all design documents and drawings, including the models were handed over. Models were handed over both in native and in a combined IFC format. These models can be used in future refurbishments. 2D drawings were saved as DWG-format and PDF-format in the University’s electronic archive. In addition, all project documents were archived in paper form.

Second, information was collected by a separate procedure for the RYHTI maintenance manual. Ryhti is a product of a Finnish building services consulting firm, Granlund Oy. The main users of the maintenance manual are caretakers, technical building managers and in some cases, contracted service producers. The coordinator of the maintenance manual (an employee of Granlund Oy) sent a comprehensive list of required information to designers and contractors. There were 13 named sources of information in the list and additionally, 35 other smaller suppliers. The number of different types of information, the source of information and some examples are depicted in Table 1. Information in the maintenance manual is in PDF-format so it is easily opened and read. The maintenance manual does not include models.

Table 1: Sources and number of different information types gathered in the maintenance manual

Source of information	Number of items of data required	Examples of information
Architect	6	Basic information, location drawings, window schedules
Structural engineer	4	Types from structures, system description
HVAC engineer	9	Catchment area drawings, target values for indoor conditions
Electrical engineer	9	Catchment area drawings, target values for electricity consumption
Main contractor	2	Material information
Ventilation casing	2	Device card information
Pipe contractor	4	Device card information, repair and care instructions
Ventilation contractor	4	Device card information, repair and care instructions
Automation contractor	5	Device card information, repair and care instructions
Electrical contractor	6	Device card information, repair and care instructions
Sprinkler contractor	5	Sprinkler location drawings
Reserve power contractor	3	Device card information, repair and care instructions
Elevator contractor	2	Device card information, repair and care instructions
Other suppliers	35	Use, repair and maintenance information
TOTAL	**96**	

The information handed over to the electronic archive guarantees that all possible information is in use for future refurbishments. The data collected for the maintenance manual are the information most needed in the everyday maintenance work.

THE USE OF INFORMATIONAL TOOLS IN MAINTENANCE WORK

As part of the study, the work of the caretaker of Kaisa Library was shadowed for two days. Shadowing is a research technique, which involves a researcher closely following a member of an organization over an extended period of time. The researcher follows the person being shadowed everywhere he or she goes and takes field notes about what the shadowed person is doing, with whom is he or she discussing, and the times and contents of conversations. (McDonald, 2005, Czarniawska, 2007) The data consist of 9 hours of audio and 5 hours of video material, and the field notes. In the analysis, the recordings were watched and listened to and with help of them a data template was filled. The data collected included 61 events, the starting and finishing times of these events, conversations related these events, and the software used. The events were categorized into 10 main types of tasks. The tasks, the number of different events and the time spent in these tasks are listed in Table 2.

Table 2: The caretaker's tasks

Task	Explanation	Time spent (minutes)	Number of realized events
Following the work of subcontractors	Following the work of subcontractors, commenting, helping	135	11
Leading subcontractors to their posts	Opening doors, guiding routes	88	12
Regular inspections	Monthly inspections in ventilation plant rooms	75	5
Repair and maintenance tasks	Repairing things, changing fuses, putting warnings of falling snow	64	7
Using automation and maintenance software	Checking automation system, maintenance manual, e-mail	48	7
Checking smoke detector system	Regular test of smoke detector system	42	1
Looking for and delivering information	Looking for information from papers and software, delivering it to subcontractors	41	4
Investigating announced faults and problems	Investigating faults for further measures	36	6
Conversation with users, feedback	Getting and giving feedback, changing information	17	7
Ordering subcontractors	Ordering subcontractors for falling snow	9	1

The analysis shows that the caretaker spent most of his time following, guiding and helping subcontractors and other workers. The caretaker followed the subcontractors' work, listened to them and collected “silent information” about the repairs. The second biggest part of his time was spent leading subcontractors to their posts. Kaisa Library is a complex building and the most of the routes contain locked doors. The caretaker guided the routes and opened doors to subcontractors.

Third, the caretaker made regular inspections in ventilation plant rooms. He inspected every ventilation plant room monthly to secure that everything worked correctly. The fourth task consisted of small repair and maintenance tasks such as changing fuses and putting up signs and fences to warn about falling snow.

Fifth, the caretaker spent time on his computer checking the building automation system, checking and filling the maintenance manual and reading his e-mail for service requests.

In addition to these tasks, the caretaker also spent time checking the smoke detector systems, looking for and delivering information, investigating reported faults and problems, discussing with users and ordering subcontractors.

Table 3 presents the software used by the caretaker and the main uses.

Table 3: Software the caretaker used

Software	Use	Number of realized events
Trend – building automation and energy management system	Watching data sent from control panel switchgears	3
	Keeping track of room temperatures	1
	Keeping track of daily energy consumption	1
	Checking ventilation system diagrams	2
	Checking alarms	4
Atmostech – building automation system	Checking ventilation system diagrams	3
	Keeping track of daily energy consumption	1
	Checking a meter read-out	1
	Looking for information about devices for the maintenance manual	2
Ryhti – maintenance manual	Tagging tests and regular inspections done	2
	Keeping track of monthly energy consumption	2
	Checking, responding and commenting service requests	2
	Checking a use register	1
Tampuuri – maintenance manual	Keeping track of monthly energy consumption	1
	Looking for last year data for a new maintenance manual	2
E-mail	Getting service requests	4

The caretaker used two building automation software, two maintenance manual systems and e-mail. The caretaker used building automation software for keeping track of and observing the general condition of buildings. He checked alarms, read diagrams and meters to get an overall picture of the buildings.

The caretaker used Ryhti maintenance manual in tagging tests and the regular inspections made. He also checked and commented on service requests and kept track of energy consumption. The other maintenance manual was used only when he tried to find out information on another building he took care of besides Kaisa Library.

VIEWS OF THE STAKEHOLDERS ABOUT THE POSSIBILITIES AND CHALLENGES IN UTILIZING BIM IN MAINTENANCE AND FM

The coordinator of the maintenance manual, the caretaker and the contact person of the library had no views about either the possible uses of BIM in maintenance or the requirements for utilizing it. This was evidently because they mainly operated with RYHTI and other maintenance software and were not knowledgeable of BIM.

The architect had doubts whether there was anyone capable of maintaining the model and its information content in maintenance. The HVAC engineer and the BIM expert also thought that maintaining the model would require skills of the maintenance personnel. However, the HVAC engineer and the BIM expert found many possible uses for model, such as space management and planning and scheduling maintenance tasks.

"If they don't maintain it [the model], it will lose its meaning. And I can't tell what will happen to it [the model] within the next 10 years, for example. Like, who is the person to maintain the model?" (architect)

"In my opinion, it [the model] would need to be useful. It is good just in the construction phase, but it seems senseless if its use ends there. It should be able to be used somehow for this sort of maintenance manual data, or that it would be directly obtainable to maintenance software." (BIM expert)

Persons in the real estate administration responded positively towards modelling. The property service manager combined BIM to environmental issues and simulations and meters in energy consumption. More generally, he found it potentially useful to have a model for calculation and simulation. The HVAC Coordinator thought that using models in maintenance would require simplification of the designers' models. The different maintenance models should be allocated to specific tasks so that they contain only the needed information.

"But if we want it [BIM] in use in maintenance, it should be able to be reduced so that all its elements are in a scale that is reasonable in maintenance. At this moment, these needs [between different maintenance and repair tasks] diverge so greatly that it would be possible to use the reduced model in different sectors such as fire safety, electro-technical repairs, and controlling different dangerous situations… The use of this building information model should be increased the right way, the use of this heavy model as reduced, controlled, and allocated to different actions." (HVAC coordinator)

The technical building manager was hesitant about the benefits of models and suspected it would be time consuming and expensive to build a useful model. He imagined that models could be useful in getting a better picture of a room or space for renovation and in helping with making contracts with service providers.

"…One can't always remember the shape of a space so then, if you could perceive it better with a picture, and then maybe if more people had to discuss one thing so there, in that situation, it perhaps (-) I don't know, were you looking for something like this?" (technical building manager)

CONCLUSIONS

Our expectation at the beginning of the study was that the central library project would elucidate the relationship between design and construction modelling and the FM information systems. It, however, turned out that the owner and the client wanted the project modelled only in the early stages of design. The client announced that it would not pay for modelling after the early design phase and the decision of the use of models was left to the designers. For this reason, an as-built model never emerged and the possibility of interaction between design modelling and maintenance software disappeared.

The case, however, showed that the Facility Management had been active for years in developing and interconnecting FM and maintenance tools it had implemented. These tools included Optimaze space management system, RYHTI maintenance manual, ATOP cleaning systems, and an electronic archive of drawings of all buildings as well as the newest system, a system for planning the care of the outdoor area. The owner underlined that information can be exchanged between the systems. For this, the property owner has asked the vendors of Optimaze and RYHTI systems to develop a function that makes the communication between the two systems possible. For the Facility Management it was a challenge to get these information tools into efficient use. They thought that the uses of BIM models would not provide an essential added value in relation to the informational systems already in use. In addition, they thought that the use of the design of BIM models would be too demanding both for the facility management and even more for the maintenance personnel. The challenge for the FM is to get the RYHTI maintenance manual into efficient use.

The representatives of facility management did not see concrete uses that would exceed the possibilities of the present uses to be valuable enough for the investment in maintaining the BIM models. The management, however, believed that the utilization of the models would proceed. They thought that the possible progress would realize by requiring the designers to provide models from which the key information could be directly transferred to Optimaze and RYHTI. This solution would, however, require that the parts and sets of information needed for these two systems should be defined in a way that specifies the requirement for the designers.

The case shows that instead of defining possible or imaginary uses for BIM model, the starting point should be shifted to the needs of the owners, who will be in a key position in enhancing the utilization of BIM in FM and maintenance. Maybe a rethinking of the concept of BIM is also needed. It has strongly been emphasized that the stakeholders should share all information during the lifecycle. It might be more realistic to recognize that the FM and maintenance information systems are an essential part of building information management with their own functionalities and contents that differ from the models developed to be used in design and construction. A partial, stepwise integration based on selective communication between systems may be the way forward. Such steps of integration between multiple information tools will partly take place locally according to the needs of the owners.

REFERENCES

Azhar, S, Khalfan, M and Maqsood, T (2012) Building information modeling (BIM): now and beyond. “Australasian Journal of Construction Economics and Building”, 12(4), 15-28.

Becerik-Gerber, B, Jazizadeh, F, Li, N, & Calis, G. (2012) Application areas and data requirements for BIM-enabled facilities management. ”Journal of Construction Engineering and Management”, 138(2), 431-442.

COBIM (2012) Yleiset tietomallivaatimukset 2012. Osa 12. Tietomallien hyödyntäminen rakennuksen käytön ja ylläpidon aikana (in Finnish)

Czarniawska, B. (2007) Shadowing and Other Techniques for Doing Fieldwork in Modern Societies. Malmö/Copenhagen: Liber/CBS Press.

Eastman, C. Teicholz, P. Sacks, R. & Liston, K. (2011). BIM Handbook. A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors. New Jersey: John Wiley and Sons, Inc.

Enkovaara,E, Salmi, M, Sarja, A (1988) RATAS project. Computer aided design for construction. Hämeenlinna: Karisto Oy.

Hänninen, R, Jokela, M, Aavaharju, H, Reinikainen, E (2010) “Insinööritoimisto Olof Granlund Oy. Suomalaista talotekniikan suunnittelua ja konsultointia vuodesta 1960” Keuruu: Otavan Kirjapaino Oy. in Finnish

Kiviniemi, A. (2013), Value of BIM in FM/OM – why have we failed in attracting owners and operators? Presentation in “BIM and Facility Management” seminar, April 4th, in Aalto University, Espoo.

Kiviniemi, M (2006) General introduction. Pro IT. http://virtual.vtt.fi/virtual/proj6/proit_eng/indexe.htm

McDonald, S (2005) Studying actions in context: a qualitative shadowing method for organizational research. “Qualitative Research”, 5(4), 455-473. SAGE Publications (London, Thousand Oaks, CA and New Delhi)

Newton, R. S. (2004) ‘Inadequate Interoperability in Construction Wastes 415.8 Billion’, *AECNews.com*, 13, Article 342.