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OPTIMIZING THE VALUE STREAM – APPLICATION OF BIM IN FM. STATUS QUO IN GERMANY.

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ABSTRACT

Facility Management includes all services that are necessary to support the core business of a company in a building. Therefore, a lot of information is required, for example building elements, operational costs, contract types, room allocation, logistics or maintenance. This data is essential to organize all processes, both effectively and efficiently. However, a lot of data gets lost throughout the building lifecycle, due to the temporary participation of many different parties, e. g. planners, contracting companies, service providers or owners, and various interfaces between them. Retrieving this information is both arduous and time consuming, if even possible. In order to reduce this unnecessary effort, to eliminate waste and to enable a continuous improvement of all facility management processes, new methods and tools should be considered.

Building Information Modeling, as a promising method to provide data not only in the planning and construction phases but throughout the whole lifecycle, can help to overcome the challenges described above. This paper aims to identify the area of application of BIM and its possible benefits in Facility Management. The integration of BIM in computer aided facility management tools in Germany will be illustrated and examined. In a single-case study, selected IT-applications will be further analyzed and development needs regarding standards for the implementation of BIM will be outlined.

KEYWORDS

Building Information Modeling, Facility Management, Collaboration, Benefits Realization, Flow

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INTRODUCTION

Over the last years, Building Information Modeling (BIM) has become an important tool within the construction industry. In Germany, the German Ministry of Traffic and Digital Infrastructure published a masterplan regarding the integration of BIM in December 2015. The ministry defines BIM as a collaborative working method which gathers and administrates all lifecycle-relevant information and data of a building consistently in a digital building model. The digital model enables a transparent communication and the handover of data for further work. According to this plan, national standards have to be developed and from 2020 on all federal infrastructural building activities have to be planned and constructed with BIM (BMVI, 2015). Other countries like USA, UK or Finland have already implemented standards like these (Borrmann et al., 2015).

Furthermore, BIM meanwhile is an approved method within the Lean Construction community as it supports the project participants in achieving Lean Principles like eliminating waste, cutting costs and improving team productivity (Gerber et. al, 2010).

Facility Management (FM) is an important sector of industry although often underestimated. In Germany, it generated a gross value added of 130 bn Euros in 2012, which was about 5.4 % of the German gross domestic product. The construction industry generated about 109 bn Euros, in comparison to 94 bn Euros of the automobile industry (Thomzik, 2014). Due to this economic importance FM should be brought into focus in order to improve all related processes and to induce a continuous value stream. Therefore, not only Facility Management itself, but every individual building including its lifecycle should be considered.

BIM is a promising method to support the operation and maintenance (O&M) phase and FM, as examined in recent studies and literature (Becerik-Gerber et al, 2010, Oskouie et al., 2012, Teicholz, 2013). The possible value regarding the whole lifecycle becomes apparent by combining two different kinds of studies. Studies concerning the lifecycle costing show that the major part of lifecycle costs occurs during the operation and maintenance phase, whereas the ability to impact these costs decreases over time (Schulte, 2008). Other studies point out that the planning effort with BIM takes place in earlier phases of the project, compared to the “traditional” planning effort without BIM (Egger et al., 2013). In the following figure, the figures of both studies are matched. Accordingly, lifecycle costs can be better influenced via BIM.

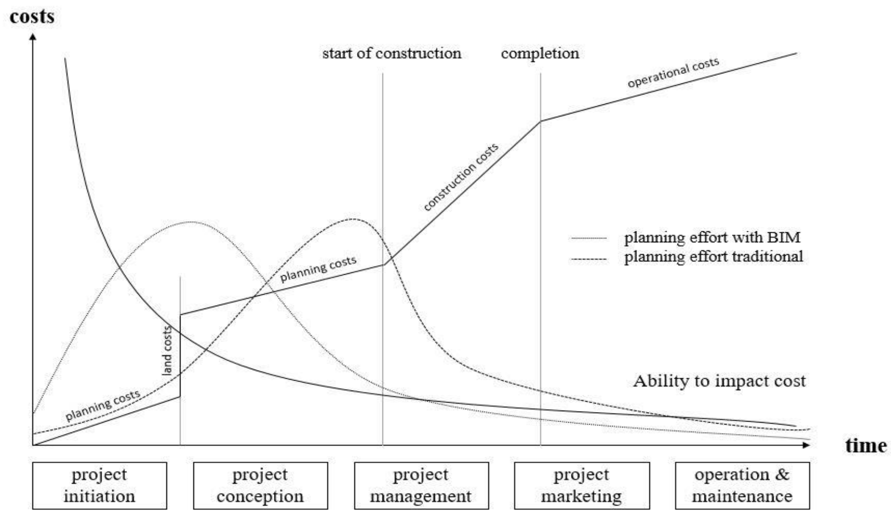

Figure 1: Cost trend during the lifecycle (Schulte, 2008 and Egger et al., 2013)

In the following, the areas of application of BIM in FM and its additional value will be outlined. Subsequently, the Status Quo of BIM in FM in Germany will be illustrated and examined. Via a single-case study, three selected IT-solutions have been further analyzed. The approach and the results of this study will be presented. Furthermore, development needs regarding standards for the implementation of BIM will be outlined.

BIM AND FACILITY MANAGEMENT – ADDITIONAL VALUE

COMPUTER AIDED FACILITY MANAGEMENT

FM in Germany is often supported by Computer Aided Facility Management (CAFM). CAFM-applications are IT-solutions that normally consist of a database and a user interface. They facilitate processes like e. g. management of space, maintenance, equipment, health and safety, locking systems, cleaning, helpdesk and many more. In English-speaking countries, similar software-applications are also known as facility management software or Computerized Maintenance Management Systems (CMMS). In Germany, Austria and Switzerland there are about 60 companies which offer different CAFM-solutions.

A study of the German Facility Management Association shows that users identify the following points as the main advantages of CAFM-solutions:

- better transparency regarding costs and services
- better documentation regarding the operator's responsibility
- more efficient services
- cost savings
- better space utilization
- less business interruptions

Furthermore, the study points out that serious challenges by implementing CAFM systems are the correct estimation of effort (time and personnel) and the generation of a sufficient data set (GEFMA, n.d.).

BIM AND FACILITY MANAGEMENT

By combining BIM and FM, additional value can be created, as shown in recent studies. For example, the following BIM application areas enable advantages during operation and maintenance: Locating Building Components, Quantity Survey, Cooperation, Facilitating Real-Time Data Access, Space Management, Personnel Training and Development, Visualization and Marketing, Checking Maintainability, Creating and Updating Digital Assets, Planning and Feasibility Studies for Noncapital Construction, Emergency Management, Controlling and Monitoring Energy (Becerik-Gerber et al., 2011, Teicholz, 2013). Some of these advantages can also be realized to some extent via well-tended "traditional" CAFM-solutions, but of course, the use of BIM facilitates work even more. This can be led back to visualizations and finally the data which is stored within the digital model and can be accessed easily.

As shown in figure 2, the importance of the different types of data is changing throughout the lifecycle, irrespective of using BIM or not. In the planning phase graphic data is very important for the owner, to get an impression for the building, whereby attribute data (e.g. materials) is secondary. In contrast, attribute data is very important during operation & maintenance and thus for FM (Teicholz 2013). As attribute data turns a 3D visualization into a building information model, it becomes apparent that a digital building model is the best data platform for FM (Eastman et al., 2013).

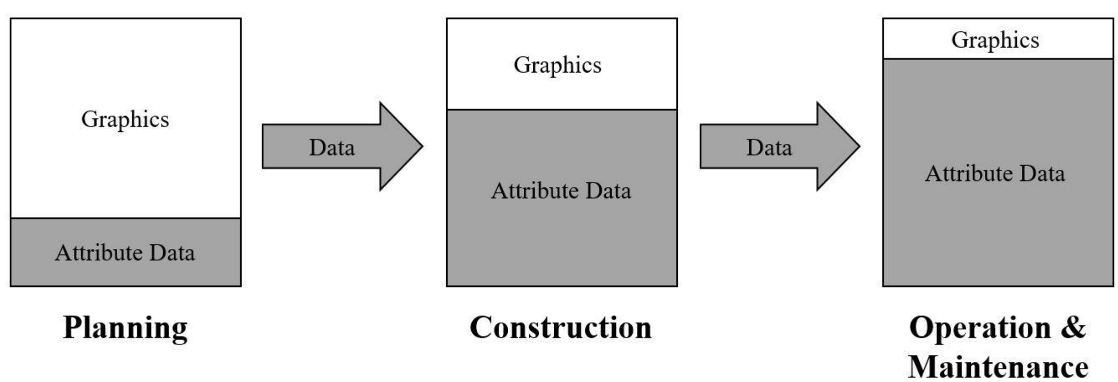

Figure 2: Mix of data changes over the building lifecycle (Teicholz, 2013)

Theoretically, FM-relevant data is already stored in the "as-built-model" and can be taken over from the construction team. Figure 3 shows the idealized flow of information with BIM. In this ideal conception, all information is stored in the model without any losses throughout the whole lifecycle and can be handed over for reconstruction or change of ownership. In practice, there are still interfaces and some of the information gets lost during the hand-over from one phase to the next (Eiberger and von Heyl, 2015). Compared to traditional methods, these losses are smaller and will be further optimized in future. Accordingly, the use of BIM is beneficial regarding flow and value stream.

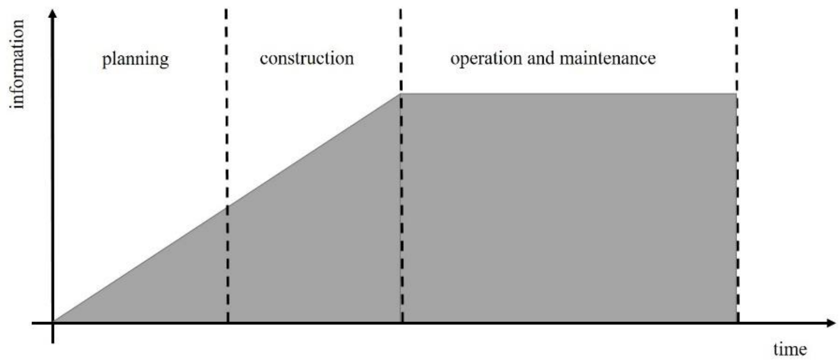

Figure 3: Idealized flow of information with BIM (Eastman et al., 2013)

As information is the basis for BIM, it is very important to clarify who is responsible for each model and necessary changes or additions of data not only during the planning and construction phases, but during all phases of the lifecycle (Becerik-Gerber et al., 2011). During operations and maintenance, all participants need access to the digital model, e. g. the facility manager, craftsmen, caretakers etc. To avoid unintended and wrong input, most IT-applications offer a detailed authorization concept so every user can access information, but only authorized personnel is able to alter data.

Teicholz summarizes the following points as the main benefits of connecting BIM and FM (Teicholz, 2013):

- cost reduction (accurate and complete data ready for use)
- integration of systems (CMMS, CAFMS, BAS)
- improvement of performance (more complete and accessible data allows faster analysis, happier and more productive users)

Regarding lean principles, the integration of BIM in FM enables a continuous value stream and therefore also a better flow. Additionally, it improves collaboration. On the one hand, it helps to interlink the different phases within the lifecycle. On the other hand, the different participants in the O&M, like owner, users, facility manager, caretakers, craftsmen etc. can be linked and decisions can be facilitated, e. g. via visualizations. Furthermore, BIM enables a higher quality which minimizes waste and rework.

STATUS QUO IN GERMANY

MARKET RESEARCH

In the German-speaking market, the integration of BIM into FM is mostly managed via CAFM-solutions.

As mentioned above, there are a lot of different solutions on the German-speaking market. Since 1999, the "CAFM Market Survey" is yearly released by the German Facility Management Association, the journal "The Facility Manager" and VALTEQ (part of CBRE). The survey intends to give potential users an extensive, objective and up-to-date overview of CAFM-software. In 2015, the survey presented 34 CAFM-solutions via standardized datasheets (GEFMA, 2015). The market research on BIM in FM is based on this survey. Of course, further software-manufacturers which offer "BIM-able" products were included as well.

The first step of the research was to examine which IT-solutions are "BIM-able". BIM-able means that the CAFM-software supports the neutral data format IFC and/or has a direct interface to a BIM-able CAD-software, so the model and the CAFM-software can be connected. 21 of the examined CAFM-solutions correspond to this definition. By only considering the BIM-able CAFM-applications, it becomes apparent that 80 % support the neutral IFC data format. Proprietary interfaces to Nemetschek Allplan®, Graphisoft ArchiCAD® and Autodesk Revit® are only supported by 25 % - 40 % of the applications.

In the next step, the BIM-able CAFM-applications were analyzed regarding their solutions for the different branches of FM: technical, infrastructural and commercial FM. Considering the BIM-able CAFM-tools, only 35 % support all three application areas (to fulfill an application area, the software has to process 66 % of the possible tasks in this area). Regarding the application areas separately, 90 % of the tools support the technical as well as the infrastructural FM, 45 % support the commercial FM. Commercial FM is often processed with ERP-systems so many BIM-CAFM-manufacturers rely to this specialized software and only offer interfaces to transfer necessary data.

SINGLE-CASE STUDY

To further examine the BIM-ability of CAFM-software, three applications have been selected to conduct a single-case study. One of the products is relatively new and particularly specialized in BIM; the other two products are well-established on the CAFM-market and have been extended regarding digital building models over the last years.

The study is based on a digital model of an existing office building (acknowledgments to Ed. Züblin AG, Stuttgart, Germany). The architectural as well as the installation model of the office building were generated in Autodesk Revit® 2013 so they had to be transferred into a later version, Autodesk Revit® 2015, before they could be connected in order to compile a comprehensive model. Subsequently, the model had been imported into the BIM-able CAFM-software. Within the software-products, the model had been used and tested in different categories. The following table shows the results of the single-case study.

Table 1: Results of the single-case study

	Software A	**Software B**	**Software C**
Short description	stand-alone CAFM-solution or plug-in for Graphisoft ArchiCAD®, Autodesk Revit®; Modules: maintenance, keys, tenants, relocation	stand-alone total CAFM-solution for technical, infrastructural and commercial FM; additional plug-in for Autodesk Revit®	stand-alone CAFM-solution, additional plug-in for Autodesk Revit®; Modules: commercial 1+2, technics, web, app
BIM-able interfaces	Graphisoft ArchiCAD®, Autodesk Revit®	IFC, Autodesk Revit®	Autodesk Revit®
Data-transfer BIM-CAFM	- interface Revit-CAFM-Server - configuration of attributes and parameters is quite complex, but can be saved for further models/projects, if parametrization is identical - transfer of all attributes and parameters	- interface Revit-CAFM - customizable templates for query-regulations; configuration of attributes and parameters is quite complex, regulations can be used for other models - transfer of all attributes and parameters	- interface Revit-CAFM-Server - only information contained in room stamps can be transferred - building parts like doors or windows can be transferred but without parameters - installation parts could not be transferred
Type of interface	bidirectional	limited bidirectionality via separate reports	limited bidirectionality via separate reports (not included in the demo-version)
Building space utilization book	- existing (customizable) templates - visualization possible	- existing (customizable) templates - visualization possible	- existing (customizable) templates; contains only information, that could be transferred
Inventory	- relocations via CAD or CAFM - list of inventory - quantity takeoff	- relocations via CAD or CAFM - list of inventory	- relocations only via CAD - by transferring the data a duplicate is produced in CAFM

Cleaning	- quantity takeoff of different surfaces (glass, different floor coverings) - Compilation of a bill of quantities - export to MS-Excel or GAEB	- quantity takeoff of different surfaces (glass, different floor coverings) - export to MS-Excel	- quantity takeoff possible, but more complicated - discrepancies to the quantities identified by the other programs - export to MS-Excel
Maintenance	- additional mobile version - real-time data access during maintenance walk-throughs	- additional mobile version - real-time data access during maintenance walk-throughs	- additional mobile version - only via lists, data model is not interlinked
Visualizations, virtual walkthroughs	only in combination with CAD-software	2D, 3D only in combination with CAD-software	only in combination with CAD-software

The single-case study shows that the three examined CAFM-solutions facilitate working with BIM during the O&M phase to different degrees. In two out of three cases it has been possible to import the building information model and all FM-relevant data into the software. In the third case the import was possible as well, but the configuration of the mapping could not be customized freely so not all FM-relevant data could be transferred. After some preparatory work, the import could be completed quite quickly. This is confirmed by another case study; about 98 % of time could be saved by integrating BIM in FM (Eastman et al., 2013).

The information model used for the study is a model from the late planning phases. Still, it contained a lot of data which is not FM-relevant. As-built-models may contain even more data which is not necessary for FM (e. g. formwork drawings). Furthermore, they are very extensive in size and therefore difficult to process. Thus, some clients of construction companies demand separate FM-field models. Irrespective of this consideration, it is very important that the facility manager determines at an early stage of the project which data is relevant for operation and maintenance so the information is parameterized and included into the model. Depending on the CAFM-software, the parameters have to be defined in a certain way to be readable by the FM-application. This is essential for an accurate and quick import of the information into the CAFM-tool.

The single-case study also shows that proprietary interfaces are working well at the moment; the information is exchanged quickly and completely. The neutral format IFC (IFC4) promises an easy data exchange but often some of the information gets lost during the process. The usage of Excel sheets or the exchange via databases is not recommended as it is very difficult to configure and to filter the information. Additionally, the CAFM-application would only be linked with the information, but not the model itself. To profit from advantages like visualizations or simulations, a link between the CAFM-application and the model has to be established. Next to the CAFM-tool, a CAD-tool is required.

Also considerable is the bidirectionality of the interfaces. After appropriate configuration in software A, information that is included or changed within the CAFM-software could be added to the digital model (and the other way round). Like this, the model is always up-to-date and can be used one-to-one for modifications of the building, modernization or demolition. The interfaces offered by the other two CAFM-solutions are based on separate reports and therefore limited, but the manufacturers are working on better interfaces at the moment.

CONCLUSIONS

Via the use of building information models, Facility Management processes can be supported optimally. Compared to traditional CAFM-software the use of digital information models enables additional functionalities, reduces time effort, improves collaboration and provides a continuous data flow throughout the lifecycle of a building. To this effect, the connection of BIM and FM complies with important lean criteria.

To integrate BIM in FM appropriate software is necessary. On the German-speaking market several IT-solutions are available. Most manufacturers of CAFM-software have already realized that the connection of BIM and FM offers numerous chances. Thereby, import and transfer of data are very important topics. As these solutions are relatively new at the moment they still have some weaknesses and processes need to be improved. In this context, structure and extend of the model should be mentioned. Presently, separate models for O&M are generated as many CAFM-solutions cannot process the "whole" model of the planning and construction phase. To eliminate this additional effort (waste), the systems should be further optimized.

The digital information model used for FM has to contain as many FM-relevant parameters as possible. In order to ensure this, facility managers should be integrated in an early phase of the project.

Furthermore, the requirements of each CAFM-software are different. Depending on the software, parameters in the model have to be defined in a certain way to be readable by the FM-application. This is supposed to change in future, so that BIM-parameters can be allocated to FM-features via separate configurations. Currently, only few software manufactures offer such a function.

At the moment, there are no technical standards to interlink BIM and FM in Germany. The German CAFM-Ring, an association of Software manufactures and operators, works on this topic. The CAFM-Ring focuses on the neutral interface IFC which is enhanced by buildingSMART as well. In this context, international data-standards like COBie (Construction Operations Building Information Exchange) which help to capture and record important FM-relevant data should be further followed up in Germany.

Finally, it seems that the foundation for connecting BIM and FM in Germany is laid. To use all resulting possibilities, further work regarding interfaces, systems, processes etc. is necessary. In future, more methods and tools of lean construction should be examined regarding their applicability to Facility Management.

REFERENCES

Becerik-Gerber B., Jazizadeh F., Li N., Calis G. (2011). Application Areas and Data Requirements for BIM Enabled Facilities Management. In: *Journal of Construction Engineering Management*, 138(3), 431-442

BMVI Bundesministerium für Verkehr und digitale Infrastruktur (2015). *Stufenplan Digitales Planen und Bauen*, Berlin Bundesministerium für Verkehr und digitale Infrastruktur

Borrmann, A., König, M., Koch C. and Beetz, J. (2015). *Building Information Modeling Technologische Grundlagen und Industrielle Praxis*. 1st edition, Wiesbaden Germany: Springer Publisher.

CAFM-Ring Branchenverband. (2016). *Agenda BIM im FM- Building Information Modeling im Facility Management*, Wuppertal CAFM Ring e.V.

Eastman, C. M., Teicholz, P., Sacks, R., and Liston, K. (2013). *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Architects, Engineers, Contractors, and Fabricators*, 2nd edition, John Wiley and Sons, Hoboken, NJ

Egger, M., Hausknecht, K., Liebich, T., Przybylo, J. (2013). *BIM-Leitfaden für Deutschland – Information und Ratgeber*, Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumentwicklung (BBR)

Eiberger, M., von Heyl, J. (2015). 'Applying BIM to Infrastructure Refurbishment Projects' In: Rickers, U. and Krolitzki, S., *Lake Constance 5D-Conference 2015 – Proceedings*, Constance, Germany, 4-5 May 2015

GEFMA Deutscher Verband für Facility Management e.V. (n.d.) <http://gefma.de> (March 16, 2016)

GEFMA Deutscher Verband für Facility Management e.V. (2015). *Marktübersicht CAFM-Software 2015*, GEFMA 940

Gerber, D.J., Becerik-Gerber, B. & Kunz, A. (2010). 'Building Information Modeling and Lean Construction: Technology, Methodology and Advances From Practice' In: Walsh, K. & Alves, T., *18th Annual Conference of the International Group for Lean Construction.* Haifa, Israel, 14-16 Jul 2010

Oskouie, P., Gerber, D.J., Alves, T. & Becerik-Gerber, B. (2012), 'Extending the Interaction of Building Information modeling and lean construction' In:, Tommelein, I.D. & Pasquire, C.L., *20th Annual Conference of the International Group for Lean Construction.* San Diego, USA, 18-20 Jul 2012

Schulte, K-W. (Ed.) (2008). *Immobilienökonomie. 1. Betriebswirtschaftliche Grundlagen.* 4th edition, München, Germany: Oldenbourg Publisher.

Teicholz, P. (2013). *BIM for Facility Managers,* John Wiley and Sons, Hoboken, New Jersey

Thomzik, M. (2014). *FM-Branchenreport 2014 – Die volkswirtschaftliche Bedeutung der Facility-Management-Branche,* GEFMA 980