Knowledge-Based Services in Building Management

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ABSTRACT: In recent years Facility Management (FM) developed as a know-how-oriented service. Equally the Building Automation attained a prime importance in the creation of optimized operations through digital systems for measurement and control. The target of future solutions is to combine the central Building Automation Systems with the FM-Systems for an integrative usage. Within the development of open date interfaces of the available Building Control Systems the present singularly used dates will be provided to services for an integrated FM. In that case the already existing services can be improved or new services can be created. The shown results of completed scientific research projects are determined in the creation of an applicative interface between the systems of FM und Building Control, the definition of the system architecture and possibilities for new services.

1 ACTUAL SITUATION AND FUTURE REQUIREMENTS IN BUILDUNG MANAGEMENT

1.1 Actual Situation

In recent years Facility Management developed as a new, know-how-oriented service. Main part is the grouping of the available special knowledge of individual disciplines. Clear efficiency-increases can be observed through the possible integrated building rationing.

Equally the Building Automation attained a prime importance in the creation of optimized operations. Today the digitalization of the technical processes allows a pursuing consideration of the central Building Control System in connection with the general management concepts in the real estate. Evolutions in this direction set up a combination of the automated processes to the overall consideration of Building Management. The consideration of the Facility Management requirements in the different parts of the Building Automation is at the moment not sufficiently available.

Proprietary and partial redundant data networks characterize the currently available systems of Building Control and Computer Aided Facility Management. The demanded dates are mostly available in the central Building Control System, but they cannot be used due to the missing completeness of the IT-environment (see figure 1). The interface with considerable format problems separates the two existing systems and prevent interacting advantages. If a Building Management service provider wants to use information obtained from Building Control Systems, the only chance mostly is to get the input data by the manual way.

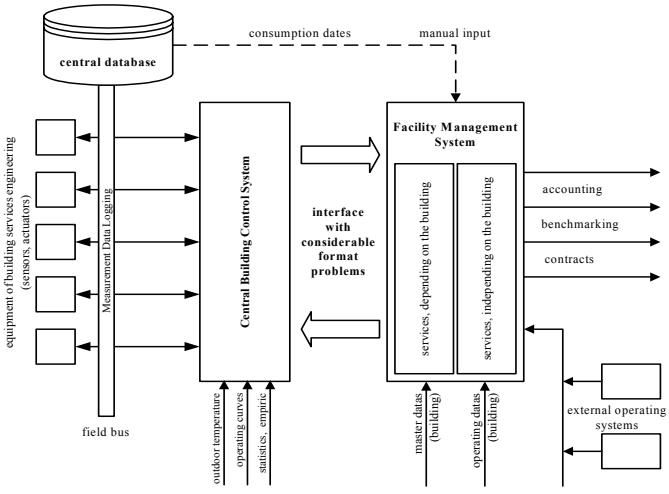

Figure 1. Facility Management Systems (CAFM) and actual interface problems

1.2 Future Requirements

Actual developments on the renting market for buildings and results from actual research projects show, that future requirements for offices and involved services will rise.

The daily project business is stamped by very flexible processes. Both, the timing horizon and the on-site horizon will be important to achieve good

results in the project business. Services have to support the flexible processes in an effective and efficient way. Therefore service providers need realizable service structures, instruments for quality assurance and comprehensible, transparent methods on an acceptable cost level.

In case of influencing the operating cost for buildings a survey determined interesting developments, especially for the cost for energy consumption in single rooms. The target group of the represent survey has been office users in whole Germany, more than 450 different users has been questioned. Three selected results of the survey are shown in the following.

The requirements of office users are tending to a contemporary and room-specific billing of the rent. Figure 2 shows that 88 % of the office user wants to have a monthly bill interval for operating costs. Therefore any technical/administrative system does not exist at the moment, which could effort the short interval in an economical way for determining the heating, cooling or lighting costs.

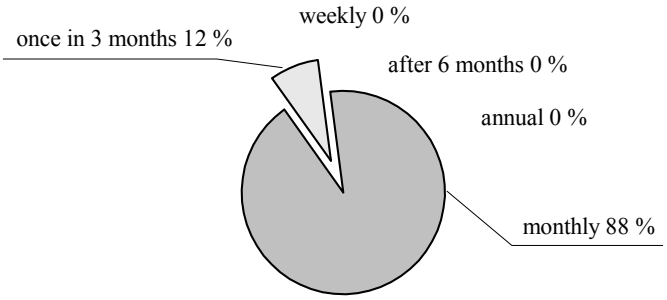

Figure 2. Bill intervals for operating costs

Another topic aimed to energy-saving behavior of the building users. In the survey the users have been asked, whether they see possibilities to save energy in their personal office surrounding. Half of the questioned persons specified, that they see obviously possibilities for energy saving (see figure 3). The answer shows the existing potentials for minimizing operating costs.

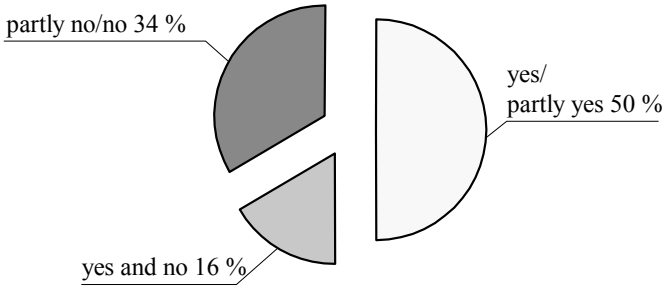

Figure 3. Office users answer of the question, whether they see possibilities to save energy in their personal office surrounding

The users expect from the single room automation possibilities of controlling their personal working environment. On the same way they demand a total automated procedure with integrated learning functions. Global aim therefore is the increasing of the comfort, combined with energy-saving settings of the actors in offices. Figure 4 shows clearly the preferential operating interfaces with the user for technical installations, especially heating, cooling and lighting.

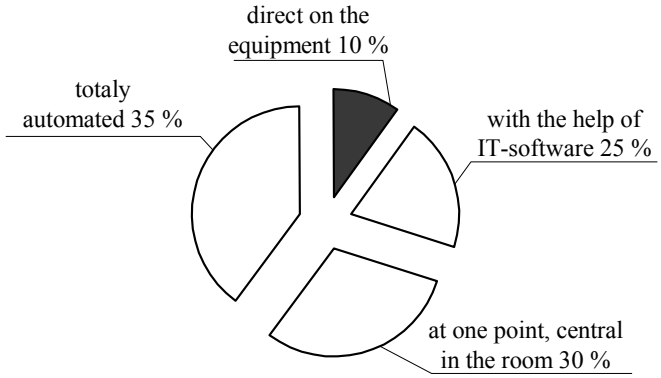

Figure 4. Preferential operating interface for technical installations in single rooms

The target for implementation of future service requirements is to combine the available central Building Control Systems and Building Automation with the established Facility Management Systems for an integrative concept. Within the development of open date sections and interfaces of the available Building Control Systems the present singularly and proprietarily used data will be provided to new knowledge-based services for an integrated Facility Management. Based on the gathered information the services can be more specialized to fulfill the users need. The supposition of such a system is an integrated database, that contains master data from the building and operating data from the Building Automations System.

2 IMPLEMENTATION OF KNOWLEDGE-BASED SERVICES

2.1 Knowledge-based Services

For services that use the information gathered from data of Building Automation System the word “knowledge-based services” will be introduced. Therefore the dataflow between the Building Automation System and Computer Aided Facility Management System (CAFM) needs to be open and standardized.

Figure 5 shows the different sources and interfaces that are required for a global data provision. For the most elements of the building information about their place, their producer or their state of the Building Automation (if existing) will be gathered in a central database. Therefore a unique data model and a large extend for standardization is needed.

The development of open data interfaces for the different systems can provide a huge rate of information to service providers about building- and user-specific processes.

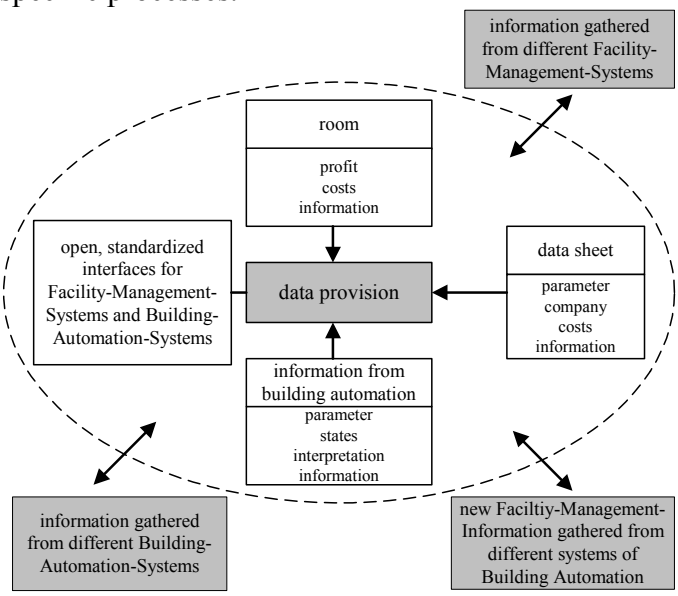

Figure 5. New data zones and interfaces between Facility Management Systems an Building Control Systems

As an example the following processes could be optimized or offered as new services:

- Maintenance of elements depending on the real amount of using,
- Allocation and billing of the used resources (energy, water) to their consumptions (room-specific and contemporary),
- Benchmark the behavior of the users with the provision of the depending controlling- and regulating-strategies,
- Justify services on conditions, which can be defined by evaluating data.

Profit of an integrated database for	
Building Automation	Building Management
- Adaptation of the regulating functions on the real room occupancy - Economical industrial management - Contemporary comfort	- Automatic transfer of data between the two systems (instead of manual transfer)
- Commercial and energetic comparison of consumptions and cashing - Free order of services	- Online information of building- and user- processes, like presence or disturbances
- Usage of the master data in the systems of Building Automation - Increase to building safety thru communication of different systems	- Contemporary monitoring and evaluation of specific benchmarks of the building, like cost of heating/m²·hour - Allocation of costs to separate renting areas

Figure 6. Advantages of open interfaces

Figure 6 summarizes many potentials for savings, which are provided by an integral database.

2.2 Concept of a Database-Structure and their Application

In the previous chapters the necessity and advantages of integrative data structures and a central database for Building Management was substantiated. Following the concept of a database-structure will be presented. The structure can be used even for the superior network-layer as for the field- and automation-layer in Building Automation Systems (LON, EIB). The diagrams in figure 7 show the tables of the database and describe essential functions of the performed attributes as well as the relations between the single components.

As an example the table Building-Automations-Information is described more in detail: They are standardized according to EN ISO 16484-3 (VDI 1314, part 2) and contain real and virtual information about the Building Automation states. Each information is dedicated to a physical address in the field-layer or is created virtual by the automation-layer. The table contains any kind of attributes like physical or virtual messages, states, analog measured values or switch orders.

In case of the sensor for open windows the following attributes in the table would occur:

- BA_ID — database-specific code for the window-sensor
- BA_info_name — 00121=window
- BA_info_shortmessage — window 2 in room 123
- BA_info_type — 0002=digital entrance
- BA_info_value — 0=closed / 1=open
- BA_info_unit — 0=none
- BA_info_time stamp — 2005_09_11_14_25_12
- BA_info_actic/inacitv — 0=active / 1=inactive

That specific information is primary used in the Building Automation for security reasons. In addition the window information can be used for heating, cooling and lighting. In combination with the presence-sensors the window-sensor can be used for an automatic controlling of room automation systems. For example the heating or cooling of the room could shout down, if there are open windows. In that case energy would be saved. Furthermore the information about the window can be use for Building Management tasks. For example the status of open windows could be monitored for the maintenance supervisor. If there is a need to close all windows at night, the supervisor can see on a screen which windows he has to close instead of watching all windows in each room separately. Such examples show clearly, in which different ways data can be used for services.

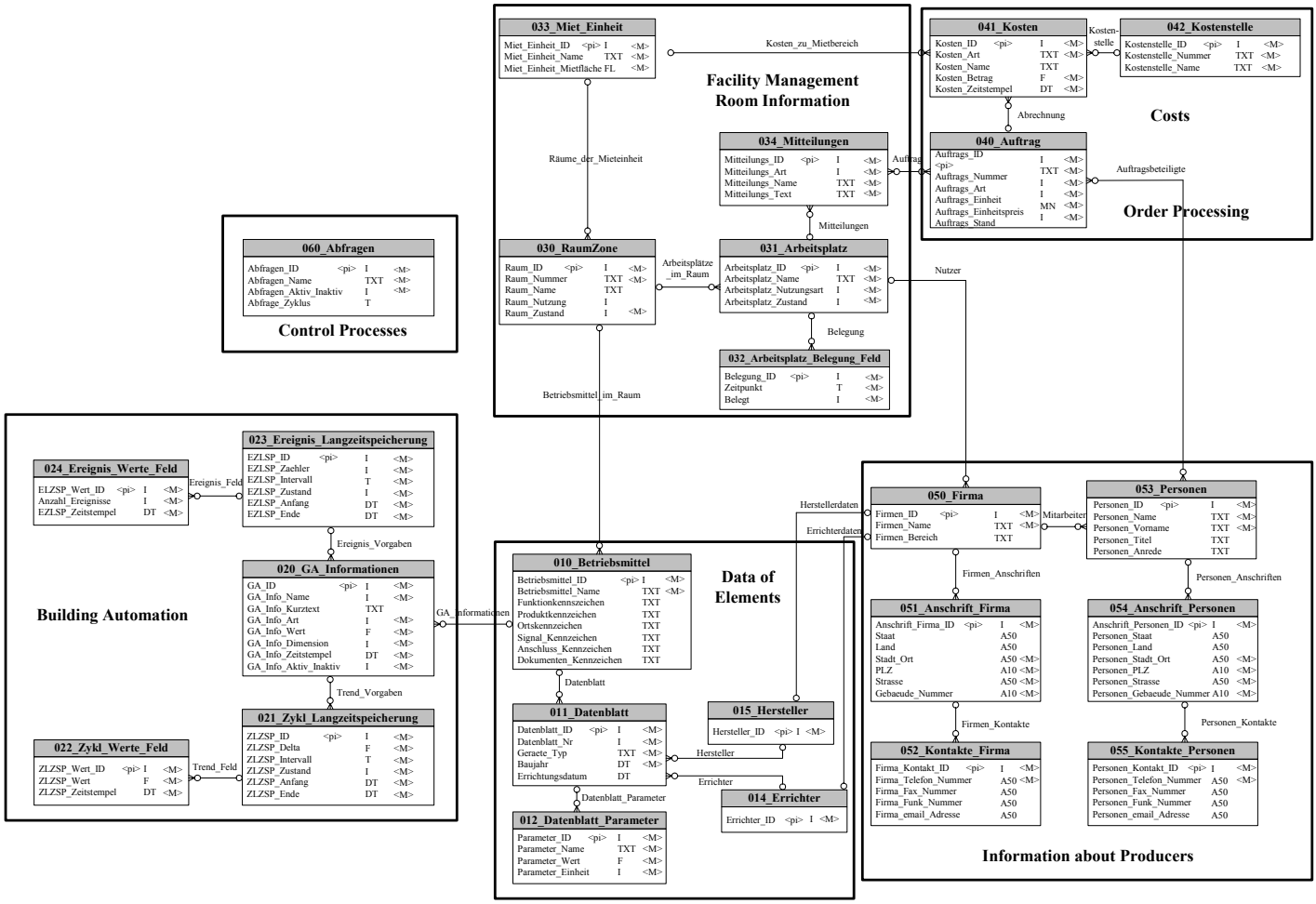

Figure 7. Concept of a database-structure

More examples for such knowledge-based services are described in chapter 3.
More detailed information of the database concept is specified in Schach/Kabitzsch/Höschele/Otto, 2005.

3 EXAMPLES OF KNOWLEDGE-BASED SERVICES

3.1 Virtual Counting and Allocation of Used Resources

German laws determine the accounting of heating in buildings, depending on the personal consumption. Through the introduction of that law the users are encouraged to safe energy, a total reducing of the heating energy consumption of 10 % to 25 % has been determined (Tritschler, 1999, p. 1). In opposite the personal and metrological expenditures have to be taken into account. Those financial expenditures are exceeded with the increasing heat insulation standard and much more efficient installation engineering (Koch, 2002, p. 1). Consequently the reduction of costs for the user-specific allocation is aspired. Beside the economical reasons the new requirements of the users need to be considered, like spatial and temporal allocation of costs for single rooms.

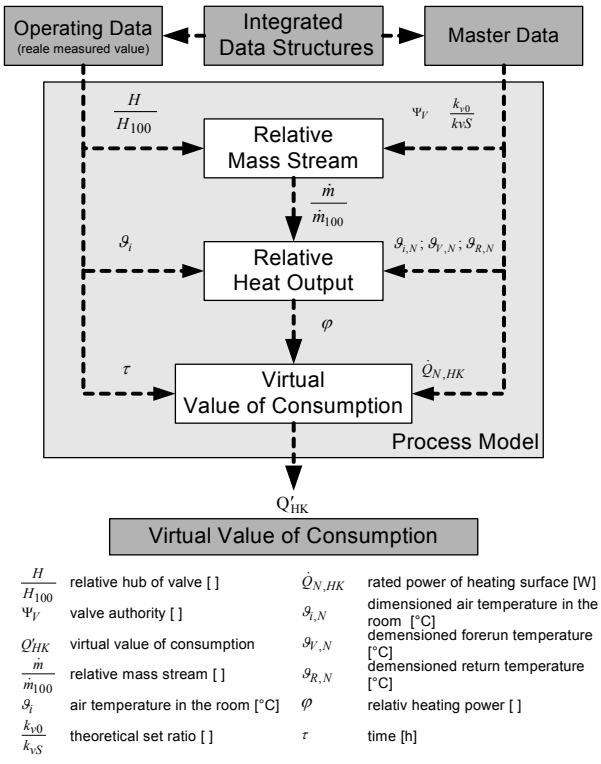

Figure 8. Process model of the virtual counting for a hot water heating with pumps

Therefore the virtual counting of used resources can be seen as a practical solution. Virtual counting means in that specific case the determination of the

used energy for heating, cooling or lighting only by the master data and operating data (without special counters). A process model transfers the information received from the data into a virtual characteristic value of consumption. As an example a model of the virtual accounting of heating energy is shown in figure 8.

The figure shows the needed master data und the operating data, which have to be used for calculating the virtual characteristic value of consumption. Under the condition of free access to the data the registration and calculation could be totally automated. The kind of determination is very flexible and can be transformed without borders of time and space. Own tests resulted, that the safeness of correct results is higher than traditional measurement devices.

3.2 *Online Advisory Expert System*

The interpretation of the surveys gave the result, that office users wish to get support in the adjustment of their personal settings for air conditioning and lighting. Therefore a service like an Online Advisory Expert System could be provided. The system collects information about room conditions and evaluates the required results. The evaluation contains the automatic identification of energy-wasted settings (heating with open windows or lighting in empty rooms), gives a forecast of the expected costs and suggestions for optimizing the settings. The most important task for the Online Advisory Expert System is the communication with the office user. Each user has his own interface, which is available via Internet. On the same way the user can lay down settings via their personal desk computers. As an example figure 9 shows a possible user interface for the Online Advisory Expert System.

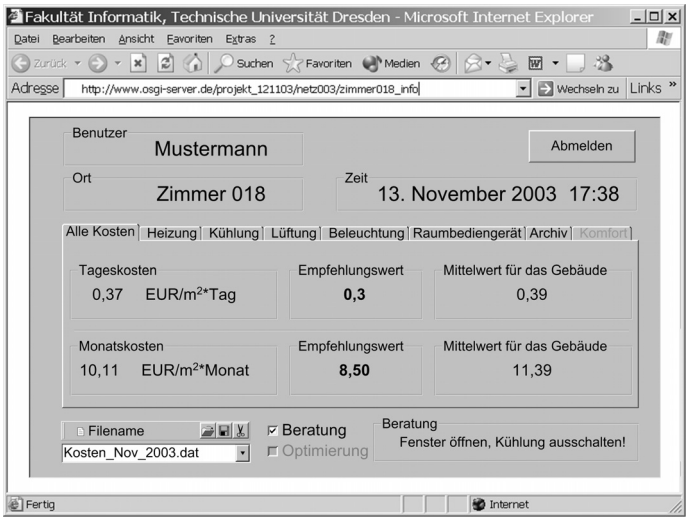

Figure 9. User interface for the Online Advisory Expert System.

The Advisory System is based on two different working regimes: the advisory and the automatic optimization. In case of the advisory the user gets presented the actual situation in the room, including the actual costs for using and advised recommendations for energy saving. In case of the automatic optimization the recommendations will be changed automatic by variation of the desired values. If wanted, the automatic optimization can be shut down.

More information, especially about the modeling of the background algorithms is given by Schach/ Kabitzsch/Höschele/Otto, 2005 or the conference article "Knowledge-Based Services in Building Management: Online Advisory Expert System" by Dementjev & Kabitzsch.

3.3 *Cleaning Management*

The cleaning of buildings is a service with high priority in Building Management. The fact causes on the conservation of the buildings value, high costs and the direct contact to the office users. Differences in the demanded price depend on

– expenditures of cleaning,
– frequency of cleaning and
– personal and material costs.

The most difficult problem with cleaning is the determining of the frequency (to keep the rooms in a defined clean condition) and the controlling of performance. Additionally it is nearly not possible to provide data about the real state of dirtiness and pollution. Often the rooms are cleaned without considering whether the room was used or not. For that specific case a research work determined that the dust pollution in used rooms is 10 times as high, as in rooms without any use. In conclusion a system needs to perceive, how often a room has been used. Figure 10 shows a possibility of a knowledge based cleaning service, that determines the real demand for cleaning from the data gathered from the Building Automation System. In that case it is possible to configure the cleaning activity conforming to the actual dust pollution. Therefore mainly the data of presence in room is needed to destine the value of usage.

The system bases on master data (areas, surfaces …) and operating data (presence, weather conditions …) of the integrated data structures. From the data base the data will be transferred contemporary to the software tool that derive the required information. Therefore regulations from the contract will be considered as well as administrative guidelines like performance benchmarks or number of available manpower. In addition the external short-term demands are taken into account (meetings rooms after their usage …). The result gives a cleaning plan for the building, which considers the actual cleaning demand with optimized sequences of operation.

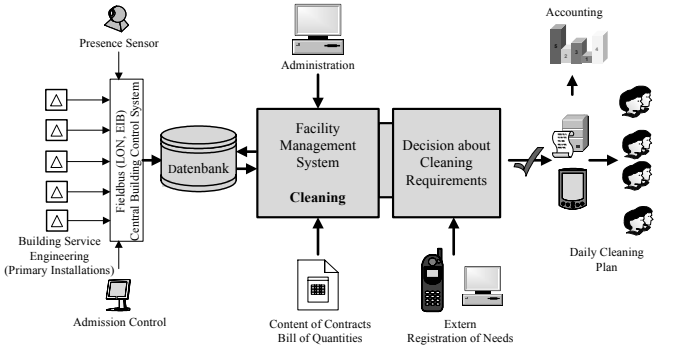

Figure 10. Registration and processing of the cleaning management

4 SUMMARY AND OUTLOOK

The present examples of knowledge-based services in Building Management give an overview in the different way of using integrated data structures. It can be seen as an attractive configuration and interactive support of the prime process of the clients. But for a practical implementation the appreciation of all responsible persons is needed for the necessity and advantages of open data structures. The main participants are the building owners and the producer of building service engineering. The building owners have to consider and plan a flexible and cost optimized using of their building. Therefore exact guidelines and sophisticated operating concepts, especially for standardized Building Automation Systems are prerequisites. On the other side the producers of building service engineering needs to disclose their proprietary data structures and use open, standardized structures like LON, EIB (KONNEX) and Backnet.

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