TRANSPARENCY, CONTROL AND OPTIMIZATION THROUGH BUILDING MANAGEMENT SYSTEM

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Abstract: *The paper presents the defining aspects of the building management system that obtained an important role because of recent technological progress and variety of data facing companies today.*
Building management system integrates, monitors and controls data of several building equipment, transmits commands and issues reports in real time. This system uses energy more efficiently, reduces utility and staff costs, while the management can make correct strategic decisions based on real data in real-time via the integrated software.
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Introduction

The advanced technology has become the main component of business activities. Integrated IT solutions for facility management or building management are already a priority for designers and constructors.

The modern terminology for the solutions which include all areas related to assets and real estate management is IWMS – Integrated Workplace Management Systems. These solutions appeared because the responsibilities for physical assets converged towards the facility managers. In addition to the traditional areas as space management and maintenance management,

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integrated management solutions include integrated applications for workplace management and project management, environmental management, health and safety management, energy management and many other applications. The main advantage of an integrated solution is to link data within the system.

Nowadays, change is the watchword, the workforce is mobile, and the real estate portfolio structure and the space used by an organization are increasingly complex.

As a result: mobile extensions are added (applications for mobile terminals such as smart phones, tablets, etc.) to enable the collection and interaction with infrastructure data anywhere and anytime, to reduce consumption, optimize costs and support sustainable strategic decisions based on data available in real time.

Building Management System - an overview

Building Management System (BMS) is a control system that can integrate, monitor and control signals from multiple types of mechanical and electrical equipment in a building, such as electrical installations, video surveillance, access control, lighting, ventilation etc. This definition is based on *An Overview to BMS* by Honeywell. Also through BMS, as far as the integrated systems permit, not only can signals be taken, but remote commands can also be transmitted.

BMSs are often implemented in large projects with extensive mechanical systems, HVAC and electrical systems and have a significant role in reducing energy consumption. Studies show that a project with BMS has reduced energy consumption by up to 70% when the lighting system was included.

This system basically controls the internal environment of a building, and sometimes it is linked to the access control (access doors which monitor and control the in-and-out-traffic of the building) or other security systems such as closed circuit television (CCTV). This has been supported by Redmann (2000). The BMS can also integrate fire alarm systems or elevators. The advantage consists in emergency situations when there is a fire, when only an alarm panel can control the ventilation system, stop the spread of smoke and send all the elevators downstairs in order not to be used.

BMS is a computerized system that, based on *An Overview to BMS* by Honeywell, can do the following operations:

- provide automatic and detailed information in text or graphic form in situations of alarm, about the place of the incident and the tactical procedures to be followed;

– provide indications of the alarm for the operational crews or of the overall risk situation;
– register and archive information related to reports and activities;
– take the control tasks of the communication systems, building facilities, alarm systems;
– facilitate the operation and maintenance of technical equipment;
– assist the operator in his duties of enacting security.

BMS is used to receive and share information, alarms and instructions and to interconnect control operations.

Depending on the data introduced into the system, BMS can be effective to deal with bomb threats, hostage taking, etc.

The system is equipped with powerful interactive software, secured and password protected and has accessible control panels, easy to use with mouse, touch screen and keyboards.

BMS functions and data collection system

According to the glossary of the online journal Baunetzwissen Sicherheitstechnik (*Aufgaben und Funktionen von GMS*) some of the important BMS functions are:

– receiving notifications and emergency calls;
– assistance;
– remote control of devices;
– surveillance of the monitoring equipment;
– care and maintenance of the system.

All actions are partially executed by BMS and stored in a comprehensive diary.

The data collection function provides real data about states and processes within the company. Personal data, contracts, equipment capabilities, their statuses, quality and maintenance are created in the data collection terminals and transmitted to ERP (Enterprise Resource Planning). In addition to the working time of employees, according to the glossary of the online journal Baunetzwissen Sicherheitstechnik (*Betriebsdatenerfassung BDE*) the following categories of data are important:

– data related to construction contracts, in particular, data such as control, cost, processing times, quantities;
– data related to personnel: the performance and working time of each employee, as well as data regarding their access permissions into the system;
– equipment data: working time, uptime, and downtime. On this data relies the decision making process about the maintenance of the equipment;

- information about tools and their use in the production process: life time;
- quality data: are used for monitoring and quality assurance, e.g. measuring values, classification of pieces, frequency measurement;
- data on the manufacturing process and its physical factors e.g. tolerances, temperature, pressure etc. with which the production process is monitored and controlled.

Benefits of the BMS

The benefits of implementing a BMS are various. In the following table we present just the most import benefits based on *An Overview to BMS* by Honeywell, Ramadan (2014), and World Bridge (2015).

Table 1 - Multiple Benefits of BMS

Building occupants	**Building owner**
Efficient control of internal comfort conditions Individual temperature control Excellent occupancy comfort Improved staff productivity Effective monitoring and targeting of energy consumption Improved plant reliability and life Effective response to HVAC-related complaints Save time and money during the maintenance	Higher value on property Higher rental value Flexibility on change of building use Individual tenant billing for services facilities manager Central or remote control and monitoring of building Increased level of comfort and time saving Remote Monitoring of the plants Central or remote control and monitoring of building
Other benefits	
Energy efficiency Lower operation, maintenance, utility costs Centralized data Intelligent reporting Simplified Building Operation Risk reduction by managing alarms	

This list makes it clear that BMS is as an effective partner of the company's management through the technical optimizations it offers, which are reflected in the company's economic and financial indicators.

BMS advantages given by its components structure

Taking into consideration the information given by Honeywell, we can state that BMS consists of the following components:

- ✓ Field devices:
  - Temperature, humidity, pressure sensors;
  - Valves, actuators;
- ✓ Controllers:
  - Micro-processor based;
  - Pre-configured / Freely programmable;
  - Controls the HVAC equipment of the building;
- ✓ Centralized WorkStation Computers: web servers, computers with user-friendly software used at:
  - Management level for communication (data and log requests, order entry, programming parameters, etc.) and data processing and saving;
  - Operational level, including automated systems capable of communicating with each other and with central systems, with resident programs suitable for all tasks of algoritming, computing, alarming, reporting, optimization, monitoring and control.

System operation is ensured by controllers. They exchange information between them. The common commands are the time programs. The control loops are automatically controlled based on implemented programs. The system operates continuously without a permanent presence of a human operator.

Because of its three components, with well-defined functions, BMS presents to the organization a number of quantitative and qualitative advantages, as Redmann (2000) has already noticed:

- ✓ Quantitative advantages:
  - Reducing energy costs;
  - Optimizing the maintenance service
- ✓ Qualitative advantages:
  - Increasing the level of safety;
  - A high degree of comfort for the occupants;
  - Decrease of the intervention time in case of a failure of the equipment.

Examples of portfolios with BMS

As Messenger (2014) says, BMS can be used in new constructions as well as in old ones, so it can be integrated into the following types of constructions:

- Rehabilitation: it is a major opportunity for the existing buildings to reduce energy consumption. The challenge in this case is to integrate all categories of equipment in one system (e.g. International Hotel Iasi, Romanian National Library – Bucharest);
- New constructions: in this case the building managers optimize the building in the phase of design, initiation, planning (e.g. Petrom City – Bucharest).

a) International Hotel Iasi

After the rehabilitation of the International Hotel, as we found in the Siemens press release (2014), a BMS was introduced, as follows:

- the automation of HVAC installations,
- the fire system,
- security system,
- automation control system of hotel rooms,
- heavy current (electrical panels, bars, analyzers, electricity etc.).

These solutions manage the temperature in rooms and the light in common spaces, the access into the hotel and the fire prevention, through the constant information of the operator about the condition of the building. All systems are controlled by the building management software package that can be managed with simple commands, even by people without programming knowledge. This reduces both energy and personnel costs, and the hotel is managed by three people responsible for maintenance, compared with 10 people responsible of these activities before implementing BMS.

The entire BMS implemented could lead to an estimate energy consumption three times lower comparing to a similar hotel with traditional operating systems.

b) Romanian National Library

Installations and systems serviced by BMS, according to AIIRO (pdf) are:

- heating sources (thermal general point and thermal individual points for each building);

– cooling sources (chillers and cooling points for each building);
– air treatment plants;
– climatic cabinets for archives and book deposits;
– ejecto-convectors for cooling local spaces inside the National Library;
– monitoring nearly 600 fire dampers.

The BMS implementation results are:

– the building can be operated by two people per shift;
– due to the graphical operating environment, the building can be operated by staff without advanced knowledge about computers;
– all defects and malfunctions are automatically displayed;
– there is the possibility to generate reports, graphs, etc.;
– possibility to perform remotely interventions by specialists;
– automatically sending messages (SMS, e-mail) when alarms occurs;
– based on the information acquired over time, the system has the possibility of implementing energy optimization algorithms.

c) Petrom City

BMS in Petrom City is implemented separately for each of the two main buildings. It provides a fully automated building management system, consisting of:

– control stations (servers);
– operating stations including inputs and outputs needed (PCs);
– mobile operating stations (notebooks) for local operation system;
– automation devices including peripherals;
– switching cabinets for informatization and communications power supplies;
– automation systems rooms (individually controller of rooms);
– required interfaces to connect to other systems, such as safety management, etc.
– operating licenses, including cooperative activities with other subcontractors for commissioning, verification, preparation of documentation etc.

Automation devices are designed to read functions, application programs and / or operating parameters through media and network media,

as GMP Technical Solutions (pdf) explains. In case of power outages or connection interruptions, it will automatically transmit internal system error messages according to the failures.

The automation system of the rooms has a connection interface and standard communication protocol that is connected to the building automation system. It includes:

- temperature control devices for cooling components, floor convectors, ceiling cooling, air flow, etc.;
- light control system depending on the type of rooms;
- control device sunshades;
- monitoring/signalling fire protection.

For each control or area circuit of room automation, there is a separate program running to be configured and operational parameters must be established.

For each room the control circuit will be set at least with three operation modes: normal, low or night (and/or outside office hours).

Switching the mode of operation is performed:

- automatically through multi-sensor programs (for office areas, management rooms and meeting rooms) and/or switching programs;
- manually through the presence sensor into the operating room or through centralized control.

All relevant data (according to customer specifications) will be displayed on the monitors of the operating station of the building automation system.

The monitorization of the information is done at each block of automation level.

d) Other examples

There are numerous other examples that highlight the benefits of implementing BMS analyzed in terms of economic, social and energy efficiency. Among the buildings that have implemented BMS we can name: Coltea Hospital, 'Henri Coandă' International Airport, the new building of the National Theatre of Bucharest, factories: Hella (Lugoj), Eurotire (Drobeta Turnu-Severin), Expur (Slobozia), Renault Technologies Roumanie, Bucharest Business Park, Marriott Hotel, International Hotel Sinaia, hotel chain NH, Pirelli factory (Gorj), hypermarkets: Cora, and Kaufland.

Future perspectives

There is a tendency to increase investments in BMS due to the economic advantages: low energy consumption cost, low maintenance costs. This view has been supported by Siemens (online)**.** The upward trend of investments in BMS is observed both in the private and public sectors and covers all types of buildings.

Due to the fact that the systems allow complete automation of the heating, ventilation and air conditioning processes, as well as of the lighting and shading solutions, energy consumption by up to 30% lower can be obtained (Roth, 2002). Building managers are more open to improving the energy performance, in particular because of the opportunity to reduce managerial costs, but also because of the trend of alignment with the development of the 'intelligent buildings' concept.

Future technologies are based on aggregated information derived from a wide range of applications and data sources. With a comprehensive catalogue of locations, objects and installations of a building, their functions can be optimized in order to meet the requirements of the current time and space.

Integrated automation systems will lead to what is inevitable: smart buildings that have already begun to appear.

The buildings are constructed in order to ensure the comfort of the people inside. Over time, building components have been developed and improved to allow building managers to select independently lighting, security, heating, ventilation and air conditioning systems, as they should be integrated into a complex system. Today, the buildings are complex concatenations of structures, systems and technologies.

Building managers have started to look beyond the building's walls and to consider the impact of the economic activities on the mission of the building, the electrical network, the global environment. Managers have understood that it is not sufficient for a building to be equipped with systems that provide comfort, light and safety. The buildings of the future must connect these systems in a dynamic and functional way, to fulfil the mission while reducing energy costs, supporting a robust electricity network and mitigating a negative environmental impact.

At the most fundamental level, smart buildings are providing services that ensure a high productivity for their occupants (by providing appropriate lighting, thermal comfort, high air quality, security, etc.) at the lowest cost

and with a positive environment impact throughout its lifecycle. This view has been supported by Coles (2011). This development requires complex information from the early design phase until the end of the building's life cycle. Intelligent buildings are connected to the electricity grid and interact with the entire building operators and occupants to empower them with new levels of visibility and information. In a not too distant future, we can imagine, as Messenger (2014) has already imagined, even smart cities.

Conclusions

Building management system is an efficient modular system, necessary and important, which is based on a fast and efficient exchange of information between the different involved components and devices. The system is an assembly of equipment for automatic control and centralized supervision of various subsystems that equip the building. This view has been supported by GMP Technical Solutions (pdf).

By permanently monitoring and by its independence from the human factor (no need of human intervention), costs are minimized and the building's operating conditions are optimized. Cost minimization, energy efficiency and high productivity achieved by implementing the building management systems on a large scale are leading to a sustainable development at micro and macroeconomic levels.

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