WS 23: Quality management for building performance: Closing the gap between design and operation

Tuesday, May 24, 10.30-12.00 (Meeting room: Bondestuen)

Workshop organiser

IGS, TU Braunschweig, Germany, www.igs.bau.tu-bs.de

Presenter

Stefan Plesser, IGS, TU Braunschweig, Germany
Michele Liziero, Energy Team SPA, Italy
Jan Mehnert, synavision GmbH, Germany
Niels Delaere, Factor4, Belgium

Introduction and Background

The tremendous technological advances and integral approach to building conceptualisation allow design, building and operation of highly energy efficient buildings, but at the same time contribute to the increasing complexity in building systems and their mutual interactions. As a result, a new risk with high intensity has presented itself: lack of quality in building performance.
To tackle the challenges related to quality of building performance, QUANTUM, a research project within the European Programme Horizon 2020, develops and demonstrates services and tools, which support quality management in design, construction, commissioning and operation phases. The main objective is to close the gap between predicted and actual energy performance in European buildings.
Three Quality Management (QM) tools will be developed and applied within the QUANTUM project.

Summary of the Presentations

Stefan Plesser introduced the workshop topics with the presentation "From Design to Performance: Why quality must be the next step towards better building performance?". The gap between predicted and actual energy performance is caused by different factors such as lack of quality, deficiency in technology, and lack of incentives. The European call EeB-07-2015 demanded new tools and methodologies to reduce this gap at the level of buildings and blocks of buildings, proposing that activities should focus on ICT at Readiness Level 5-7. Annex 34 of IEA Energy in Buildings and Community (EBC) Programme (Computer Aided Evaluation of HVAC System Performance) also stressed that, although quantitative performance have been defined, «It is sometimes difficult to apply them, particularly in real buildings*".*
QUANTUM consortium, formed by 14 partners, will provide a solution to these issues, developing pragmatic services and appropriate tools with high replication potential supporting Quality Management (QM) for building performance. "Quality" is measured by the degree of compliance with predefined standards and other recommendations (European Commission). By controlling the deviation between the predefined requirements and the outcomes you can deliver quality. Within QUANTUM, the core mechanism is to "design for testability" by specifying transparent performance targets with cost effective testing methodologies.

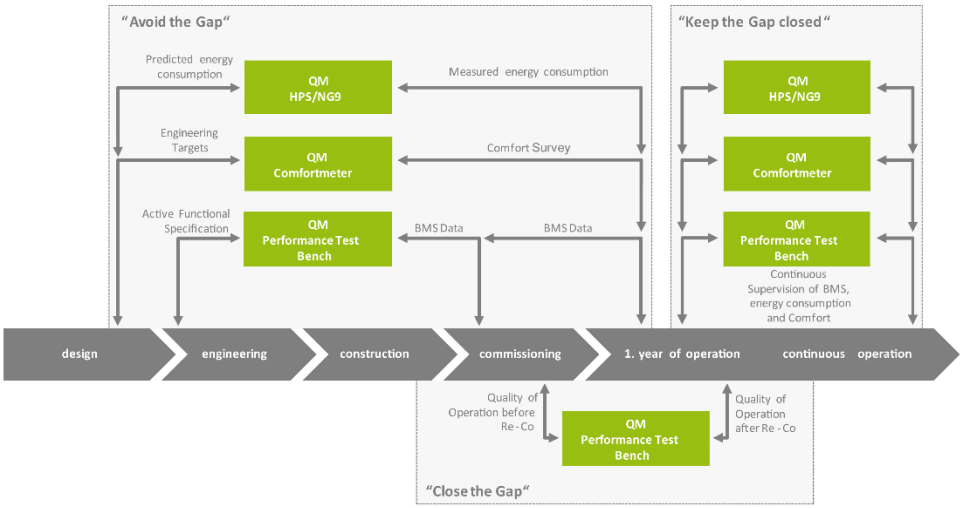

Figure 1 - Quality management processes in the QUANTUM project which involves different phases from design to ongoing commissioning (continuous operation).

Including QM to the construction sector means to develop and integrate quality control loops that define a testing procedure between target and measured value. Although it is difficult to define the target value (expectation), this is the only way to carry out a transparent and proper evaluation which will actually make the difference. Other aspects of QM are also important such as carrying on QM in an independent way, testing QM (and not only running it), creating a constructive and positive spirit around QM and ensuring QM is enforced (even if that means stopping a production chain and losing billions of Euros). Previous experiences showed the importance of being involved in a project from the beginning and to clarify what the purpose of QM is and what needs to be tested since usually there is a lack of interest and awareness about it.
QUANTUM project aims to:

- Develop tools, services and business models supporting within the building life cycle (from design to operation phase);
- Implement QUANTUM tools to representative set of typical European buildings;
- Proof cost effective multiplication.

Three ICT tools have already been developed by consortium partners and are almost ready to be used:

- HPS/NG9 (by Energy Team, Italy). Cost effective and easy to install in-situ energy metering devices with online and on-site data analysis;
- Comfortmeter (by Factor4, Belgium). Completely web-based questionnaire for perceived user comfort;
- Performance Test Bench (by synavision, Germany). First tool for a digital specification and automated validation of Building Management Systems (BMS).

The companies will retain the ownership of the tools and sell them in order to guarantee technical support, training and keep a high business interest on them.

Michele Liziero talked about using energy data to obtain measurable energy efficiency within energy monitoring of buildings. Two examples of applications of methods for identifying energy saving were described:

- Energy signature (scatter plot) of an office buildings according to the system power (e.g. for heating system, Daily Average Heating Gas Power in Kw) and External Temperature (°C). By combining different variables, for different energy needs, it is possible to identify incorrect set-up and potential energy savings;
- Carpet plot according to Specific Electric Power [W/m2] and time (day and hour). A different visualisation of data which for example help to identify the saving potential during weekends.

Energy Team proposes and implements also other methods to highlight savings potential by advanced data visualization.

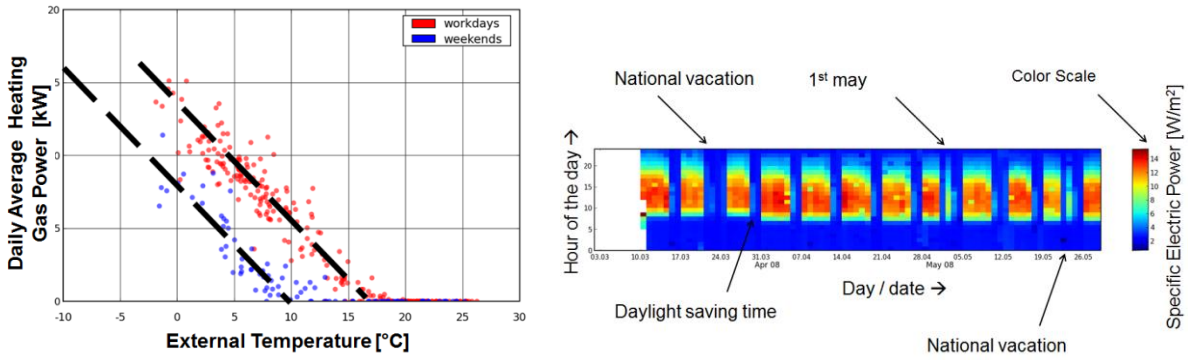

Figure 2 – Different energy signatures of heating systems (on the left) for the same building considering clusters of data (workdays and weekends). The carpet plot (on the right) shows the energy pattern condensing a lot of data and providing much more information compared to other types of representations (e.g. histograms or power curves).

An experiences from Energy Team has been shown, demonstrated that more than 1000 Euros of annual savings can be achieved just by spotting unexpected usage on a single Air Handling Unit (e.g. during night). Mr. Liziero described the main characteristics of NG-9 tool responsible for evaluating energy performance:

- Plug and play probes, from 1 to 2000 Amps;
- Power analyser, Mono-phase and Three phase, other probes;
- Easy configurable, up to 160 measures in 5 DIN modules;
- Very low power consumption;
- Possibility to integrate in the same tool also digital signals (e.g. coming from temperature probes).

On the other hand, the Harvesting and Publishing System HPS will evaluate performances of Building Management Systems (BMS) by:

- web and local analysis: distributed intelligence without the need of installing a software;
- collecting and exporting a lot of local data, from proprietary systems or other systems;
- providing access locally via mobile or WI-FI hot spot, remotely via internet;
- guarantying secure communication.

The tool will deliver an integrated solution for energy consumptions monitoring on Web Server platform, implementable also in existing buildings. The audience rose an interesting debate concerning the right balance between quality requirements (to be defined in advance) and affordable monitoring devices (e.g. probes). Mr. Liziero highlighted the difference between cost of apparatus and total cost of monitoring systems, considering also installation cost, configuration cost and maintenance cost. NG9 addresses expressly the total cost of energy monitoring reducing it considerably.

Niels Delaere illustrated the evaluation of indoor environmental qualities, based on building users' answers, with the Comfortmeter. Factor 4 usually applies the Comfortmeter in Energy Performance Contracting (EPC) and recommissioning projects, before and after the execution of the project, in order to guarantee the quality and results. The tool currently covers 55 buildings and 120 additional building will be added in 2016 within QUANTUM project and even more before the end of the project.

Within QUANTUM project, Comfortmeter will:

- determine the comfort problems in a building;
- evaluate the impact potential of users on the comfort conditions;
- evaluate the impact of the comfort level of the users and the impact of them on the building operations.

It is important to provide comfort to the user since their behaviour will contribute to the energy gap (e.g. by opening windows or increasing heat). Nevertheless, although technical requirements for indoor environmental

quality are clear, user perception of comfort may vary considerably. Furthermore, the overall notion of comfort covers many aspects such as temperature, air, light, sound, control, office and building.
For this purpose, the system submits an online survey covering all the above-mentioned topics related to comfort, in relation with the specific building zone. The system, while guarantying the anonymity of the answers, requires also personal information concerning gender, age, productivity levels and frequency of utilization of the different buildings zones. The cost of a survey covering about 200 respondents ranges from 1500 to 1800 Euro, and it is generally submitted on trimestral basis in order to take into account seasonal variations.
The output is a pdf report for the whole building and for each building zone which analyse the comfort aspect comparing the survey results with best practises, providing also an evaluation of the comfort and productivity improvement potential.
There was a lot of interest from the audience about the relevance of the survey answers. While survey answers may be influenced by specific and temporary conditions, survey instructions require participants to define more their usual perception of comfort. Currently the survey doesn't take into account the different importance which each user would assign to each comfort aspect although participants can define it as free text comment.

Jan Mehnert concluded the presentations session summarising how Active Functional Specifications can close the loop between concept and operation of building automation controls. Most of commercial buildings has a BMS (and every newly built commercial building will have it) thus data are generally available and can be used to exploit the saving potential due to lack of quality in operation of building services. However, while standards for performance tests are available in other sector (e.g. Standard Plugin Testing for car), commissioning of building automation is usually done by visual examination due also to the specific situation of each building.
Synavision fill this gap by providing a digital performance test bench to close the loop. Evaluation in the form of a digital performance check is performed after implementation of active functional specifications (based on mathematical described rules) which are then compared with BMS data. The results show the state of operation in the form of a chart (divided by days and hours of operation) which allow to identify faults in the system and to optimize building performance.

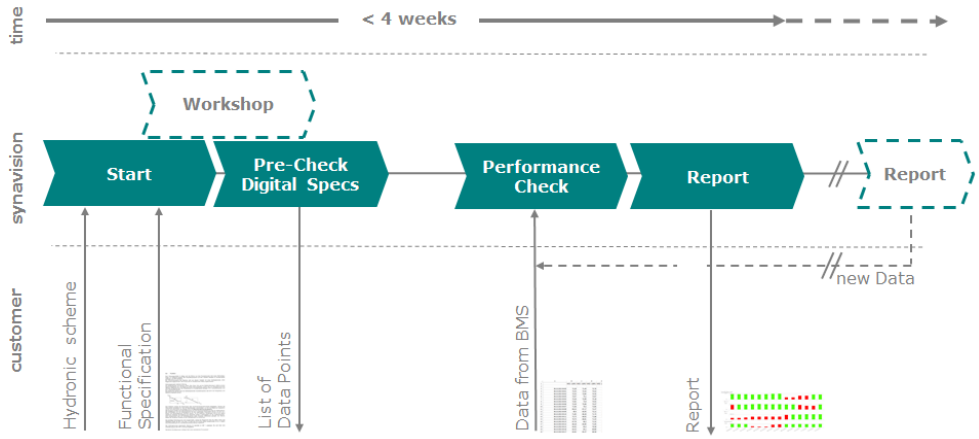

Figure 3- Basic workflows of synavision projects

The main features of Performance Test Bench are:

- Effectiveness: checks are part of regular processes in the building sector;
- Transparency: all specifications and evaluations are comprehensible and documented;
- Fastness: it takes less than four weeks from the start to the report delivering;
- Easiness: engineers need less than four weeks to start using the tool;
- Robustness: digitalization ensures scalability;
- Affordability: quality management for commissioning has a valid business model.

The process of extracting data from BMS aroused the curiosity to the participants who questioned the lecturers about why measured data is not compared to set-points to detect faults in the operation. The Authors mentioned that this approach would not detect faults which differ from designed values.

Discussion and main results

The workshop attracted mainly engineers but also other kinds of participants (e.g. manufactures and installers) and, even before the discussion panels, many interesting debates arose:

- Lack of specification of requirements (in particular Owner's Project Requirements) and unfulfilled quality expectations. First it is important to define the specifics the specific needs and then it is possible to establish measurable targets;
- Importance of quality management (especially in facility management). Without quality standards, commissioning usually results in bad outcomes;
- Timeframe of the quality management within QUANTUM. The goal of the consortium is to develop tools which address a specific part of the commissioning process (not only to the whole life-cycle) which could be used by third-party and turned into a business model;
- Role of the architect. This is very important although it may vary considerably, depending on their professional background and project organization.

The organisers collected also the feedbacks of 26 participants through an on-site pool:

- 50% of the participants answered that more than 30% of energy is wasted in buildings due to bad quality. However, that it is not usually seen and understood by the building owners.
- 72% of the participants agreed that a combination of BMS with HVAC systems is mostly responsible for quality gaps.
- The audience expressed different opinion regarding which kind of professional is mostly responsible for quality gaps. On this regard, operation and management professionals (35%) were followed by engineer (23%). A similar result occurred regarding the comfort aspects where engineers and operation management professionals (41% in both cases).
- There was no common agreement on which barrier is the most important for quality management. Building owners (29%) were closely followed by lack of competence and effective business models (23% in both cases).
- All the attendees agreed that energy gap solutions need energy monitoring systems for continuous evaluation although a small percentage (28%) stated that it depend also on energy intensity.

Conclusion and future work directions in the field

The concept of the workshop was set up to introduce the tools to the audience and gather the feedback from experts. The attendees showed a lot of interest and agreed on the importance of quality management in building commissioning although they also highlighted many barriers and constraints regarding the applicability of it in practise. QUANTUM consortium has already started to integrate the project tools into service and apply them to various buildings in order to collect representative data sets and support the market uptake.
The final results from the first set of buildings will be presented at CLIMA 2019 in Bucharest. Intermediate results will be published on QUANTUM website starting from next year until the end of the project in 2019.

Acknowledgements

QUANTUM project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 680529.

References

The workshop's presentations, photos and outcomes of voting sessions are available at
www.rehva.eu/events/clima2016/clima-2016-workshops/ws-23-quality-management-for-building-performance-closing-the-gap-between-design-and-operation/ws23-presentations-and-photos.html

Further information at www.quantum-project.eu