D1.02

Generic guideline and process structure for quality management

[Report]

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Abstract: The deliverable of generic guideline and process structure for quality management defines the generic process structure, describes approaches how it will be used within Quantum and gives an overview how the tools support the quality control.

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History of changes

CHAPTER NO.	DESCRIPTION OF CHANGE

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1 INTRODUCTION

Within industrial production quality assurance concepts are already a common practice. The target for example in the car industry is to improve their products and increase process efficiency. In contrast to the construction industry their products are mostly standardized. The producing process is often repeated in exactly the same way. Because buildings are unique products that are constructed individually quality assurance and continuous improvement is a bigger challenge. The only example for continuous quality management during a construction process is in case of fire protection issues where a high quality level is needed to protect people’s lives inside a building.

But not only for life-saving issues including quality management into construction project lifecycle has advantages. Figure 1-1 shows the meaning of including quality management into a construction project from Quantum´s point of view. There are three key issues steering a project: quality, cost and time. Quality normally has an important key role in the beginning while the building is designed. With more detail in drawings and measurements the meaning of costs increases because it gets clearer how much money it will cost in compared to how much money the owner has. When a constructor is hired costs are the most important key issue while quality aspects decrease. The same problem occurs in the end of construction stage when the date of commissioning is fixed and the building needs to be finished. Every day of delay will cost the constructor much money especially if finishing date is fixed in contract. At this stage time gets more and more important and quality stays in background. The importance of quality strikes back when the building is in use and quality lacks are recognized.

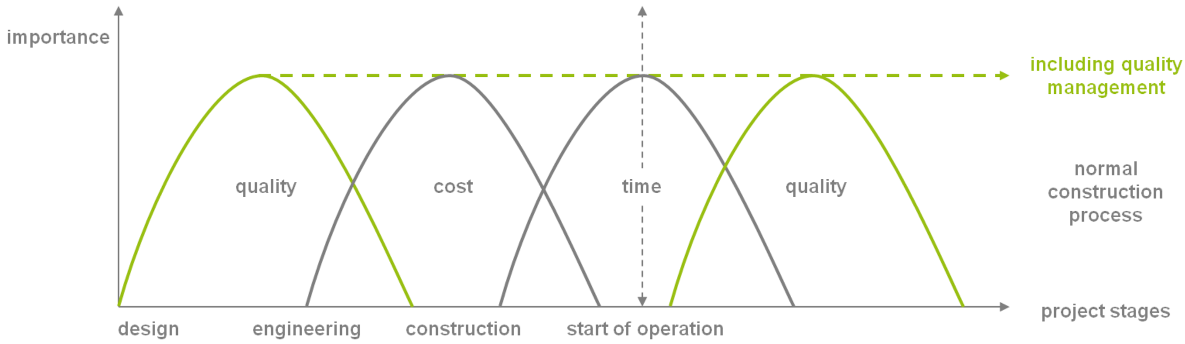

Figure 1-1: Importance of quality management during project lifecycle

Source: IGS

The solution is to include a quality management processes that ensures a high importance of quality all over the lifecycle, from design to operation. Therefore construction industry needs to learn from procedures of other industries and adapt general items.

The result of this adaption is shown in this report. Chapter 2 defines the generic process structure with its specific elements before chapter 3describes approaches within the Quantum-Project using it all over buildings lifecycle. Chapter 4 will then give an overview of how the developed tools support the quality control within Quantum.

2 PROCESS STRUCTURE OF QUALITY CONTROL LOOPS

Including quality management to the construction sector means to develop and integrate processes that guarantee regularly checks of quality issues. A general procedure is given by quality control loops that define a testing procedure between target and measured value. This should be completed with a feedback mechanism to the future of the same project or to other projects in future (Figure 2-1). A quality control loop generally consists of four key elements.

At first a target value is defined during design and engineering stage which should be fixed within the tendering documents. This points out which target a specific attribute needs to have after finished construction. Target values should be specific key factors that can easily be measured and should not require complex simulations. This could be for example time schedules for heating, specific fan power for ventilation systems, degree of efficiency of chillers as well as maximum or minimum room temperatures.

Every target value has a measured value as opponent that will be figured out at hand-over or during operation. It has to be measurable easy and precise at assigned project stage. For example the heat transition coefficient can hardly be measured at construction side. An easier way to proof the correct built-in performance is needed. The corresponding test procedure evaluates the thickness of the insulation and the designed thermal conductivity from inbuilt materials at construction side. This example shows the importance of feasible testing values and the crucial right moment because there will be a time where insulation is not visible anymore so that controlling gets impossible. In addition it is always needed to generate documentation templates for measurements to ensure the correct understanding of the results making this procedure replicable.

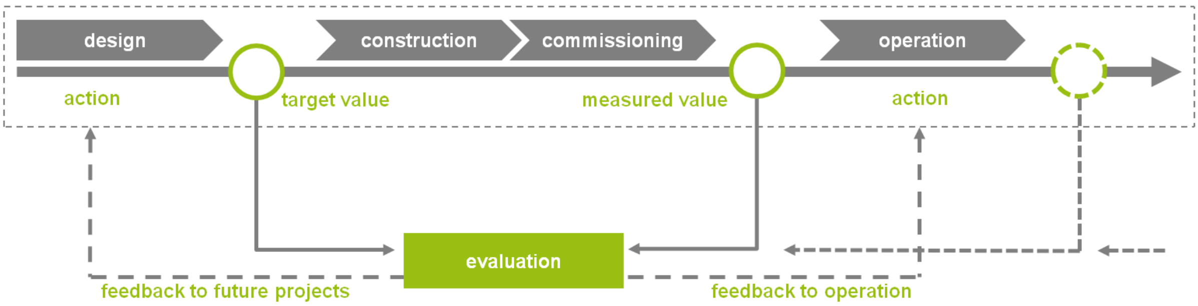

Figure 2-1: Quality control loop

Source: IGS

To compare target and measured value is the key issue of the **evaluation**. With this testing procedure it is verified how high the deviation between target and measured value is. Corresponding a level of quality can be specified which sometimes includes tolerances as an acceptable degree of deviation.

The **feedback** mechanism in the end expands the comparing evaluation procedure to a quality control loop. This ensures the closing of quality gap through a specific action and guarantees continuous improvement by learning for future projects. Using this element the quality control concept gets effective for specific and future projects.

Implementation of quality control loop into project lifecycle leads to efficient processes and high quality knowledge as well as quality thinking all over project lifecycle. If quality management issues are defined early in the project, get fixed in the contract while tendering and will be respected during construction and operation stages with feedback to future projects a continuous high importance of quality will be guaranteed. (eg. Figure 1-1 “including quality management”)

3 GENERIC GUIDELINE ON IMPLEMENTATION OF QUALITY CONTROL LOOPS INTO BUILDING LIFECYCLE

Using quality management to solve the gap problem requires an implementation of quality control loops all over project lifecycle. The gaps figured out in deliverable D1.01 “Report on state-of-the-art of quality management” should be handled within Quantum by three approaches that are shown in Figure 3-1. The main idea is to achieve robust buildings with high quality level in the end by continuous quality management all over buildings lifecycle.

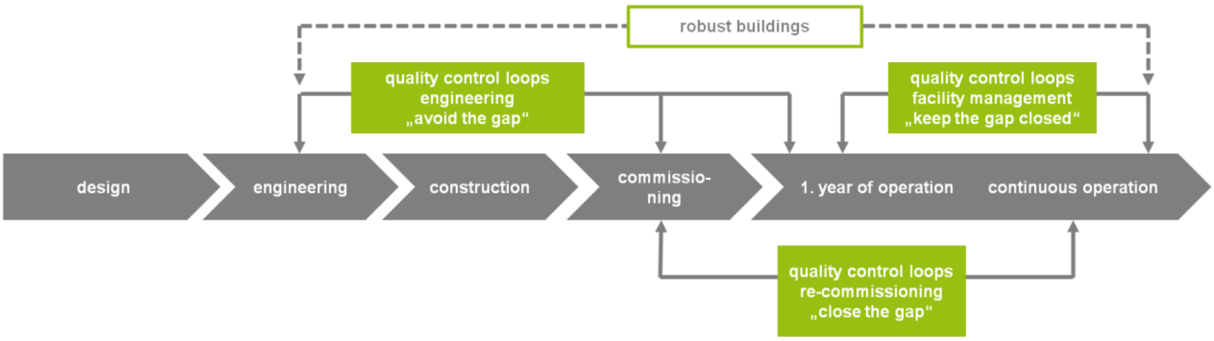

Figure 3-1: Quality control loops within Quantum

Source: IGS

At first quality control loops during engineering stage and during construction planning should early “avoid the gap” through continuous controlling of drawings, calculations and target values. This leads to high quality of guidelines for the commissioning process and a smaller deviation between design and operation stage. The second approach is to “close the gap” by re-commissioning. The idea is to have a very strong controlled commissioning process before hand-over. In addition after hand-over with the beginning of operation there should directly start operation tests to early figure out re-commissioning-activities that have to be implemented to get the building operate in the designed way. The third approach deals with the idea of “keeping the gap closed” during operation. Therefore continuous control loops are implemented during operation stage that continue in best practice all over lifecycle.

4 FIRST IDEAS OF COMBINING TOOLS AND QUALITY CONTROL LOOPS

Within Quantum there will be three tools further developed and validated for effective quality management. The tools will serve as quality testing elements that generally provide the measured values and support an evaluation between targeted and measured values. To include them into a generic quality management process it is necessary to define which approaches from chapter 3 will be used by every tool within Quantum and how they could be incorporated into the process. This chapter will show first ideas concerning a combination of the tools and quality control loops.

By using the different tools the three categories of gaps: energy consumption, comfort issues and technical building functions figured out in deliverable D1.01 “Report on state-of-the-art of quality management” can be addressed. The Performance Test Bench (PTB, formerly Energy Navigator) focuses on evaluation of technical building functions by using a robust functional specification methodology to evaluate functional performance during operation. In addition as a second tool the metering device HPS/NG9 is able to quickly check the energy consumption and early recognize significant performance faults. To complete the evaluation of holistic building performance testing the comfortmeter helps to analyze user behavior and building perception. Figure 4-1 gives an overview of how those tools address the gap-solving-approaches from chapter 3.

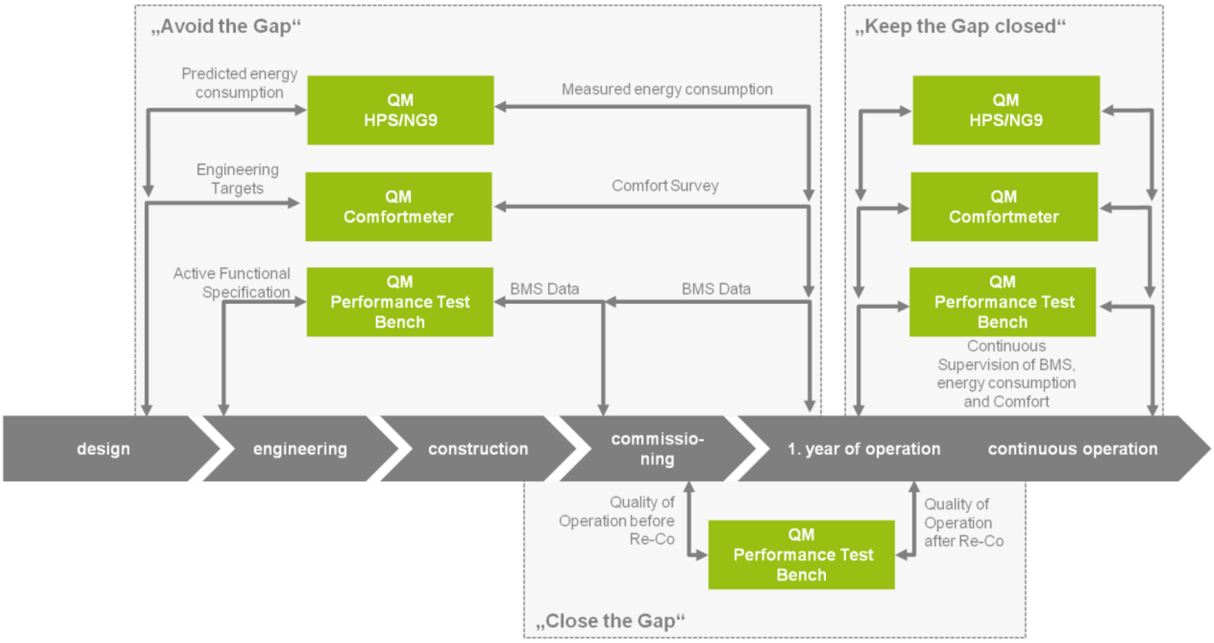

Figure 4-1: Implementation of tools into quality management process

Source: IGS

There are three possibilities to implement the **Performance Test Bench** into the quality management process:

- **Avoid the gap**
  The first option leads to avoid the gap. Therefore it can be implemented in two quality control loops: at first between design and commissioning and the other one between design and operation. During design stage building automation rules are defined in “Active Functional Specifications” that later can be compared with BMS data at the commissioning as a short term evaluation but also during the first years of operation for a long term evaluation. The gap can be avoided by using both quality control loops in combination because targets are defined early in project. Furthermore an achievement is a verification under real using conditions during commissioning which is a very critical project stage concerning building functions and during early stage of operation.

- **Close the gap**
  In-between commissioning and operation can be a quality control loop as well. It evaluates at first quality-check during commissioning. Based on these results re-commissioning activities can be defined as feedback mechanisms. After their implementation there is a second quality evaluation to check its effort. These quality control loops lead to close the gap at a very critical point during project lifecycle.

- **Keep the gap closed**
  The third approach is addressed by continuous quality control loops during operation which should keep the gap closed by continuous evaluation and early identifying these negative changes.

Comfortmeter provides two possibilities for quality management within project lifecycle.

- **Avoid the gap**
  At first there can be an evaluation between design and operation targets. These are based on engineering targets as target values and results from comfort surveys as measured values. This kind of quality control loop avoids the gap because comfort targets are defined early in the project. If comfort targets are not fulfilled from user's point of view a feedback mechanism can only be preceded in combination with another tool that is able to find technical or constructional reasons.

- **Close the gap**
  In contrast to PTB it cannot be used during commissioning because the user just becomes involved after hand-over.

- **Keep the gap closed**
  During operation it can be used to keep the gap closed. Therefore continuous comfort surveys allow supervision of comfort and early recognizing of comfort changes.

For similar approaches **HPS/NG9** can also be implemented into quality management processes.

- **Avoid the gap**
  To avoid the gap it can be used to measure energy consumption during first year of operation evaluating the accordance to predicted energy consumption.

- **Keep the gap closed**
  Second possibility to use HPS/NG9 as quality control tool is to keep the gap closed during operation. A continuous evaluation of energy consumption can easily show changes in building operation. It serves to early recognize if a quality gap starts to occur. This leads to an early activation of countermeasures. But activities concerning feedback mechanisms cannot be figured out with HPS/NG9. That´s why it needs to be combined with a second quality management tool that is able to check building functions to fulfill the whole generic quality control loop.

Using those three tools in combination lead to a holistic quality management concept for building performance that can be implemented into the portfolio of engineers as a quality management service. For every building and project several combinations of tools and tests can be used depending on specific requirements. It permits a flexible application in various project situations. To further develop these ideas the next step should be detailing the needed testing processes for each tool and show how they can work together in an optimal way.