Project nº: TREN/04/FP6EN/S07.31038/ 503135

Acronym: BRITA in PuBs

Title: Bringing Retrofit Innovation to Application in Public Buildings– BRITA in PuBs

Instrument: Integrated project

Thematic Priority: 6.1.3.2.1 ECO-BUILDINGS

D17
Quality Control Toolbox Manual

Revision: **0**

Due date of deliverable:	**30/04/2008**	Actual submission date:	**15/07/2008**
Start date of project:	**1/5/2004**	Duration:	**48 months**

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Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

D17
Quality Control Toolbox Manual

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Disclaimer:

Bringing Retrofit Innovation to Application in Public Buildings – BRITA in PuBs has received funding from the EU 6th Framework Programme under the contract:
TREN/04/FP6EN/S07.31038/503135

Content

Preface

The BRITA in PuBs project is an EU-supported integrated demonstration and research project that aims to increase the market penetration of innovative and cost-effective retrofit solutions to improve energy efficiency and implement renewable energy in public buildings all over Europe. Firstly, this will be realised by the exemplary retrofit of 8 demonstration public buildings in four European regions (North, Central, South, East). By choosing public buildings of different types such as colleges, cultural centres, nursing homes, student houses, churches etc. for implementing the measures it will easier reach groups of differing age and social origin. Secondly, the research issues include a socio-economic research study identifying real project-planning needs, financing strategies, the development of design guidelines, the development of an internet-based knowledge tool on retrofit measures and case studies and a quality control-tool box to secure a good long-term performance of buildings and systems.

Bringing Retrofit Innovation to Application in Public Buildings – BRITA in PuBs is therefore a leading project within the EU ECO-BUILDINGS programme. The ECO-BUILDING concept is expected to be the meeting point of short-term development and demonstration in order to support legislative and regulatory measures for energy efficiency and enhanced use of renewable energy solution within the building sector, which go beyond the Directive of the Energy Performance of Buildings (EPBD).

1 Introduction

The objectives of the Brita-in-Pubs project, Work Package 3 were as follows:

A quality/performance control toolbox

- A concept from design to post construction life long management, using Building Energy Management System - type procedures and using prevailing methods.

WP3 draws upon also other working packages, especially WP1, WP2 and WP 9 and is linked also to WP4.

The tool-box was planned including

- quality control procedure for implementation stage including the analysis of the realization phase of the demonstration buildings
- risk-management and preliminary energy/life-cycle costs calculation model for the design and planning stage commissioning and in the stage of use:
- Energy audit model for ascertaining the performance of the building.
- a web-based energy and facility management monitoring system, which has feedback to the planning stage and can be used in benchmarking

The toolbox was tested in one demonstration building. The work package with the coordination of VTT will have the following contributors:
IT Power (UK), Cenergia (Denmark), VTT (Finland), ENEA (Italy), EuDiti (Greece), BUT (Czech), VGTU (Lithuania).

The original overall frame for the Facility Management Quality Control System is shown in the figure 2. This was based the prevailing procedures and concepts (also partly developed in IEA-ECBCS-Annex 40- project, from ASHRAE and in the national project of Annex-40, and in the other projects of Life-Cycle Services and Risk Evaluation).

The procedure includes the different stages of the building process. Figure 2 (page 9) shows how the requirements and goals will be checked between each stages of the project. Each diamond, “salmiac” contains a list of tasks and operations – checklists.

The existing toolbox frame version has been installed to the project website. The structure of the overall quality control procedure has been simplified from 7 stages to 3 stages combining the previous checking points (see Annex 1). The checking points – “diamonds” will be opened to detailed checklists. There are also descriptions of supporting tools: Energy audit procedure, Operation and Maintenance Manual, Risk Evaluation Model and Benchmarking procedure and Life-Cycle Calculations. A streamlined flow chart is presented in the figure 1. The website opening pages are in the Annex 1.

The general frame of quality control toolbox follows the results and procedure generated and published in IEA Annex-40 project “Commissioning of Buildings and HVAC-systems for Improved Energy Performance”

The facility management tool as a link to WP 9 (e.g. https://www.rauinfo.fi) for monitoring has been started in the month 48 to take into the use in 6 demonstration buildings. Five targets will have manual data entry and in one target the FM tool (developed by Poyry Building Services) is connected to BAS (Building Automation System).

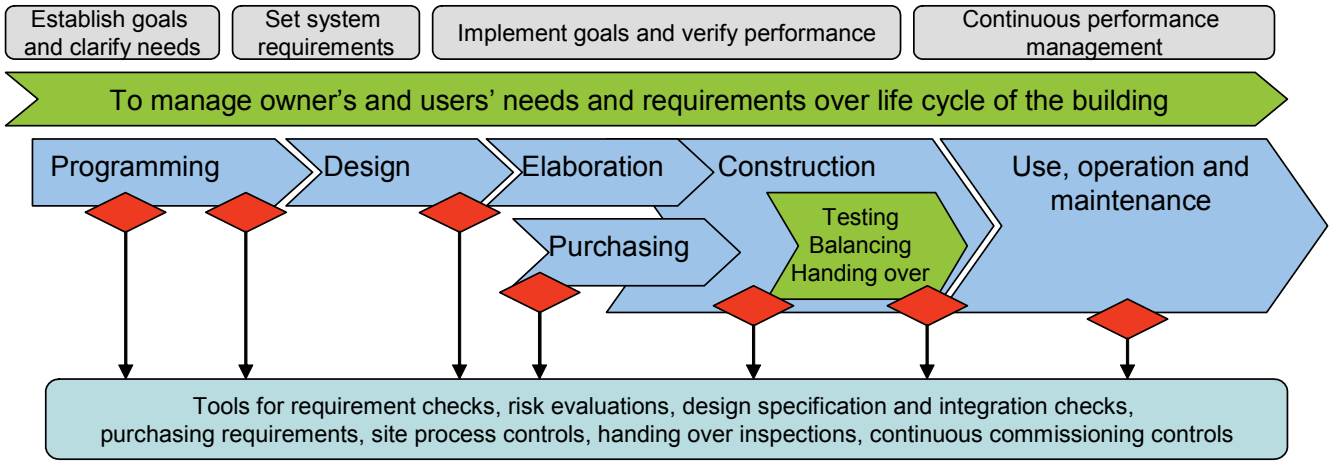


Figure 1. The Performance Verification flow chart.

1.1 Background

The energy efficiency of buildings should be confirmed in all major stages of a renovation project: planning and design, implementation, use, operating and maintenance. The energy and facility management costs can be optimized by using BEMS (Building Energy Monitoring Systems) and REMS (Real Estate Monitoring Systems) type of concepts.

In the quality control toolbox concept all the stages of construction process are considered. The early stages are emphasized on the owner's and users' needs and requirements, which are also considered through the whole process. After setting up system goals, implementing the goals and verifying the performance, indoor climate and energy consumption are managed and monitored as a long term basis for the whole life cycle of the building.

Validated retrofit measures show that it is difficult for the construction manager to assess if the realisation reaches the planned efficiency at the end of the construction phase. There is a need for reliable and simple control methods. Additionally it is important to survey the energy consumptions in the long run in order to counter sneaking aggravation. The involvement of energy control systems in the building energy management leads to long-term energy efficiency, as shown with Stuttgart's energy control system (SECS) in an exemplary way. Existing methods to secure and improve the long-term quality and efficiency of measures will therefore be optimised in the third work package (WP3). A quality control toolbox, which contains these methods, is used for the trainings activities, too and therefore lead to a fast application at maintenance personnel and caretakers. This innovation activity shall create new fields of work for SMEs.

In the project we introduced a new idea of quality control toolbox concept that was based on our previous studies on commissioning of performance characteristics and energy efficiency of buildings. In the toolbox we describe all major stages of a renovation project, which are put into practice by using new auditing tools e.g. review lists. These review lists are introduced in appendix A.

1.2 Work Package Objectives

The quality control toolbox aims particularly at providing the necessary background material and tools for clear definition of goals, procedures and documentation for future energy efficient building renovation projects. Work package 3 gives an extensive overview on up-to-date methods for quality control and facility and risk management.

In the planning and design phase, the planner will set the goal for the energy consumption for different purposes. Before the renovation benchmarking and energy audits can be used to evaluate the energy consumption and facility management costs. Reasons for too high energy consumption and the saving potential can be assessed. The planner can decide the renovation measures based on these surveys, on users needs and on energy calculations. During implementation and immediately after (during commissioning) a careful control that all implemented technologies are working and being controlled as intended in the design phase is crucial for the overall energy performance of the building. In long-term use the use and operational factors are decisive, providing the previous stages have been properly executed. In spite of new building automation and control systems the performance too often decreases, because systems can't be operated as effectively or appropriately as needed, because of insufficient or defective use.

The objective of WP3 of the BRITA in PuBs – project on this background was to develop: A quality/performance control toolbox - a concept from design to post construction life long management, using BEMS/REMS - type procedures and using prevailing methods. The toolbox was developed in electronic/internet based form and structured according to the three major building project stages, which are linked. WP3 draws upon other working packages, especially WP1 and WP2 and links also to WP4.

The tool-box includes risk-management and preliminary energy/life-cycle costs calculations for the design and planning stage, commissioning and quality control procedure for implementation stage, including the analysis of the realisation phase of the demonstration buildings, and in the stage of use: development of electronic display information panels and the involvement and acceptance of the users (a user and service manual model), a web-based energy and facility management monitoring system, which has feedback to the planning stage and can be used in benchmarking, both energy audit model for ascertaining the performance of the building. The toolbox has been tested in the demonstration buildings.

1.3 Work Package Activities

The energy efficiency of the buildings should be confirmed in all major stages of a renovation project:
1. Planning and design,
2. Implementation and
3. Use, operating and maintenance.

The energy and facility management costs can be optimized using BEMS (Building Energy Monitoring Systems)/REMS (Real Estate Monitoring System) - type concepts.

In the planning and design phase, the planner will set the goal for the energy consumption for different purposes. Before the renovation benchmarking and energy audits can be used to evaluate the energy consumption and facility management costs. Reasons for too high energy consumption and the saving potential can be assessed. The planner can decide the renovation measures based on these surveys, on users needs and on energy calculations.

During implementation and immediately after (during commissioning) a careful control that all implemented technologies are working and being controlled as intended in the design phase is crucial for the overall energy performance of the building.

In long-term use the use and operational factors are decisive, providing the previous stages have been properly executed. In spite of new building automation and control systems the performance too often decreases, because systems can't be operated as effectively or appropriately as needed, because of insufficient or defective use.

For the first stage (planning and design) the prevailing procedures partly developed in IEA-ECBCS-Annex 36 for

- Benchmarking and short-term measurement procedures,
- Risk analysis model applied for renovation plans of demonstration buildings,
- LCC-model applied for renovation plans of demonstration buildings,
- Energy consumption calculations for renovation solutions will be evaluated, adjusted, combined, applied and tested for the demonstration buildings.

For the second stage (implementation), the commissioning procedures partially developed in IEA ECBCS Annex-40-project, will be taken into the use:

- Quality control procedure including short-term measurements.

For the third (use, operating and maintenance) stage:

- The internet-based energy monitoring tool and the facility management monitoring tool will be created on the base of existing tools developed by the partners,
- The internet-based users and service manual will be generated,
- The energy audit procedure including the measurements (for 3. and 1. stage) will be established.

Using these tools the energy performance of the demonstration buildings will be compared before and after renovation. The results are:

- A prototype energy label (energy-efficiency based classification) for the buildings,
- A quality/performance control toolbox which, in its final form can be seen as an advanced facility management tool marketable which after the completion of the project can be further developed into a marketable software tool.

The project group will tend to develop the toolbox for the time after the project phase. The research partners in each country can continue the work forr identifying and evaluating national tools and testing the tools in the toolbox under development.

2 Quality Control Toolbox Concept

The basic idea of the new quality control toolbox concept is to ensure that owner's and users' needs and requirements are met as agreed. First, at the beginning of the renovation project goals are established and the owner's and users' needs are determined. Second, the system requirements are set with the help of design procedures. Third, the goals are implemented and performance is verified in the elaboration and construction phases. Finally, indoor climate and energy consumption is managed with new building automation and online reporting systems. The basic phases (red diamonds 1-7) of the quality control toolbox concept are described in figure 2.

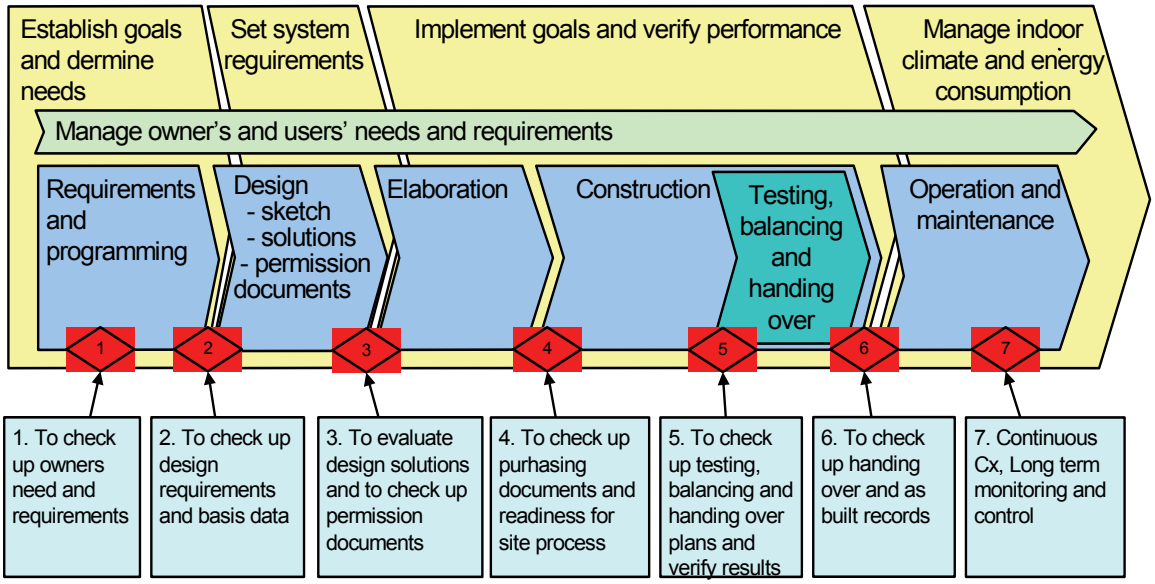
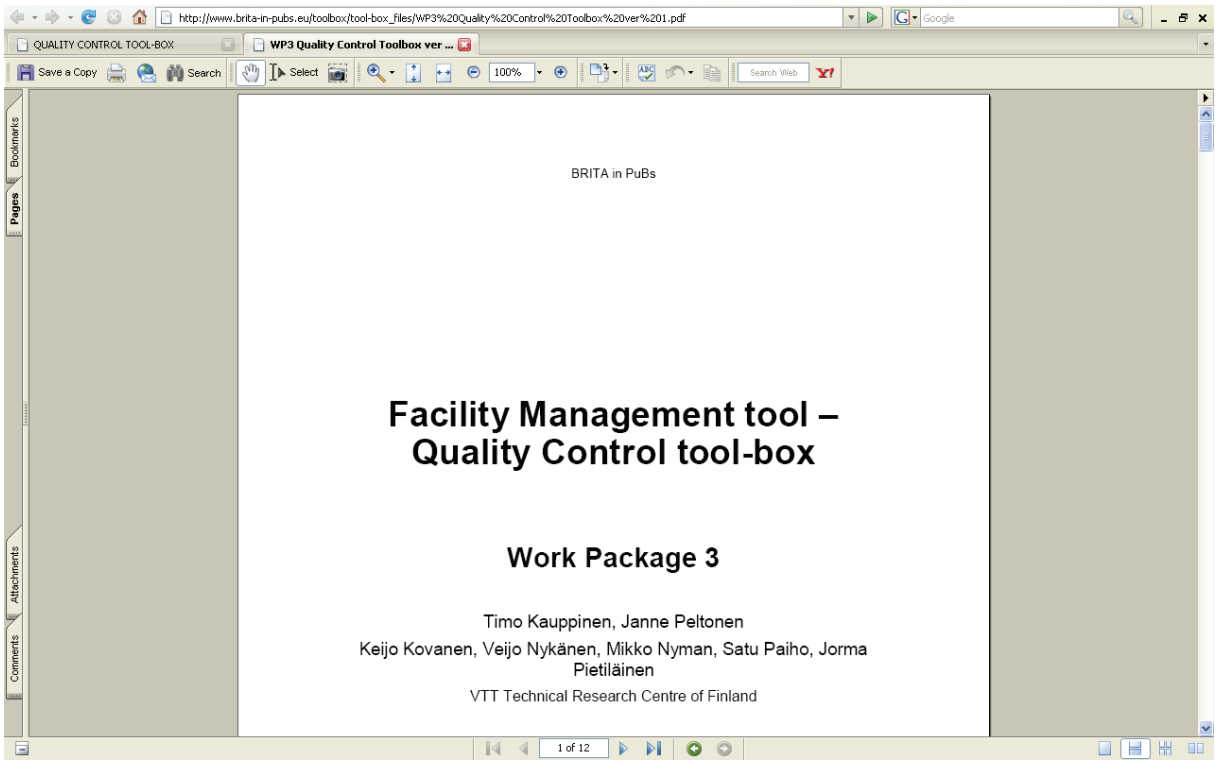


Figure 2: Phases of the Quality Control Tool-box concept.

Next, all the phases (1-7) of quality control tool-box are introduced and the objectives are clarified. These seven stages of the renovation project are put into practice by using review lists, which are introduced in appendix A.

The toolbox prototype has been completed and applied in some demonstration projects during the previous period. The quality control toolbox model has been tested in one demonstration building (April – May 2007). The final version is available at www.brita-in-pubs.eu. The toolbox gives models and concepts into the use of facility management.



2.1 Requirements and programming review

The objective of the phase (red diamond 1) is to ensure that the owner's and users' needs and requirements are met as agreed. In the project planning different options to fulfil the owner's needs are clarified, plans for the project budget are made and the goals for the next phase (red diamond 2) are defined, see figure 3.

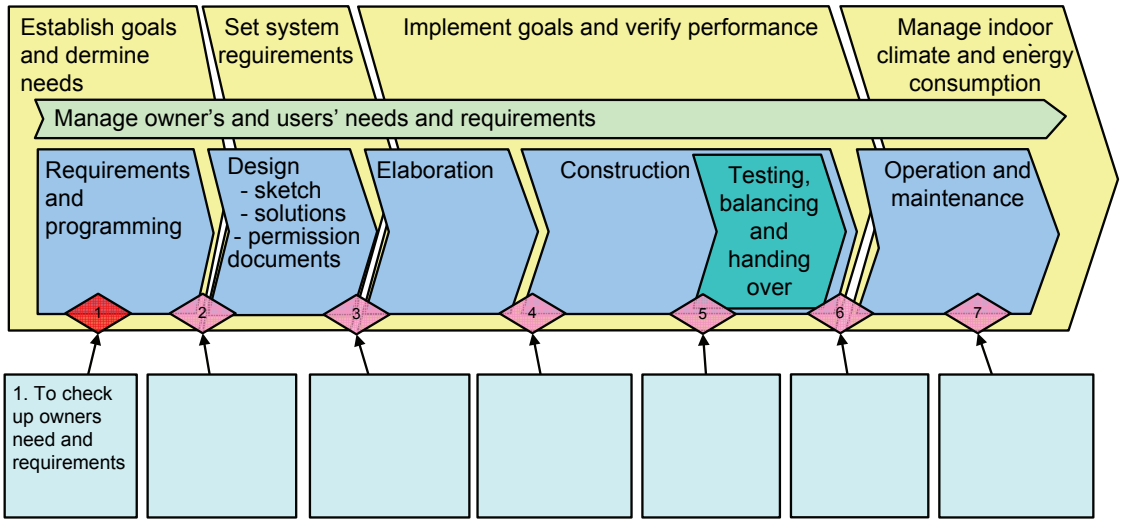


Figure 3: Phase 1 of the Quality Control Toolbox Concept.

Central activities are to:

- Check the owner's future strategies and action plans
- Check the owner's and users' needs and requirements
- Check the construction site and building plan

- Check different goals and requirements and identify the possible risks

2.2 Design requirements review

The objective of the phase (red diamond 2) is to ensure that the design requirements and basic data are relevant for setting up the system requirements. This information is also used to draw up contracts, see figure 4.

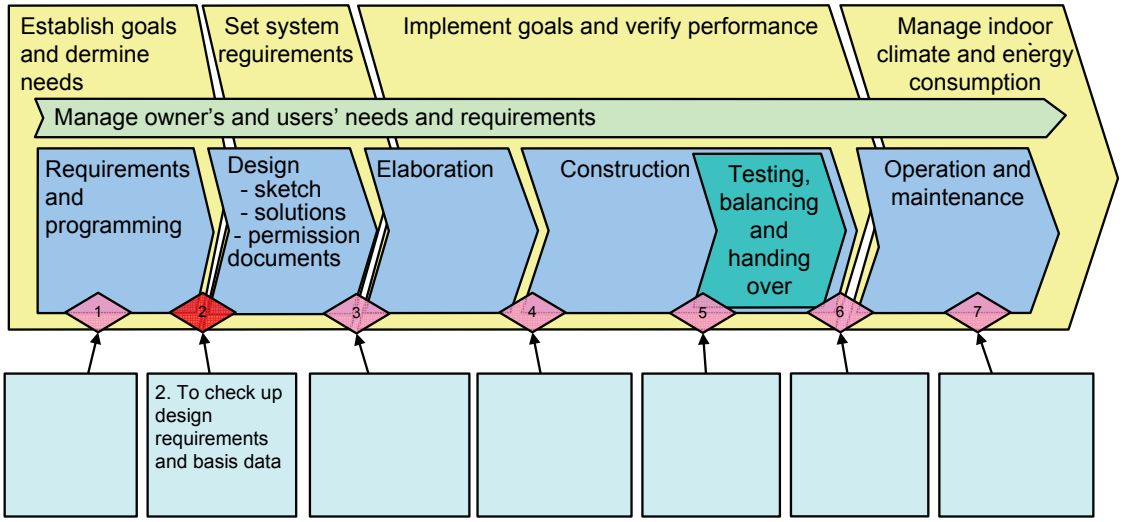


Figure 4: Phase 2 of the Quality Control Toolbox Concept.

Central activities are to:

- Make up design developments
- Make up design concepts and the master plans
- Make up building permits

2.3 Design solutions and permission documents review

The objective of the phase (red diamond 3) is to ensure that the design concepts and permission documents are correct. Indoor climate and energy consumption are based on the design concepts, proper results can be obtained only if the design concepts are relevant, see figure 5.

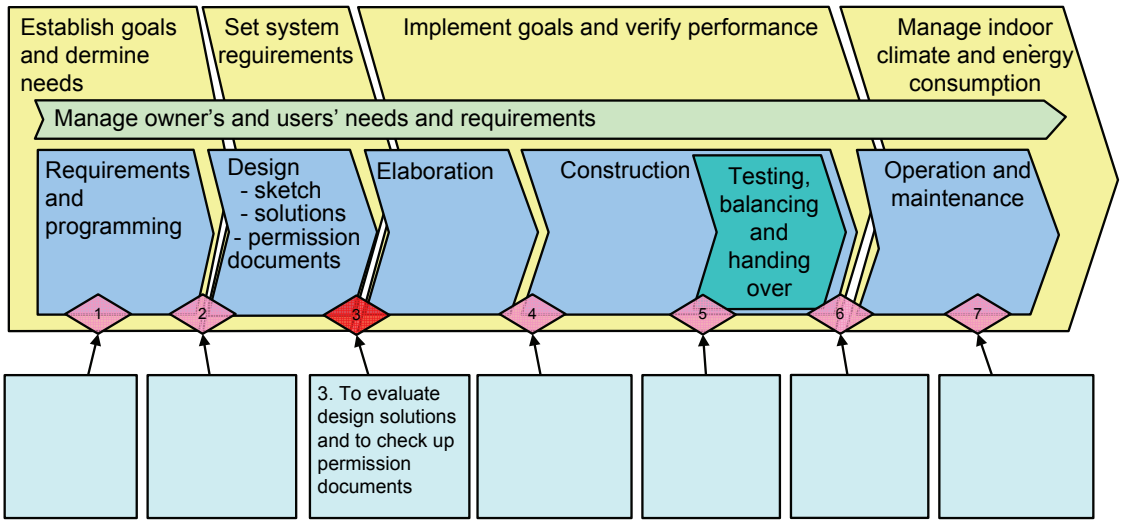


Figure 5: Phase 3 of the Quality Control Toolbox Concept.

Central activities are to:

- Check up design concepts
- Check up building permits
- Organize the contracting parties
- Take into account the system integration point of view

2.4 Purchase documents and construction site review

The objective of the phase (red diamond 4) is to ensure that the purchasing documents are relevant and the construction site is ready for implementation. In this connection it is important to accept all system specific objectives with all the contracting parties. Especially, the integration perspective of different subsystems and procurements must be taken into account, see figure 6.

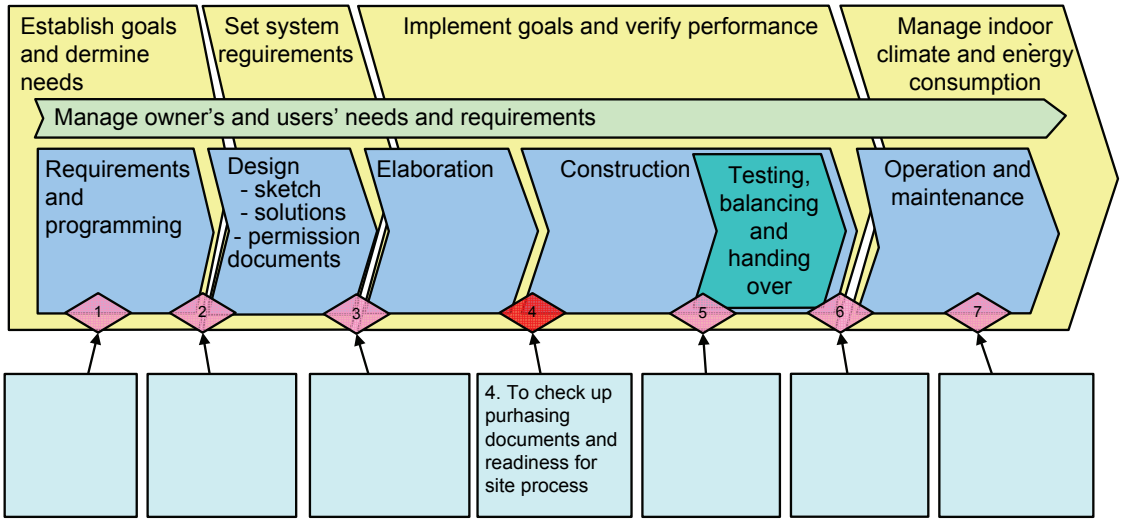


Figure 6: Phase 4 of the Quality Control Toolbox Concept.

Central activities are to:

- Choose the subsystems to be implemented
- Calculate the design and construction cost levels for every subsystem
- Agree the functional requirements for all subsystems

2.5 Functional testing and balancing review

The objective of the phase (red diamond 5) is to ensure that the testing, balancing and handing over plans are relevant. The main focus is on final tests and preparation for handing over, see Figure 7.

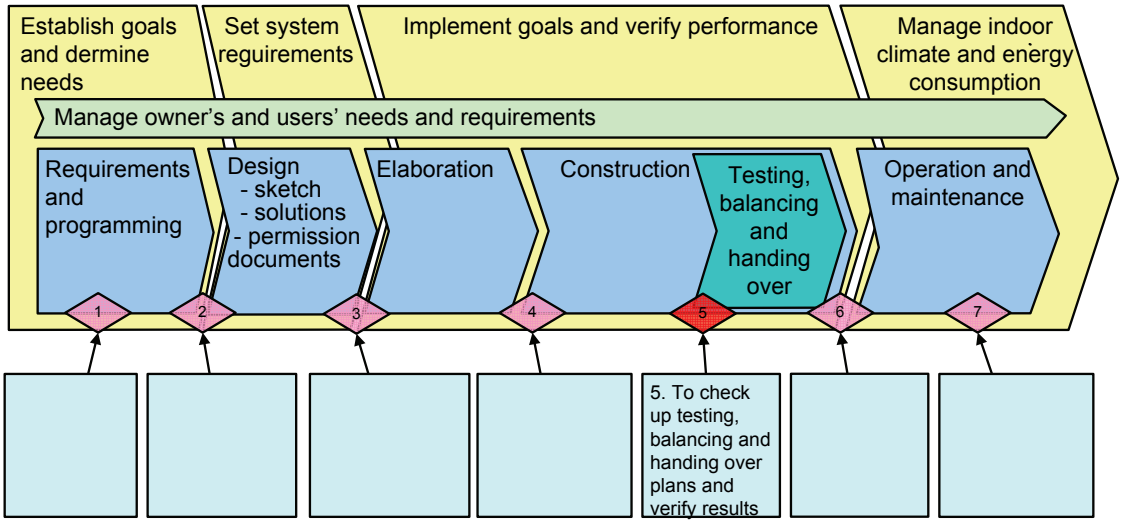


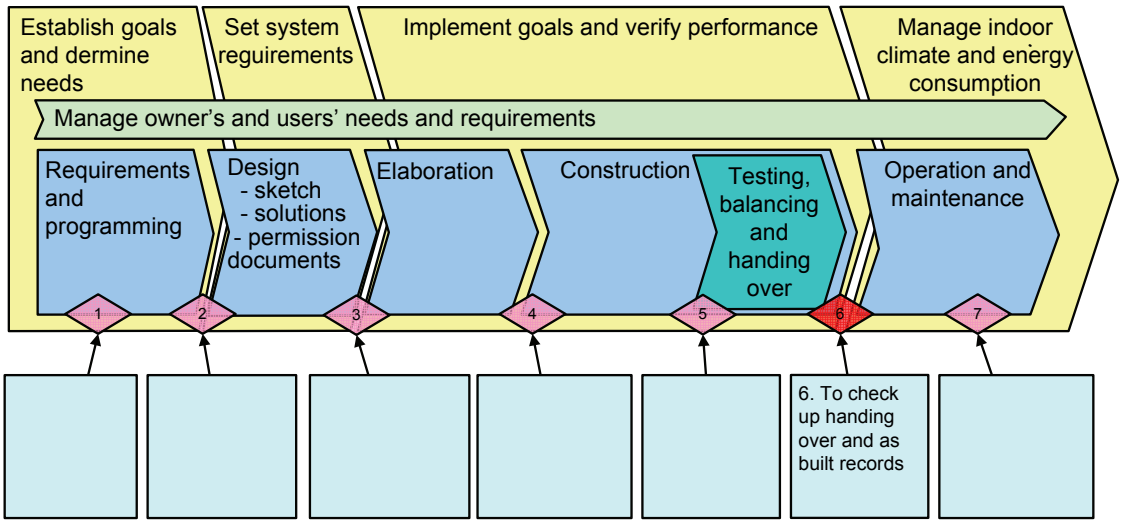
Figure 7: Phase 5 of the Quality Control Toolbox Concept.

Central activities are to:

- Make sure that the subsystems are functioning as agreed
- Make sure that the agreed level of indoor climate can be achieved
- Make sure that the deed of assignment and maintenance manual are relevant

2.6 Handing over review

The objective of the phase (red diamond 6) is to ensure the handling over process, also the as built records play an important role. At this phase the interoperation of all subsystems is crucial, see figure 8.



Figre 8: Phase 6 of the Quality Control Toolbox Concept.

Central activities are to:

- Review all possible defects in the handling over process and assess the repair work to be done
- Make sure that the building is defect-free
- Make sure that the subsystems are tuned and operating as agreed

2.7 Long term review of operation and maintenance

The objective of the phase (red diamond 7) is to ensure that the indoor climate and energy consumption are managed and monitored as a long term basis for the whole life cycle of the building. At this phase the continuous commissioning tools play an important role, see figure 9.

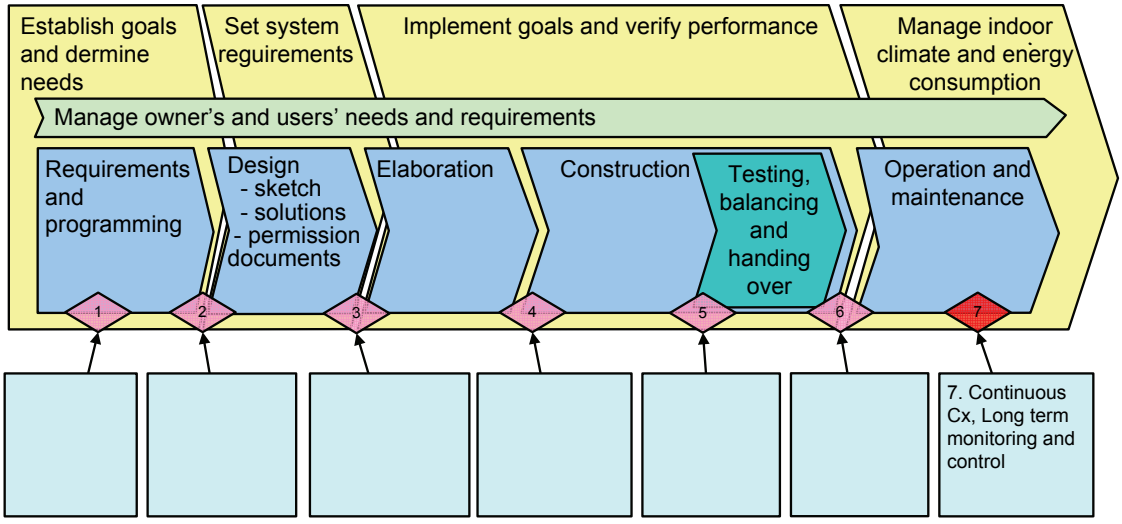


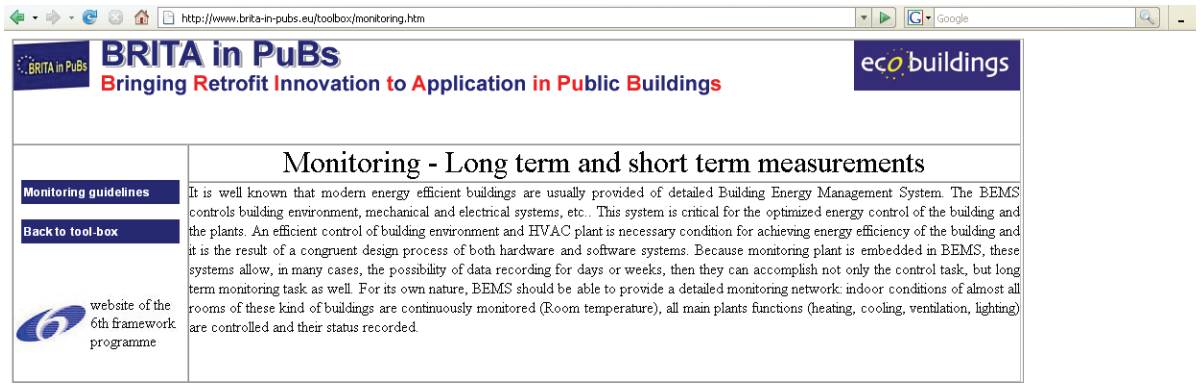
Figure 9: Phase 7 of the Quality Control Toolbox Concept.

Central activities are to:

- Monitor the indoor climate, energy consumption and water consumption
- Measurements, audits and functionality test can be used when needed

2.8 Benchmarking and short-term measurements

The benchmarking model will based on the performance rating system of Brita IT-toolkit developed in WP 4.

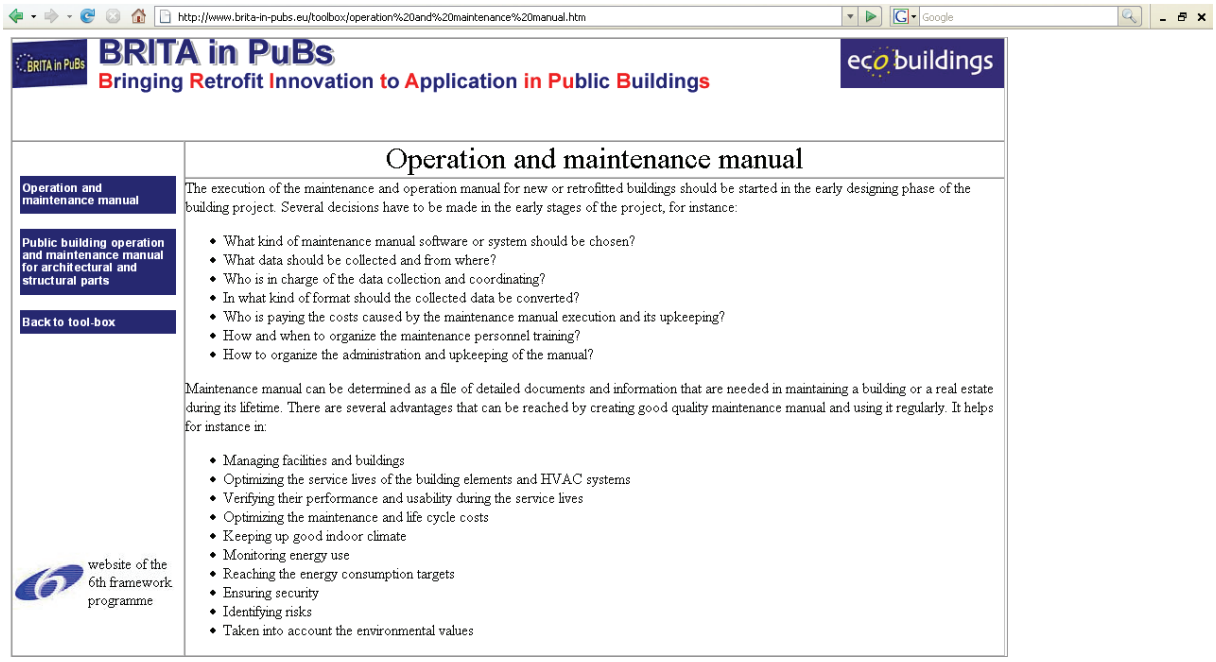


The baseline energy consumption before renovation has been collected from the demonstration buildings, if the data has been available. The latest questionnaire was arranged in January 2006. Later on post-retrofit consumption figures (meter readings) can be updated by the demo buildings into the system using the installed FM tool (WP 9).

The short-term measurements will be based on the procedure partially presented at IEA Annex-40 “Commissioning of Building HVAC Systems for Improvement of Energy Performance” and partially on a national project of building commissioning (Cx) and short-term measurement plans for it’s demonstration buildings. The short-term measurements are included in the Quality Control Toolbox checklists.

2.9 Operation and maintenance manual

Maintenance manual can be determined as a file of detailed documents and information that are needed in maintaining a building or a real estate during its lifetime. There are several advantages that can be reached by creating good quality maintenance manual and using it regularly.



There are many ways to create a successful maintenance manual. These solutions vary from paper versions to modern sophisticated information technology solutions. Modern software solutions can be divided roughly into three categories: stand-alone versions, versions used via intranet and versions used via internet. Well organized modern maintenance database can be utilized in real time by building owners, maintenance or service companies and even the end-users. Data available for different interest groups can be determined and restricted.

The access option to the description of the content and use of OMM is in the Quality Control Toolbox tool.

2.10 LCC-Models

In 2006 the European Commission appointed Davis Langdon from the UK to undertake a project to develop a common European methodology for Life Cycle Costing (LCC) in Construction. The origins of the project lay in the Commission's Communication 'The Competitiveness of the Construction Industry' and, more specifically, in the recommendations of the Sustainable Construction Working Group established to help take forward key elements of the Competitiveness study. These recommendations proposed that a Task Group (TG4) be established to prepare a paper on how Life Cycle Costing could be integrated into European policy making.

The Task Group's paper recommended the development of a common LCC methodology at European level, incorporating the overall sustainability performance of building and construction. The methodology developed by Langdon and published in February 2007 provides a basis for the common and consistent application of LCC across the EU without replacing country-specific decision models and approaches. It is aimed primarily at public sector construction clients and their project advisors, but can also be used by private sector clients and their advisors, and by contractors. That's why the methodology will be taken into the use in the toolbox.

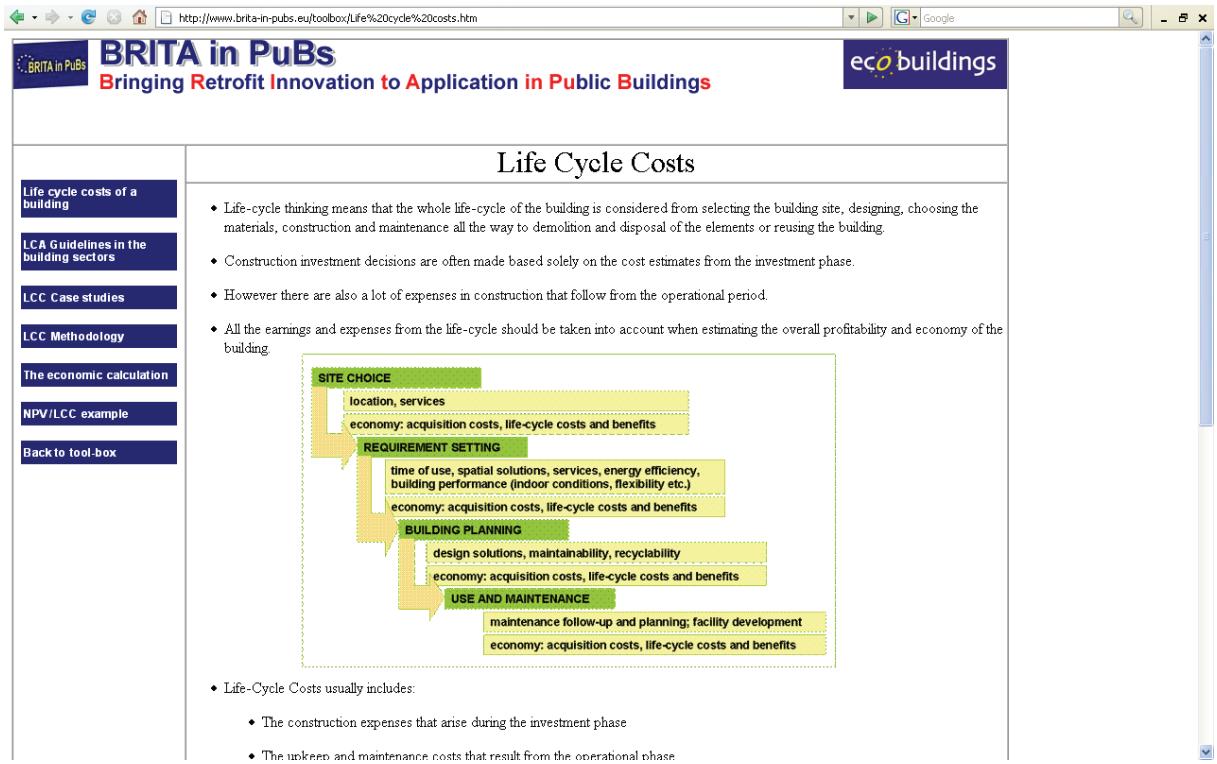


Figure 10 shows the possibilities to improve performance and life cycle economy during the building process.

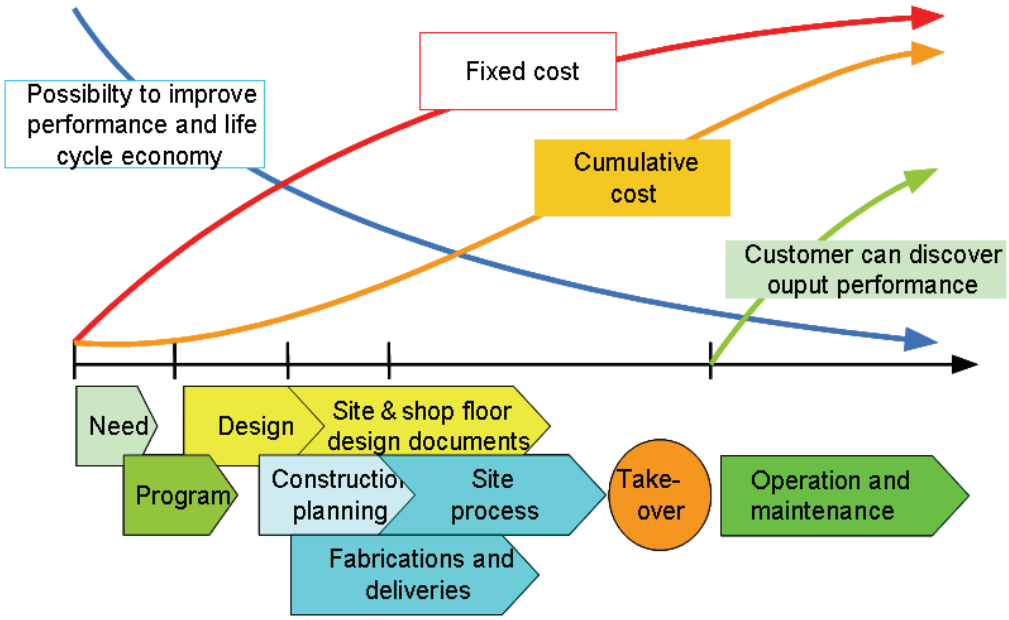
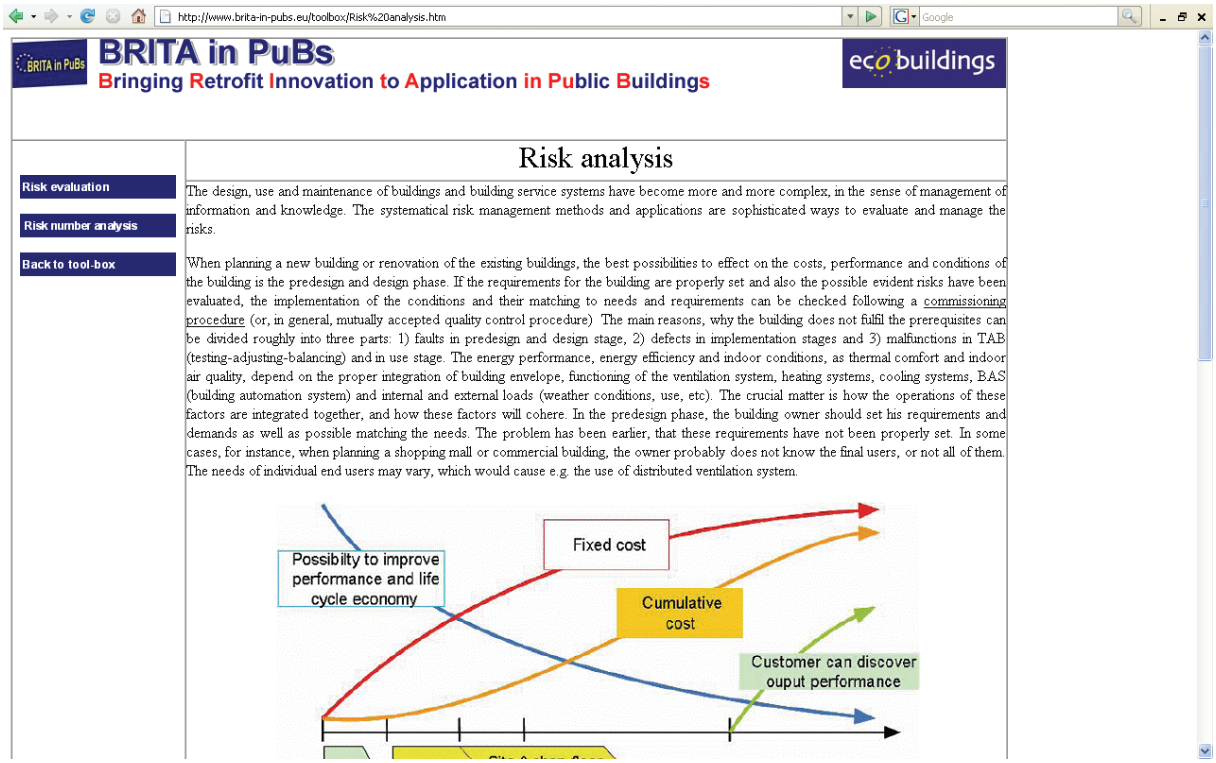


Figure 10: The possibilities to effect on the performance of the building during the building process.

2.11 Risk Analysis

Investment in a constructed asset is a long-term project and as such characterised by a range of uncertainties, for example the useful life of the facility, the service life of systems and components, and energy and other costs during operation and maintenance. Within this context, LCC is a forward looking process that inherently requires the identification and forecasting of these factors that are unknown at the time of the analysis, and which thus inevitably involves the management of uncertainty and risk (where 'risk' relates to probabilities that can be estimated and 'uncertainty' to those that cannot).



Risk analysis model is partially based on sensitivity analysis of various factors of the planned energy consumption – using simple national calculation tools the boundary conditions and limits of the renovated system will be determined. The object of these tasks is to find the key factors and the impact for possible energy consumption variations in each renovation work.
The other part of the risk analysis model is based on the classification of risks and risk matrix and success factor methods. The description and the frame of overall procedure is loaded as a part of Quality Control Toolbox.

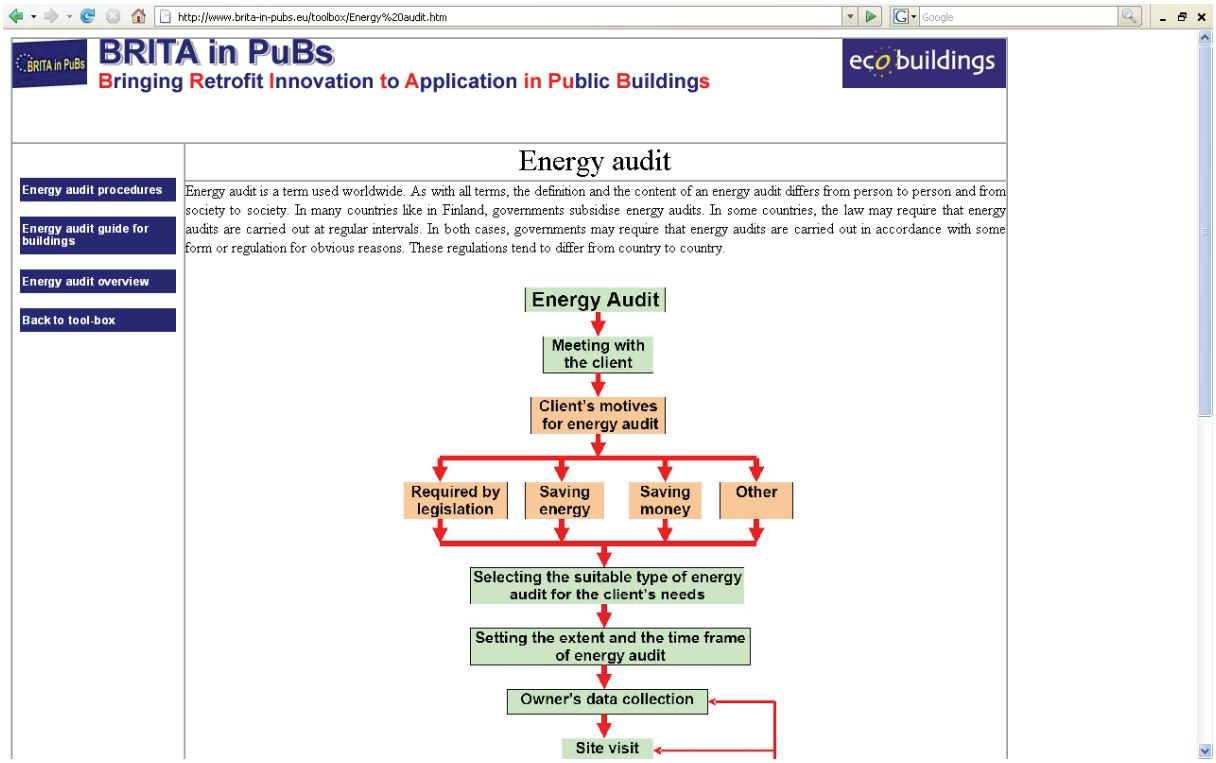
2.12 Energy Audit Models (Energy Audit Guide)

There are many definitions for an energy audit depending on the user of the term. The main objective of an audit is however to show how energy is used in an audited target (e.g. building), and what are the measures to save energy or to improve energy efficiency in the target. The scope and thoroughness of an energy audit depends on the audit model applied and on the available human and financial resources.

Before energy audit a benchmarking study can be carried out comparison between the analysis target and the statistics based on the results of benchmarking, one can make

conclusions if energy audit is needed or if only some targeted measurements or checking's must be done.

The general description of energy audit model is presented in the toolbox.



3 User's comments on the WP3 toolbox

3.1 New approach to facility management

One should emphasize in the toolbox the new approach to facility management as the process that begins with the intention to build a building and ends with a demolition of the building. The most of the operation costs (and also facility management costs) are determined in the early stage of the building design process (Improvements made during operation such as replacement of the regular light bulbs with the energy-saving ones is usually too little too late).

3.2 Only a few boxes in the web-based tool-box are clickable and the linked documents are in pdf format

It would be preferred that the whole toolbox would be in the html format and if it would possible to download the toolbox to a local hard drive. It is suitable to include the pdf files because they can be easily printed off. But, a fully electronic version with the clickable check lists would allow the user to tick off the item and save the tool-box in the current status of their building commisioning process. A solution could be to provide the MS Word documents for the user. They could then tick off the items in the Word documents and keep the documents on their computers. Another advantage would be that the users could customize the check lists and other documents to fit their situation. The user could also add some items to the check list if they encountered specific problems that are not mentioned in the current version of check lists.

3.3 Interconnection of different sections in the tool box (links and cross references)

Again, it would be very useful to have a fully electronic version of the tool box where it would be possible to create links and cross-references. It could be something like the Wikipedia. If, for example LCA is mentioned somewhere in the text the word (initials) LCA should be linked to the document dealing with the Life Cycle Analyses. It would also be useful to have a dictionary with the short explanation of different terms. Not all the people who will come across the tool box will be familiar with the whole area of facility management from the preliminary design to the building decommissioning and demolition.

3.4 Documents in the tool-box

The documents that are currently used as references for different aspects of the building commissioning process differ in their "formal" appearance. It would be good to use the same style of formatting for all the documents with the BRITA in PuBs logo, work package number, etc. However, some of the documents were produced by the third party (e.g. LCC case studies, Energy audit guide for buildings) and it cannot just added the BRITA logo to them. It can be suggested creating of an updatable page with the links to external documents for further reading. By adopting such approach one would avoid copyright infringement (regarding the documents produced by the third party).

3.5 Maintaining of Quality control toolbox

This is a very tough obligation for the subtask leader organization. Is the subtask leader going to implement all the suggestions from the users? That might be a really time-consuming task. There will probably be a lot of comments and suggestions for changes when the toolbox is published and the user are asked to use it. And if the users cannot customize the tool themselves the subtask leading organization would have to do that for them. Again, a kind of an open-source tool would be suggested, where users, who are in different stage of the building commissioning process, could use only some parts of the tool and customize it to fit their needs.

Appendix A: Checking lists

The purpose of the performance and energy efficiency checklists is to support and be a tool for quality control and commissioning agent when planning commissioning and quality control actions and subproject-specific checking lists.

The content of the checklists has been timed in the building process as follows:

- The owner`s and user`s requirements for the project
- Confirmation of the planning prerequisites and –targets before starting the planning and design
- Confirmation of the validity of the design solutions and building permits
- Checkings and verifications dealing with the launching of the building process, detailed plans and acquisitions
- Checking of the performance tests of the building and building systems and commissioning of building performance
- Checkings connected with the assignment, acceptance and use of the building
- Planned performance and energy efficiency commissioning measures during the life-cycle of the building

The aim is by Quality Control Toolbox to confirm and verify the integration of various systems in terms of indoor air quality, thermal comfort and energy efficiency. When preparing the Qx-plan must the quality control of the contractors and other enterprises must be taken into account.
In these lists there is no division between different building types or complexity classification. When using lists one must exploit them when applicable.