BIMplement

Towards a learning building sector by setting up a large-scale and flexible qualification methodology integrating technical, cross-craft and BIM related skills and competences.

www.bimplement-project.eu

Report:	D5.2 A self-instruction guide for implementing new technical or conceptual topics and for implementation in other Member States
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Version 1	February 27, 2020	First version
Version 1.1	March 13, 2020	Improved readability
Version 1.2	May 15, 2020	Check before tryout with replication partners
Version 1.3	July 15, 2020	Added improvements based on replication in NL, LU and MK
Version 1.4	January 19, 2021	Added clarifications to chapter 5 concerning RIBA and clarification of the elaborated example

Some quotes from the replication experiments:

"Valuable experience, especially in learning to "think" in a way to distinguish Knowledge, skills and competences"

"We are still used to put everything in one sentence (even in description of learning outcomes of formal education), so it is quite challenging."

"The feedback is clear, overall speaking the methodology totally makes sense, I just see the challenge that it's complicated to explain to somebody who doesn't know the topic at all."

1. Executive summary and Introduction

This is the self-instruction guide for use of the BIMplement Qualification methodology.

It is developed in order to replicate and implement the BIMplement Qualification Framework in other areas, regions and for other technical and conceptual nZEB related topics. This guide is based on the results of workpackages 2 and 3 of the H2020 BIMplement project. It is developed in cooperation with H2020 NEWCOM project.

Implementation testing of this guide was part of testing the BIMplement implementation service concept as it is developed in the replication workpackage of BIMplement. Testing has been done in Luxembourgh and Macedonia and at ISSO internally by applying the qualification method for multifunctional green roofs and heatpumps. The heatpump case was special in the sense that this time the method was used by a colleague without experience in development op qualifications. These tests did not involve the use of the Model nZEB Cross-trade Quality and BIM-Skills Matrix as that part of the method is designed for use within pilot projects applying BIM to ensure quality control. A summary of the testing process and its outcomes is added as Annex 1 to this document.

Based on the outcomes this guide has be updated. The updated version is also linked to BIMplement deliverable D5.5 'Methodology guide on qualification methodology, raising awareness methodology and methods and supports for contractors'.

In this self instruction guide the BIMplement Qualfication Framework is addressed.

It consists of two parts:

1. A flexible methodology that allows definition of professional activities, related skills and required competences. Which results into task based qualifications.

   These qualifications can be added to the BUILD UP Skills advisor app qualification database. This database enables export to Excel, using qualifictions for personal recognition and in the future linking competences to available course supply.

   For use of the qualification database a separate User manual is available for download
   In this manual not only use of the qualification database is explained, but also the other BUILD UP Skills advisor-app functionality.

2. The Model nZEB Cross-trade Quality and BIM-Skills Matrix for linking content of the qualifications into a process oriented workflow for implementation in construction projects. This matrix enables thorough preparation of changes that have to be made in the process, in order to create the right context for upskilling and application of newly acquired competences.

For questions and support I am available at j.cromwijk@isso.nl

Jan Cromwijk, Rotterdam

2. List of acronyms and abbreviations

Abbreviation	Meaning
BIM	Building information Model
CPD	Continuing Professional development
ECTS	the European Credit Transfer and Accumulation System
EHEA	Qualifications Framework of the European Higher Education Area
EQF	EQF – European Qualification Framework (Common use) https://europass.cedefop.europa.eu/lt/europass-support-centre/other-questions/what-european-qualification-framework-eqf
IAQ	Indoor air quality
ISO/IEC 81346	International Standard 81346, published jointly by IEC and ISO defines classes and subclasses of objects based on a purpose- or task-related view of the objects, together with their associated letter codes to be used in reference designations
ISCO-08	The International Standard Classification of Occupations (ISCO) is an International Labour Organization (ILO) classification structure for organizing information on labour and jobs.
PI	Post initial education
nZEB	Nearly Zero Energy Building

3. Definitions

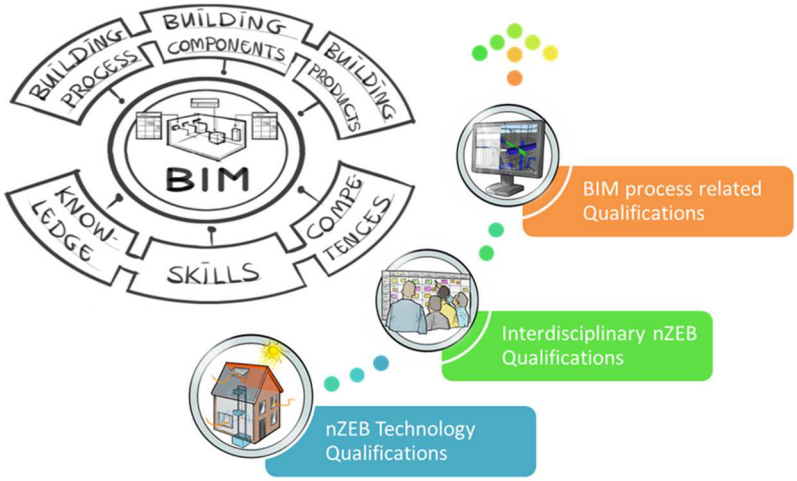
Term	Meaning
Accreditation	Accreditation is a quality assurance process under which services and operations of (educational) institutions or programs are evaluated by an external body to determine if applicable standards are met. If standards are met, accredited status is granted by the appropriate agency. (*Wikipedia*)
BIM-axon	BIMAXON is a human-readable classification of BIM element properties. That would facilitate communication, help fill in gaps in the BIM process, and make it easier for every actor to obtain and understand the information that they need at any given moment. It is based on BIM uses and the needs of specific BIM actors, to ensure that deliverables are right for every drop point and to provide just the right set of information to each actor at every moment.
Building stages & RIBA	A building life-cycle consists of several stages. The RIBA Plan of Work is the definitive UK model for the building design and construction process.
Competence	The ability of an individual/organisation to do something effectively. It consists of a cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation. In a BIMplement qualification it is worded as a result somebody can take responsibility for
Initial education	Training people receive before entering the labour market. In general, initial education is based on qualification documents and corresponding professional competency profiles. These qualification documents are drawn up nationally by the knowledge centres of the various professional sectors. Completing initial education results in the earning of a certain EQF level and a diploma, which has an unlimited validity.
Multilayered qualification	A multilayered qualification is a description of tasks that have to be performed to be effective. It consists of a layer with basic tasks and one or more layers of context specific layers. For example nZEB related tasks, BIM-related tasks or Indoor air quality (IAQ) tasks.
Occupation	An occupation is a a job or profession
Post-initial training	Training people receive after leaving initial training. In general, professional post-initial training is based on demand from market parties for retraining. These (short) trainings results most times in a certificate, which offers a limited validity. They do not result in the earning of a certain EQF level.
Profession	A profession is a specialized occupation characterized by profession specific education and training.
Recognition	A pass of an examination or an official completion of a course, especially one conferring status as a recognized practitioner of a profession or activity.
Qualification	A qualification is a set of one or more qualification schemes.
Qualification scheme	A qualification scheme describes what a participant in education should know and master at the end of a (intermediate vocational training) course. A qualification scheme describes the level of starting professional workers (school leavers).
Qualification structure	A formal system describing qualifications It makes visible which qualifications or sets of competences are sought by the labour market, education and society to secure a job, start further studies or participate in society.

<table>
<tr><th>Term</th><th>Meaning</th></tr>
<tr><td>Skill</td><td>The ability to do something well; expertise
In a BIMplement qualification it is something a person needs to be able to do/perform in order to reach a certain result</td></tr>
<tr><td>Skill-level</td><td>
<table>
<tr><td>0</td><td>Not applicable / no knowledge and skills required</td></tr>
<tr><td>1</td><td>Has little knowledge and skills with respect to the relevant field / technology (mostly outside the own field of expertise). Understands basic principles and is able to take part in project team discussions.</td></tr>
<tr><td>2</td><td>Understands basic knowledge and has practical skills within the field / technology, is able to solve simple problems by selecting and applying basic methods, tools, materials and information (mostly outside the own field of expertise).</td></tr>
<tr><td>3</td><td>Has comprehensive, factual and theoretical knowledge and skills within the field / technology, is capable of solving standard problems within the field.</td></tr>
<tr><td>4</td><td>Has advanced knowledge involving a critical understanding of theories and principles and skills, required to solve complex and unpredictable problems in the field and is aware of the boundaries.</td></tr>
<tr><td>5</td><td>Has specialized knowledge and problem-solving skills, partly at the forefront of knowledge in the field, in order to develop new knowledge and procedures and to integrate knowledge from different fields.</td></tr>
</table>
</td></tr>
<tr><td>Specialism</td><td>A technology or application of several combined technologies specific set of tasks</td></tr>
<tr><td>Task</td><td>A piece of work to be done or undertaken.</td></tr>
<tr><td>Taxonomy</td><td>A taxonomy defines classes of objects and relations among them</td></tr>
<tr><td>Training Scheme</td><td>A scheme for teaching people skills in a particular field or profession</td></tr>
<tr><td>Trias Energetica</td><td>A concept that is based on 3 steps:
First, we need to limit energy demand through energy saving.
Second, renewable sources should be used to meet the remaining energy demand.
Only as last step fossil fuels should be used, as efficiently and cleanly as possible.</td></tr>
</table>

4. BIMplement Task based Qualification Framework

The BIMplement Qualification Framework consists of a flexible methodology that allows definition of professional activities, related skills, required competences in order to achieve a desired quality in the field of nZEB. It is composed out of tasks and related subtasks that have to be performed on a certain time in a process and by (a) certain person(s) with a certain skillset.

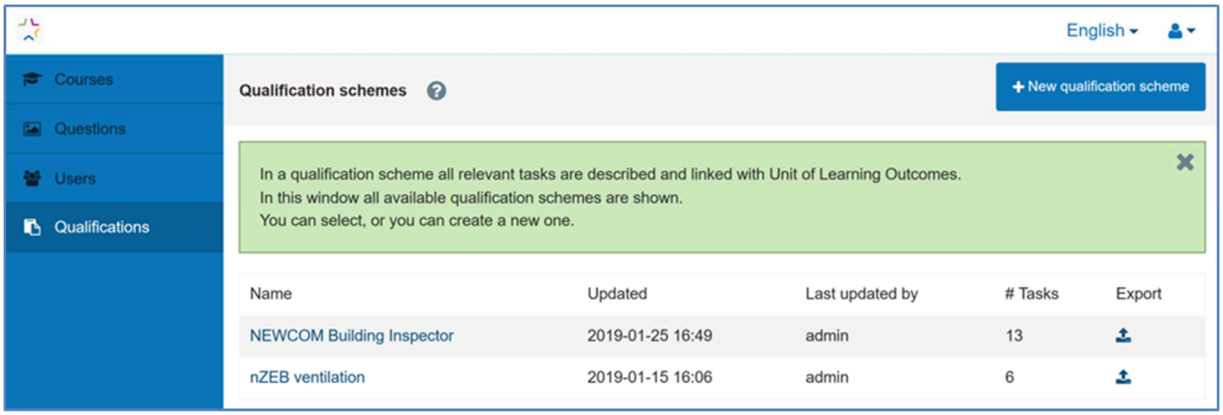
The BIMplement qualification framework is a multi-layered qualification. It consists of a layer with basic tasks and one or more context specific layers. For example nZEB related tasks, BIM-related tasks. If needed additional layers can be added, for example for Indoor air quality (IAQ) tasks or Circular Building tasks. The qualification framework is also suitable for non-nZEB related topics. For example prevention of carbon monoxide when installing and maintaining heating systems.



01 Multi-layered task-based Qualification

A task based qualification developed following the BIMplement methodology in general addresses all relevant building/process phases and all professions/actors involved. For practical use subsets from the qualification can be published in a qualification scheme addressing one or more project phases and one or more professions. For example a subset of tasks and subtasks for a craftsman that installs the converter of a Solar-PV system.

The corresponding BUILD UP Skills advisor-app ULO database identifies for each technology which professions and specialisms are involved in each phase, the needed skills, competences and descriptors, i.e. the related qualifications and which trainings, courses, learnings are available.



02 Screenshot of the Qualification / ULO-database (co-developed with H2020 NEWCOM)

4.1 How to develop a task based Qualification

In this paragraph a compact overview of steps is given that are needed to be filled in in order to develop high quality task based qualifications. When creating a new qualification it is recommended to design it offline using a tool like Excel, with special attention for correct use of verbs.

After checking content and quality the new qualification can be entered into and normalized with support of the ULO-database. When entering the Qualification into the database the database shows you comparable items. This to assist in getting a as good as possible Qualification that is also fit for mutual recognition.

🔔 The ULO-database is a normalized database.
This means that each item in the database is unique, there are no doubles. When entering the tasks, subtasks, knowledge, skills and competence information, the database shows already existing content that matches with the new content. This to make effective re-use of existing qualification content & to make easy recognition of already earned competence possible.

🔔 An Excel template for creating draft versions is available (Empty Qualification Format.xlsx).

Step 1: make a list of tasks to be performed & by whom.

The most practical way of making a list of tasks and subtasks (in step 1 and 2) are expert interviews. In these interviews the interviewer:

1. Uses the overview of project phases(for example RIBA) to create an overview of all tasks and subtasks that have to be performed in a certain way to reach a certain result.
2. Asks for the result (and partial results) that each task has to deliver.
   These results are later on in Step 3 re-formulated in the form of competences.
3. Drafts an overview of skills and knowledge needed to deliver a certain result (as scribbles/sidenotes).

In general after interviewing 2-4 experts a first draft of can be composed.

Step 1	
An overview of tasks (from initiation to re-use)	**Occupation(s) involved**
Task 1…	Occupation name(s)
Task 2…	…
Task 3…	…
🔔 1. Start each task with a 'verb' in the tasks to make the task active. *e.g. Perform a feasibility study* 2. Use different wording if tasks are performed in different phases. e.g.: *Check attention points on comfort in inner spaces* in planning phase *Verify attention points on comfort in inner spaces* in delivery phase	

Step 2: define the relevant 'sub-tasks to be performed' & by whom

Step 2	
An overview of subtasks	**Occupation(s) involved**

Task 1…	Occupation name(s)
Sub Task 1.1…	…
Sub Task 1.2…	…
Task 2…	…

🔔 Use a 'verb' in the tasks to make them active

🔔 If the name of a task or subtask is the same for multiple actors, but the competence, skills and knowledge differ, then create separate tasks / subtasks with unique task names for those actors!

🔔 In BIMplement we did not describe tasks that are already part of occupations addressed in regular education. We assume that it is not needed to describe tasks that are part of occupations, those are in most cases already covered in existing national qualifications for regular education. The qualifications we develop are focused on upskilling of already skilled workforce.

🔔 When performing expert interviews on the tasks and subtasks you can jot down keywords on skills and knowledge in play. These can be later on used to work out the ULO's.

Step 3: provide didactical details for the tasks and subtasks

Step 4		
Competence involved (responsibility and autonomy)	**Skills involved**	**Knowledge involved**
ONE COMPETENCE	(SKILLS separated with ';') Or each skill on a single line	(items separated with ';')
…	…	…
🔔 The ability of the learner to apply knowledge and skills autonomously and with responsibility Competences need to be described in active form using verbs from BLOOM's taxonomy Most times you start with the verb	Skills required to successfully carry out the sub-task Skills need to be described in active form using verbs from BLOOM's taxonomy Most times you start with the verb	Knowledge required to successfully carry out the sub-task. Please do not add verbs to them. Lists of keywords are enough!

For more information about development of sound ULO's and task definitions you can access the following resources:

1. St Edward's University, Centre for Teaching Excellence (2004). Task-oriented question construction wheel, based on Bloom's taxonomy. Available at http://www.stedwards.edu/cte/files/BloomPolygon.pdf
2. University of Arkansas https://tips.uark.edu/blooms-taxonomy-verb-chart/
3. University of Arkansas https://tips.uark.edu/using-blooms-taxonomy/

4.2 The Excel template for taskbased qualifcations explained

For easy processing of the qualfications an Excel template is available. On the first tab of the excel-file an overview of tasks and subtasks can be created.

Optional	Regions	Tasks	Sub-tasks	NOTES area for jotting down knowledge and context	Professions involved	Specialisms involved	ULO Numbers
		Example maintask					
			Example subtask		Example profession	Example specialism	1, 2

Optional: mark with an X if a task or subtask is optional
Regions: enter regioncode (use two letter countrycodes) if the task or subtask is region specific
Task: enter the task in the grey cell under the column tasks
Subtasks: enter relevant subtasks in the column Sub-tasks
use one row for each subtask
Notes area to jot down knowledge and skills elements during interviews
ULO Nr: After each subtasks make numerical references to relevant ULO's
The ULO's related to a taks do not have to be entered.
The task is a collection of all subtask content (including ULO's)
(in the database each ULO gets a unique ID)

All subtasks can be linked to involved professions and addressed specialisms.

Professions: Occupation(s) involved
Specialisms: Specialisms involved

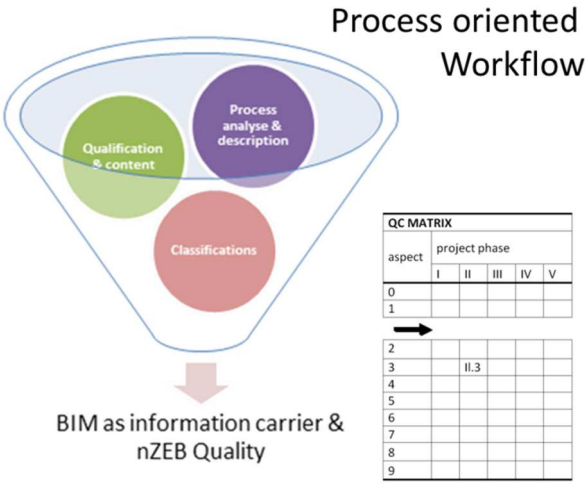
In the tab for entering ULO's you work out the results of Step 3 into an overview of Competences, Skills and Knowledge aspect. There is also room for adding the types of assessment that are advised to assess the newly acquired competence.

ULO Nr.	Competence	Skills	Knowledge	Preferred assessment types [optional]
	Is always worded as a result somebody can take responsibility for	Something a person needs to be able to do/perform in order to reach a certain result	Know how you need to know by 'head' in order to perform a task as efficient and effective as possible	
1	Competence	Skill 1 Skill 2	Related knowledge 1; related knowledge 2	Theoretical test, Practical test, Silhouetted by colleague
2				

ULO Nr: an ID-number for the ULO
Competence: the formulated competence ALWAYS ONE
Skills: the formulated skills behind the competence ONE or MORE
Knowledge: relevant knowledge behind competence and skills ONE or MORE items
Assessmenttype: Optional (Theoretical test, Practical test, Silhouetted by colleague)

5.The Model nZEB Cross-trade Quality and BIM-Skills Matrix

To facilitate just in time, just in place and fit for purpose delivery of learning and/or inspection content a process oriented workflow is needed. To attain this BIMplement developed the Model nZEB Cross-trade Quality and BIM-Skills Matrix.



03 Elements of the process oriented workflow

The BIMplement Model nZEB Cross-trade Quality and BIM-Skills Matrix is a structure for overall quality control. This structure helps to analyse and optimize the linkage between the process, qualifications and classifications. It can be applied to control the production process including specifications, design, construction, hand-over and operation.

This from perspective of focus on avoiding failures on all strategic aspects and moments in this process. It is an instrument for controlling the total process of making building services and can be applied for advanced ventilation systems and concepts (i.e. ventilation systems in relation to properties of the building and other building services. It contains all operational techniques and activities, necessary to achieve a defined level of quality.

The quality level has to be precisely formulated. In the framework “Quality” means that the delivered performance matches the required and precisely formulated requirements and expectations of the principal, including time planning, budgets as all other technical aspects.

Quality Control should focus on:

- avoiding failures in all the phases of the process, starting with the programme phase up to and including the operational phase;
- assuring reliability in defined time intervals

In order to deliver a good final product, the activities of all individual building partners as well as their skills (and skills levels) must be mutually geared. In all the phases of the process several activities will be carried out that will have an impact on the quality of the final product. For example, a client is perhaps not able to formulate her/his requirements and expectations in the program phase. This leads to the risk that technical ideas are developed in the design phase and elaborated in the elaboration phase will not be financially feasible or match with the overall client’s expectations. Another risk is the employment of unprepared work force to install complex designed technical solution due to the lack of definition on the required skills to properly execute the task.

The BIMplement Model Quality and BIM-Skills Matrix is based on IEA EBC Annex 40 'Commissioning of Building HVAC Systems for Improving Energy Performance' (2004) and ASHRAE 0-2005 ASHRAE Guideline 0-2005 'Commissioning Process'.

There are several commissioning procedures, methods and documents, often with different wordings of the phases and/or several subphases. However, in general all these methods have the same process sequences. The method, used in bIMplement (and IEA EBC Annex 40) is simplified to five phases, to make a easier to handle within the matrix with the 10 quality control aspects. As the ASHRAE commissioning guidelines (1996, 2005, 2019) is mainly used bu (HVAC) engineers, architects are more common with RIBA (Royal Institute of British Architects). The RIBA Plan of Work is published by the (RIBA). It was originally published in 1963 as a fold out sheet that illustrated the roles of participants in design and construction in a simple matrix format. The latest version, published in 2020, reflects increasing requirements for sustainability and Building Information Modelling (BIM). Therefore the RIBA Plan of Work is now becoming wider used and can also further enrich the BIMplement MQC method.

As for the project phases, RIBA follows eight work stages (recently re-structured and re-named) which can be synchronized with the BIMplement MQC matrix as follows:

RIBA	**BIMplement MQC matrix**
0 - Strategic definition	I programme
1 - Preparation and briefing	
2 - Concept design	II design
3 - Spatial coordination	III elaboration
4 - Technical design	
5 - Manufacturing and construction	IV realisation
6 - Handover	
7 - Use	V operation

Quality Control in BIMplement (the 'Model nZEB Cross-trade Quality and BIM-Skills Matrix') can be applied for all kinds of processes (building and building services, industrial etc.). For example regarding HVAC systems it is possible to elaborate a Quality Control system for the total HVAC system or for separate elements (i.e.: heating, cooling, ventilation). The most important characteristic for the BIMplement Quality and BIM-Skills Matrix is a structure that follows all the process phases. This enables to build in a number of strategic decision and quality control moments in the (construction or renovation) process and to assess if a ventilation system meets the targets and requirements, as defined in the program phase. As the total quality is determined by several aspects (not only technical but also financial, organization and communication) 10 different quality control aspects can be discriminated. This leads to the basis of the BIMplement Model nZEB Cross-trade Quality and BIM-Skills Matrix. On the horizontal axis of the matrix the phases of the process are distinguished. On the vertical axis of the matrix ten distinguished quality control aspects are listed.

		project phase				
		I programme	II design	III elaboration	IV realisation	V operation
quality control aspect	0 general					
	1 organisation					
	2 communication					

	3 requirements					
	4 means					
	5 purchase					
	6 time					
	7 finance					
	8 documentation					
	9 experience					

Process phases:

I Program phase: In the program phase an inventory takes place of requirements, demands and expectations of the ventilation system. Also all limiting boundary conditions must be listed and formulated. For the preliminary selection of the concept and type of HVAC system the main consequences are visualized. At the end of the program phase the principal, architect and (ventilation) consultant have enough information to make a first selection of the ventilation concept/system.

II Design phase: In the design phase the ventilation concept, as preliminary selected in the program phase, is elaborated by the ventilation consultant. Communication with architect and constructor takes place to tune building technical and architectural boundary conditions with the ventilation concept and vice versa. There will feedback to the starting points of the programm phase. At the end of the design phase a final selection of the ventilation concept takes place.

III Elaboration phase: In the elaboration phase the ventilation concept will be elaborated to a system level and a component level. Specifications will be elaborated and materialization takes place in this phase. This includes also detailed financial calculations.

IV Realization phase: In the realization phase the actual construction of the ventilation system takes place. This phase ends with the acceptance and hand-over of the installation. Note that during this phase, and in particularly during the acceptance, “commissioning” takes place according to the “English” definition (i.e.: testing of the installation of realization to check if it meets the terms of reference).

V Operation phase: In this phase the actual operation of the building and ventilation system takes place after the acceptance and hand-over of the installation. In ASHRAE publication 1996-1 this phase is called “post-acceptance phase”, in BREEAM this is called “post construction review (PCR)”. In this phase commissioning is the continued adjustment optimization and modification of the ventilation system, including maintenance to meet and to maintain the specified requirements.

Quality Control Aspects:

0 General: Description the general objective(s) of each phase including the starting points, boundary conditions and points of particular interest.

1 Organization: Description and allocation of tasks and responsibilities.

2 Communication: Description and recording of the necessary information exchange between all parties involved in the process is reported including a description about the necessary consultations including which parties, when, the objective and deliverables of each consultation.

3 Requirements: Inventory of internal and external requirements including a base level of legal and technical requirements like buildings regulations, standards and others as well as recommendations, according to (higher) quality level.

4 Means: Listing of all necessary calculation methods, execution protocols, assessment and evaluation tools including references to standards (like calculation, determination and measurement methods) measurement instruments and literature.

5 Purchase: Description of necessary external expertise that has to be purchased.

6 Time: Guarding of the object planning as well as process planning.

7 Finance: Controlling and guarding of the object costs (i.e. ventilation installation) as well as the process costs (co-ordination, consulting, commissioning).

8 Documentation: Reporting of the input and output of all sequencing phases.

9 Experience: Evaluation of the process at the end of the phases

From the main cells in the matrix that will be references to other cells. In these cells is stated which subjects and partial subjects are addressed. In separate specification sheets these (partial) subjects are further elaborated:

QC MATRIX					
aspect	project phase				
	I	II	III	IV	V
0					
1					
2					
3		II.3			
4					
5					
6					
7					
8					
9					

CELL CONTENTS > BIM		
subject	partial subject	specification sheet
II.3-1		
II.3-2		
II.3-3		

SPECIFICATION SHEET II.3-2	
characteristic	specification

Using the BIMplement Model Quality and BIM-Skills Matrix it is not necessary (and often not possible) to fill in all cells. But every information that is available can be "recorded and stored" in logical way in a cell, elaborated in specification sheets. Often this information is spread over two or more phases, consequently, over several specification sheets, corresponding with the distinguished phases and/or quality control aspects. It is important to analyse exactly in which phase and for what quality control aspect the information is necessary. Therefore it is important to know the meaning of each different quality control aspect. It is not possible and necessary to address all the quality control aspects. Parts 5, and specially 6, 7 and 9 are much more related to specific projects. On the other hand it is possible to write general guidelines for quality control of ventilation systems within this BIMplement Model Quality and BIM-Skills Matrix structure without addressing these aspects.

BIMplement Model Quality and BIM-Skills Matrix is not only for consultants and installers. All partners in the building process have to deal with the BIMplement Model Quality and BIM-Skills Matrix and will have to confirm to it. Also the principle must be aware of the fact that his responsibility reaches further then only the financial aspects. He has an important role during the program phase to formulate functional specifications, that can be “translated” by his consultants in a technical design and specifications.

The BIMplement Model Quality and BIM-Skills Matrix structure provides a perfect basis for the implementation of commissioning within a (production) process. Within the matrix cells can be identified which should be addressed for commissioning. Specification sheets can be further elaborated. As a commissioning document on ventilation has a general character (i.e. not related to a particular project) not all cells can be filled in. More over all descriptions and specification sheets will give in many cases guidance how to fill in specifications related to a “real” project (this will be the case for organization, communication, purchase, time, finance and experience). On the other hand, aspects as requirements, means and realization can be elaborated in detail.

Within TripleA-reno the BIMplement Model Quality and BIM-Skills Matrix will be used mainly for analysis purposes. Based on the analysis trigger points for the gamification engine that steers the learning and QA process can be distilled.

5.1 An example

Basically, the BIMplement Model Quality and BIM-Skills Matrix follows the sequences in a construction or renovation process. The idea is that:

- for each phase (only) the most relevant quality control aspects will be described
- quality control aspects in later phases should also be described in the earlier phases (for example, if in the realization phase and in the operational phase system performances should be controlled, it should also be taken into account in the design phase)
- if necessary and useful the MQC matrix can be further elaborated or revised during a construction or renovation process.

It will be evident that there will be a difference between new construction and renovation. In new construction much emphasis will put in the programme phase, especially, making consequences of choices clearly visible in terms of quality versus costs. For renovation much emphasis will be put on communication and organization.

In general, following the BIMplement Model Quality and BIM-Skills Matrix cells can be filled regarding Quality Control and commissioning:

I Program phase:

In 0 quality control must be mentioned as one of the boundary conditions in a project. This means that in the program phase provisions must be described in the ToR to execute all necessary activities for quality control (like BEMS, measuring points, balancing provisions, provisions for scheduled maintenance etc. etc.). In 1 can be stated who will be responsible for organizing quality controls (as described in 0) in the program phase and in following phases and which other parties should be involved. In 2 can be described during which phases which parties should discuss quality control, what kind of meeting(s) are necessary as well as the deliverables of the meetings.

Very important is 3, in a direct way as well as in an indirect way. Indirect means that proper specifications and the understanding that a principal knows what he asks and what he gets (i.e. that the specifications meets his expectations) is the beginning of good quality control. Of course all necessary provisions for quality control (mostly needed in phase IV and V) must be specified already in phase I. Of special concern is specification of components and provisions that allows maintenance and cleaning.

II Design phase:

In the design phase all necessary provisions for quality control must be taken into account in the final design and specifications.

III Elaboration:

In the elaboration phase final selection of provisions for quality control are selected. This means that component specifications must be given under 3 and selection criteria and methods for components must be given under 4. Purchase costs must be reported and guarded under 7.

Special concern is that for the final selection of components special requirements must be given to allow maintenance and cleaning. For example, if a ventilation concept contains metal ducts, special requirements must be given for duct joints to avoid clogging and to allow cleaning (no screws!). Ventilation provisions in the facade must be selected such that cleaning is possible without the risk of destroying the controls and mechanisms or without the change to disturb adjustments.

IV Realization:

In this phase actual quality control takes place. This means that in 1 the organization of the quality control must be arranged (i.e. definition of responsibilities, who is doing what, quality control authority/organization, installers, etc.). If specialist and external expertise must be hired in it must be reported under 5. Under 2 is arranged if meetings to arrange and discuss quality control and quality control results are necessary. Directives and guideline values are reported in 3. Tools, instruments, checklist procedures, measurement methods etc. etc. are listed in 4. Guarding of planning and costs are described in 6 and 7. In 8 is precisely described how the quality control results must be reported and documented; (note; in 2 the authorization and approval of these reports is arranged).

V Operation:

In the operation phase the continuous quality control process is arranged. Although the organisation and management structure that was operational during a building process is not available anymore in the operational phase the organisation of the continuous quality control can be described. It clearly will be another organisation and management structure then reported under I – IV. The tools and instruments as described under 4 will be partly the same as described in phase IV. Special attention in phase V is needed for maintenance. This also includes schedules for maintenance, to be reported in 6, and costs (i.e. cost reservations), to be reported in 7. As in phase IV precisely described quality control results must be reported in 8.

Note that this description only gives a preliminary idea how to arrange and organise quality control in a logical way in the sequential phases of a production process. This structure can be elaborated if necessary. It can also be used to fill in specification sheets on particular places where they are needed. In practice this can often follow from quality control aspect “9 – Experiences”.

Elaborated example on a MVHR system (Mechanical Ventilation with Heat Recovery)

For example, in an experimental site a MVHR system is selected to be applied in dwellings.

For designing, selecting and installing a MVHR system in a dwelling, in the design phase a professional designer will be involved who should have knowledge of all the principles of MVHR, the (legal) requirements conform the building regulations, but also about the required level of air change rate of the dwelling. The designer should also be able to communicate with the architect, in order to optimize dwelling design in relation to the necessary duct work (i.e. in the matrix it can be indicated (under 2. Communication) that a meeting/consultation between the designer and architect should take place, including the expected outcomes).

The output of the design phase is an actual design of the system (which can reported under 8. Documentation). This output must be understandable for the purchaser (in the elaboration phase-III) to order right components and craftsmen (in the realisation or execution phase - IV) who have to do the actual installing work.

Under 3. Requirements the actual requirements of the MVHR system can be listed (i.e. required air flows, maximum energy use, control possibilities, maximum sound levels). These specifications are the basis for the handover in the realization phase (IV).

Under IV.4 means the methods of measurements and verification can be described. For example, a description of the measurement procedures and equipment for measuring air flows as well as the way of reporting (in IV.8). In the next layer, the competences and vocational training can be listed to be able to perform the measurements.

		project phase				
		I programme	II design	III elaboration	IV realisation	V operation
quality control aspect	0 general	I.0	II.0	III.0	IV.0	V.0
	1 organisation	I.1			IV.1	V.1
	2 communication	I.2			IV.2	
	3 requirements	I.3	II.3	III.3	IV.3	
	4 means	I.4	II.4	III.4	IV.4	V.5
	5 purchase				IV.5	
	6 time				IV.6	V.6
	7 finances			III.7	IV.7	V.7
	8 documentation				IV.8	V.8
	9 experience				IV.9	

6. ANNEX I Replication results

For replication of the qualification part of the BIMplement Qualfication Framework several activities have been performed:

1. At ISSO by the author for a qualification for multifunctional green roofs
2. At ISSO by an un experienced collegue for a qualification on heatpumps
3. In Macedonia by a partner of the TRAINEE project
4. In Luxembourgh by a professional working at Centre de Compétences Génie Technique du Bâtiment

6.1 Qualification for multifunctional green roofs

This replication was done in a project running in parrallel with the BIMplement project. Goal was to design a qualification addressing all phases in the construction process of multifunctional green roofs. The outcome was used to create an outline of a practical handbook and a formal branche recognition for craftsmen working on these kind of roofs.

Lesson learned is that when creating a qualification that addresses all building phases it becomes possible to make overlapping areas in required competences visible. In the example below you can see how the training curriculum for the designer (green) overlaps with the curriculum for the planner (light oranje) and the overseeer on-site (dark orange). The overlap also means that the persons involved also need to interact on these issues in order to deliver quality.

WERKVOORBEREIDING EN PROJECTLEIDING		
Werkvoorbereiding / calculatie		
	Bepalen hoeveelheden materiaal voor realisatie MFDG	3.11
	Maken tijdsinschattingen werkzaamheden MFDG	3.12
	Opstellen kostenraming werkzaamheden MFDG	3.13
Praktijk boordeling van dak		
	Inspecteren dakbedekking (d.m.v. watertoets / visueel)	1.22
	Accepteren werkplek	2.34, 3.14
	Intepreteren toe te laten / toe te passen dakbelastingen	2.12, 3.15
	Beoordelen bereikbaarheid van het dak inclusief benodigd materiaal/materieel	2.20, 1.12
	Beoordelen / bepalen veiligheidsvoorzieningen	2.34
	Afstemmen fasering, bouwlogistiek & planning	1.12
	Rekening houden met juridische consequenties van contractvormen	1.17
UITVOERING		
Coordinerend		
	Aanspreken medewerkers + onderaannemers op gedrag en veilig werken op hoogte	3.8
	Aansturen en volgen productieproces	
	Aanspreken medewerkers + onderaannemers op risicovol gedrag schades	3.9
	afstemmen bouwlogistiek + planning	1.12
	Rekening houden met juridische consequenties van contractvormen	1.17

04 Example Snapshot from the Dutch qualification on multifunctional green roofs

6.2 Qualification on heatpumps

This replication was done in a project running in parrallel with the replication phase of the BIMplement project. Goal was to create consensus with a broad group of stakeholders on a qualification addressing all expertise needed for designing, installing and maintaining heatpumpsystems. With as expected result a detailed qualification suitable for development of practical and theoretical exams and recognition of workforce involved. It was the first time that the BIMplement method for qualification development was explained to a person without prior experience on development of qualification (a heatpump subject matter expert). In three iterations this person became able to use the method to develop and optimise a detailed and harmonised qualification for a very complex topic.

Taken en sub-taken	Monteur (N2)	Eerste monteur (N3)	Monteur service en onderhoud (N2/3)	Eerste monteur service en onderhoud (N3)	Technicus service en onderhoud (N4)	
Installeren van systemen en componenten van de warmtepompinstallatie.	X	X	X	X	X	26.5-32.1-36.1-57.1-65.1-85.1-90.1-91.1
Installeren warmtepomp(systemen) en componenten volgens geldende normen, wet en regelgeving en fabrikantgegevens.	X	X	X	X	X	56.1
Werken volgens normen en voorschriften (F-gassen besluit, PED, wet (Arbo en milieu)- en regelgeving)* .	X	X	X	X	X	Basiskennis
Voorzieningen treffen voor de elektrische aansluiting van de elektrische warmtepomp.	X	X	X	X	X	34.1
Elektrisch aansluiten warmtepompsysteem.	X	X	X	X	X	34.1
Installeren van een regelsysteem voor het warmtepompsysteem.	X	X	X	X	X	21.3-33.1
Aansluiten van het regelsysteem op de warmtepompinstallatie.	X	X	X	X	X	21.3-33.1-34.1
Toetsen en beproeven van gerealiseerde werkzaamheden.	X	X	X	X	X	27.2-59.1-60.2-61.1-62.1
Inregelen van de WP-installatie / het WP-systeem		X	X	X	X	
Lucht- en waterzijdig inregelen van de installaties.		X	X	X	X	28.2
Rapporteren (inregel)gegevens.		X	X	X	X	28.2
Inbedrijfstellen van de WP-installatie/ WP-systeem		X	X	X	X	32.1-33.1-34.1-36.1-65.1
In bedrijf stellen installatie.		X	X	X	X	27.2-59.1-60.2-61.1-62.1
Controleren installatie volgens de specificaties en juiste werking.		X	X	X	X	27.2-58.1-59.1
Verrichten eventuele eindmetingen.		X		X	X	27.2-58.1
Rapporteren inbedrijfstelling en eventueel invullen werkbonnen.		X	X	X	X	29.2-96.1
Toelichten werkzaamheden, adviseren over de werking en opleveren installatie aan de klant.		X	X	X	X	29.2
Service en onderhoud / beheer van de WP-installatie/ WP-systeem			X	X	X	32.1-33.1-34.1-36.1-63.1-65.1

05 Example Snapshot from the Dutch qualification on heatpumps with tasks and subtasks

No.	Kennis (weten)	Vaardigheden (begrijpen en kunnen)	Competentie (Verantwoordelijkheid)
14.1	benodigde middelen (warmteverliesberekening) om de vermogensbehoefte te bepalen.	begrijpt welke randvoorwaarden het uiteindelijke vermogen bepalen.	bepaalt en berekent ~~zelfstandig~~ het vermogen voor ruimteverwarming en -koeling van de warmtepomp.
15.1	mogelijkheden en randvoorwaarden in het afgiftesysteem bij lagetemperatuur verwarming.	begrijpt en interpreteert de diagrammen op basis waarvan het afgiftesysteem wordt geselecteerd.	selecteert op basis van de diagrammen het afgiftesysteem ~~en weet voor details de benodigde ISSO-publicaties te vinden.~~ conform relevante ISSO publicaties
15.2	mogelijkheden en randvoorwaarden in het afgiftesysteem bij lagetemperatuur verwarming.	begrijpt globaal de afmetingen van de verwarmingslichamen en de bijpassende verwarmingscapaciteit.	onderzoekt bij klachten of het afgiftesysteem geschikt is voor lage temperaturen.
16.1	beperkingen in het distributiesysteem bij kleinere temperatuursverschillen .	~~begrijpt en~~ interpreteert de diagrammen op basis waarvan de leidingdiameters in het distributiesysteem wordt geselecteerd (kleinere deltaT, grotere volumestromen).	selecteert op basis van de diagrammen de leidingdiameters in het distributiesysteem ~~en weet voor details de benodigde ISSO-publicaties te vinden.~~ conform relevante ISSO publicaties
16.2	beperkingen in het distributiesysteem bij kleinere temperatuursverschillen .	begrijpt de diameters van de leidingen en de mogelijke volumestromen door deze leidingen.	~~kan~~ relateert in geval van niet juist functioneren de leidingdiameters ~~relateren~~ aan de capaciteiten, temperatuurverschillen en doorstroom hoeveelheden. [Stond omschreven als een vaardigheid, competentie van gemaakt]

06 Example Snapshot from the Dutch qualification on heatumps with the ULO's

Lesson learned are:

1. Start always first with outlining the tasks and subtasks, without introducing the Unit of Learning Outcomes. When the tasks and subtask overview is ready, it is time for instructions on the ULO details.
2. Do small iterations on the ULO-definitions. After writing the first 4 ULO's it is already clear where coaching is needed. In image 6 a snapshot with feedback on some ULO's

3. The definitions for skills and competences are not clear at once. Especially the fact that competences need to address a responsibility element leading to a definable result.
4. In the case of heatpumps the stakeholders also wanted to add fundamental knowledge, skills and competences. These have been added to the main tasks. If this works this can be a good extension of the framework and the ULO database.

6.3 Macedonia and Luxembourgh

Replication in Macedonia and Luxembourgh was done in parallel. As starter I sent both candidates the self -instruction manual. A webmeeting was planned a few weeks later in order to give the participant some time for reading and digesting. In the webmeeting also a partner from Lithuania was present as preparation for a replication of BIMplement in Latvia.

During the meeting it became clear that the self-instruction guide was good as starter, but not sufficient to get enough self-esteem to start the work. In the webmeeting after a short presentation on the story of BIMplement all key elements of the BIMplement Qualification framework have been presented shortly. Both candidates applied the method successful after 1 improvement iteration.

Luxembourgh used the method for a qualification used in regular education. As a matter of fact the method happened to be also useful for that purpose.

Tasks	Sub-tasks	Professions involved	Specialisms involved	ULO Numbers
Site preparation				
	Read a plan and technical file	heating installation professional	Example specialism	1
	Design a plan			2
	Calculate material requirements (length, surface, volume, etc.)			3
	Constitute (select materials, materials and tools) and manage the stock			4
	Prepare machinery and equipment			5
	Maintain order and cleanliness of the site			6
	Perform administrative work			7

07 Overview of basis task and subtasks from the Luxembourgh replication

ULO Nr.	Competence	Skills	Knowledge
1	~~Read a plan and technical file~~ carry out an assembly according to plan	Read a plan Read a technical file (incl. drawings) Identify the operation of the installation Apply the plan	index of a plan; technical symbols; rules of drawing
2	Design a plan (for what?)	estimate necessary material make detailed drawing	rules of drawing
3	Calculate material requirements (length, surface, volume, etc.) (for what?)	identify masses on the plan and on site	know the rules of quantity
4	Constitute (select materials, materials and tools) and manage the stock	manage a parts listing stock management	mastery of the material on site, supply control, consumption control consistent parts supply
5	Prepare machinery and equipment (for what?)		

08 Feedback on the ULO's definitions

Lesson learned are:

1. A competence needs to have 'a responsibility' element in it. This was not clear from the self-instruction guide.
2. Skills are <u>all skills needed</u>, include also skills that show the ability to apply knowledge
3. Knowledge in the BIMplement QF (and Cedefop guidelines) is static.
   Use of verbs is not needed (that is done in the skills)

In Macedonia the method was applied to remodel an existing qualification from the TRAINEE project.

Designer of RES systems in buildings

Optional	Tasks	Sub-tasks	Professions involved	Specialisms involved	ULO Numbers
	Providing advice to a customer while keeping in mind customer-specific requirements and , in order to plan photovoltaic/solar thermal systems that meet demands				
		Provide, determine, document and evaluate basic information for PV/ST system with a set of instruments (measurements, devices, software etc.)	Engineer in technical sciences (electrical, mechanical)	Engineer with skills for design of RES systems	1
		Create and present standard planning layouts for PV/ST for consumer service, and also adapt them to the needs	Engineer in technical sciences (electrical, mechanical)	Engineer with skills for design of RES systems	2
		Produce extensive planning concept for PV/ST , based on technical and financial framework conditions	Engineer in technical sciences (electrical, mechanical)	Engineer with skills for design of RES systems	3
		Convince the client in ecological and economic value added by PV/ST system	Engineer in technical sciences (electrical, mechanical)	Engineer with skills for design of RES systems	4
		Provide advice on complex energy concepts	Engineer in technical sciences (electrical, mechanical)	Engineer with skills for design of RES systems	5
	Planning a consumer PV/ST system according to recognized rules of the technology, the legal requirements and the safety provisions				
		Dimensioning PV/ST system and selecting suitable components when planning PV/ST system	Engineer in technical sciences (electrical, mechanical)	Engineer with skills for design of RES systems	6, 7
		Choose relevant and suitable operating equipment from that available on the market, keeping in mind the rules of the technology and dimensioning as a foundation of the system	Engineer in technical sciences (electrical, mechanical)	Engineer with skills for design of RES systems	7, 8

Provide advice to a customer regarding photovoltaic/solar thermal systems

Can you make the tasks shorter? Now they contain a lot of verbs

What do you mean with this?
Design PV/ST system

09 Overview of feedback on tasks and subtasks from the Macedonian example

ULO Nr.	Competence -- Responsibility	Skills - Able to	Knowledge -Know how
1	Identifying systems and components specific to PV/ST system's location, layout and configuration in order to provide an advice to the consumer and do planning of the most adequate system	Can produce extensive planning concept, based on technical and financial framework conditions	Basic information for PV/ST system such as...
2	Planing PV/ST systems	Can use adequate software for planing and design of PV/ST systems	Familiarization with the basic concept and functioning of the system
3	Produce extensive planning concept, based on technical and financial framework conditions	Know how to aAdjust the PV/STsystem to technical and financial condidtions	Technical and financial aspects of the PV/ST system
		Adjust the PV/ST system to technical and financial condidtions	
4	Present the ecological and economic value added by PV/ST system	Ability for convincing client in ecological and economic value of the PV/ST system	Ecological and economic aspects of PV/ST system
5	Advicing on complex energy systems	Ability to show the benefits of complex systems	Compex energy systems such as...
6	Define required installation area, orientation and tilt for PV module	Can use current simulation software to assess and optimize energy efficiency of components	Familiarization with the rules of the technology and dimensioning as a foundation of the system

10 Overview of feedback on ULO composition in the Macedonian example

Lesson learned are:

1. the QF method is suited for development of one QF addressing both the designer and the installer. There is no need to develop them separated from each other. This to overcome double work & to see where competences and skills are overlapping. This can be done easily by adding profession columns to the format

Profession 1	Profession 2	Profession 3	Specialisms involved	ULO Numbers
x			Example specialism	1, 2
	x			
		x		

2. Many of the tasks can be worded much shorter. As the details are in the Unit of Learning Outcomes
3. Very important is the distinction between competence, skills and knowledge. Explanations have been added to the Excel template

7. Colofon

BIMplement

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