From insight into energy transition maturity to powerful task-based cross-sectoral upskilling

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Abstract. To make advancements in energy transition and creating a future proof built environment, professionals and workers who possess required skills are crucial. This paper proposes a model that can be flexibly adopted to reach an acceleration of upskilling opportunities and outcomes. The paper outlines the Technological Innovation Systems approach for delivering cross-sectoral knowledge and skill development agendas, as well as a method to develop and apply skills mappings and task-based qualifications. The combined approach is a stepping stone to enable digital support for learning on the job, learning transaction based recognition of successfully acquired knowledge and skills, as well as skills passports and micro-credentials. The approach has proven to be useful for sectors where technological innovations heavily influence ways of working, and it enables a common reference methodology in Europe. In order for the approach to be utilised optimally, key requirements should be taken into account, indicating that the taxonomy, toolkits and context of skills should be well aligned. The paper suggests future developments to address the transorganisational implementation of the approach, and the transitional management of skills gaps.

Keywords. Technical Innovation Systems, skill development, skill-levels, recognition, lifelong learning, micro-learning credentials, learning on the job
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1. Introduction

The energy transition is moving currently from take-off phase into acceleration phase. Sustaining the built environment is one of the urgent challenges in play. To realise the transition towards a people centred, energy-efficient, circular, digitised, climate adaptive and healthy built environment, acceleration is urgently needed. Although, without a proper set of mastered knowledge and skills, participation in multidisciplinary design teams and cross-craft collaborations on-site prove to be difficult, thus hindering the needed acceleration.

By applying the Technological Innovation Systems approach (TIS) [1] in Horizon 2020 projects for improved energy innovation and skills, a method has been developed and applied to pinpoint where training and course development is needed in the short, intermediate and long term. This is in order to underpin when and for which occupations dissemination of technical innovations and related knowledge and skills is needed. The resulting skills-mappings prove to be of practical value in exploration and decision making processes by reducing the number of choices and providing a clear view on skill-levels needed.

As the building services sector also acts as an innovator and is the axis between the construction, energy, IT and health sectors, integrating knowledge from these fields into training and course development is not an easy challenge. Large scale projects about BIM integration and nZEB tackled this by developing an application of a task-based qualification framework. This framework enables intersectoral teams to create task-based qualifications and corresponding Unit of Learning Outcomes that cover all occupations and sectors involved.

Resulting curricula are cross-sectoral, highlighting roles and responsibilities and the minimal set of knowledge and skills needed for assessing the

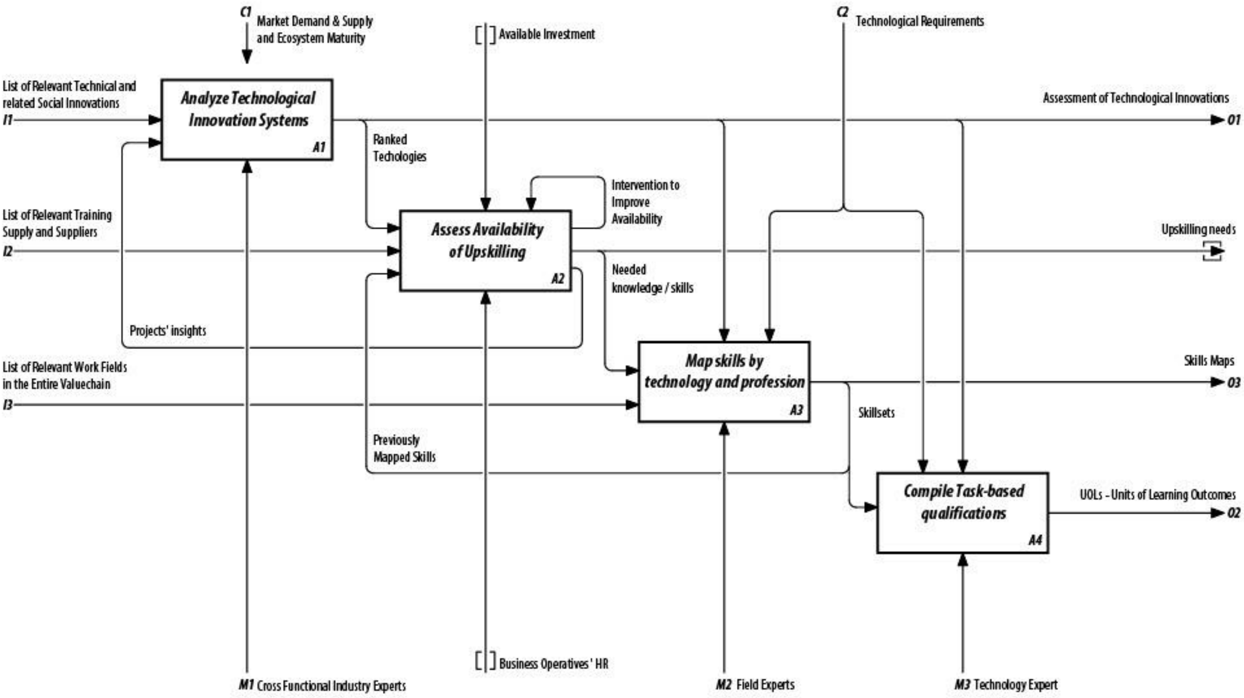


Fig 1 - Model of the main steps proposed to increase and improve upskilling opportunities, connected to their inputs and outcomes.

applied value of a specific innovation or theme. It also enables sectoral and intersectoral skills-registers / skills-passports to take task based knowledge and skill development into account. Furthermore, the development of transparent micro-learnings and micro-credentials is facilitated.

The purpose of this paper is to provide insight into methods that contribute to the establishment of upskilling, as well as propose a common language for the upskilling process. It is relevant to note that the methodology presented is hardly linear; it is dynamic for the sake of design thinking, which will allow the components to feed into one another. This can create a constant feedback loop, promoting innovation and exploration within the system. In order to make the system work optimally, the paper proposes several key requirements to consider.

2. Method

For this paper, outcomes of various large scale EU funded projects about energy technologies and upskilling have been used as input. The methodology is presented in the form of an IDEF0 diagram (Figure 1) with its main activities connected through outputs and inputs. A detailed description of individual activities is given in the follow-up sub-sections. The findings derived from the described activities are based on surveys, systematic action research, and iterative frameworking from the projects, which collectively lead to a well-informed synthesis.

3. Technological Innovation Systems approach

It is imperative that availability of upskilling supplies corresponds with the market adaptation stage and related TIS-maturity of upcoming technologies. When technologies advance, upskilling should be scalable at a fast pace. The Technological Innovation Systems (TIS) approach addresses these challenges by analysing the expected need and supply of upskilling.

The TIS model approach functions as a first step in the upskilling process that is needed to diffuse knowledge around critical innovations. The purpose of this step is to prevent knowledge gaps, allowing for new technologies to further penetrate the market. This can be achieved by providing pro-active upskilling possibilities to the workforce delivered through adapting the innovative means.

The analysis model developed applies the TIS-model and adds several additional knowledge dissemination indicators. It comprises an easy to use five-point scale ranking. The results of this ranking display to what extent the development of new training material is needed for a certain technology and in what period of time the training means should be established. Additionally, the model scores existing technologies for how well they are represented in upskilling and training at the time of investigation.

By combining the ranking of the maturity of an innovation, expected speed of development, and available upskilling, it becomes possible to make statements about what training topics and means should be developed in the short, intermediate and long term. This process enables prioritising for annual development plans and budgets. The model allows many potential other forms of use. An example is elaborated upon in paragraph 2.2.

The applied TIS model is based on existing theories of market penetration and phases of innovation systems [2]. Firstly, innovations are rated on a scale between incremental and radical innovation (See Table 1) [3]. Secondly, it is rated whether the innovation demands a more modular or system-level change. Thirdly, seven criteria have been devised based on research about learning for innovation by Hekkert and Ossebaard [5]: entrepreneurial activity, knowledge development, knowledge transfer (Table 2), steering the search process, stimulating market demand, sources of innovation and dealing with resistance. As to the scoring of the representation of the innovation in present upskilling, four availability levels for schooling are introduced: custom knowledge transfer, on-request training, widely available training, and upskilling as part of regular education.

Tab. 1 – Example criterium 'incremental/radical innovation'. Each scoring table comes with 'gaps' (score 2 and 4), because of the subjectivity of the ranking.

Score	Description	Example
1	No adjustment required for application of the product	New type of boiler, new type of petrol car
2		
3	Small or medium adjustments required for application of the product	Building management system, hybrid car
4		
5	New product that is not comparable to other products in the market	Fuel cell, electric car

Tab. 2 – Example criterion 'knowledge transfer'.

Score	Description
1	Little to no knowledge available.
2	
3	Limited availability of knowledge for individual study and education. Producers and users start learning more and more from each other.
4	
5	Wide availability of knowledge for individual study and education. Producers make use of user experience to further develop their innovation.

2.2 Application of the TIS approach for mapping of innovations

In Dutch research, the model has been applied to energy transition in the installation sector by ranking and mapping the innovations tied to mapped insights from projects sustaining the built environment. Researchers made use of a spreadsheet to rank each technology as independently as possible in order to reach objective results. Ranking of criteria were eventually displayed with qualitative descriptions, in order to further substantiate the choices that were made.

A combined analysis of the ranking of technological innovations and the availability of upskilling was conducted (see Table 3). For example, airtightness as a technology is in its acceleration phase on the market, there is no wide availability of training, and knowledge transfer is ranked at level 3. Informed by the model, it can be concluded that development of airtightness schooling should be set in motion in the short term.

Tab. 3 – Relationships between criteria for determining the investment period.

Phase innovation system	Wide availability of upskilling	Knowledge transfer	Investment in upskilling needed
Acceleration or stabilisation	No	≤3	Short term
Take-off	No	≤3	Intermediate term
Exploration	No	≤3	Long term

The use of this model resulted in an overview of technologies and skills for which a sufficient amount of upskilling needs to be realised to prevent knowledge gaps in the (near) future. In this research example, outcomes were used to devise an agenda for the Dutch installation sector development fund in order to underpin investments in training development.

2.3 Practical value of innovation mapping with the TIS approach

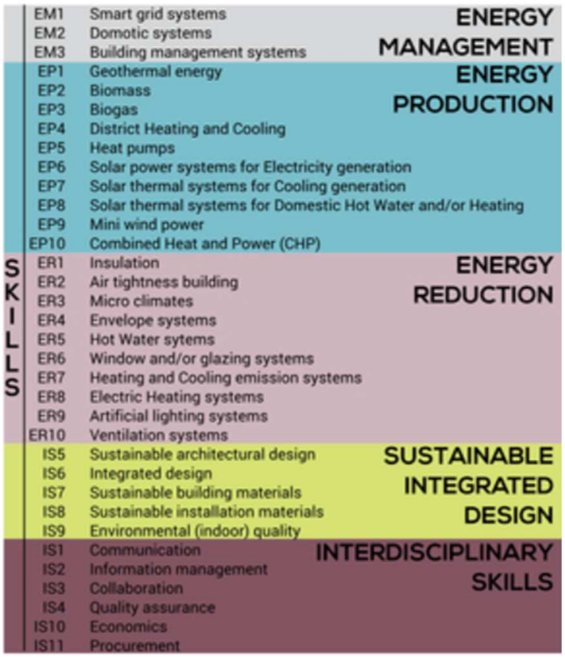
The TIS model provides an integral view on the need for upskilling, taking into account different actors and processes across the value chain. In addition, the model allows for required soft skills and specifically interdisciplinary skills (which are critical in technological innovations), to be mapped and gain visibility.

On the one hand, results of applying the model can be used in an isolated manner to devise agendas and budgeting for educational developments. Results can also form the basis for further skills-mapping and the creation of a task-based qualification, which will be discussed in the following paragraphs. Figure 1 shows an example of a first mapping of technologies, to be used as input for further steps in the process. The TIS model constitutes the point of departure in the journey towards powerful cross-sectoral upskilling: insight into energy transition maturity.

3. Skills mapping

Building on the list of technologies and innovations that result from applying the TIS model, one can execute a mapping of skills tied to the innovations. This skills mapping methodology was developed to support EU member states in finding a fast and practical manner to perform skills mappings with multiple stakeholders.

First, work fields relevant to the technologies should be considered in consultation with experts. By using expert knowledge, it can also be decided to what skill level a certain technology should be developed by a professional in a certain work field. After all, not all professions are expected to have the same skills for all the identified technologies. An example could be when a civil engineering professional is expected to reach skill level 4 for the subject of envelope systems (technology identified in Figure 2).

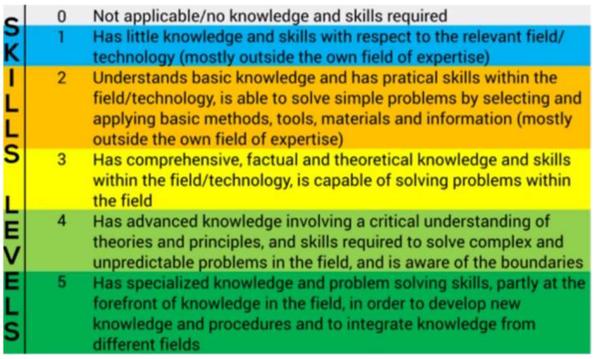


SKILLS

EM1	Smart grid systems	ENERGY MANAGEMENT
EM2	Domotic systems	
EM3	Building management systems	
EP1	Geothermal energy	ENERGY PRODUCTION
EP2	Biomass	
EP3	Biogas	
EP4	District Heating and Cooling	
EP5	Heat pumps	
EP6	Solar power systems for Electricity generation	
EP7	Solar thermal systems for Cooling generation	
EP8	Solar thermal systems for Domestic Hot Water and/or Heating	
EP9	Mini wind power	
EP10	Combined Heat and Power (CHP)	
ER1	Insulation	ENERGY REDUCTION
ER2	Air tightness building	
ER3	Micro climates	
ER4	Envelope systems	
ER5	Hot Water sytems	
ER6	Window and/or glazing systems	
ER7	Heating and Cooling emission systems	
ER8	Electric Heating systems	
ER9	Artificial lighting systems	
ER10	Ventilation systems	
IS5	Sustainable architectural design	SUSTAINABLE INTEGRATED DESIGN
IS6	Integrated design	
IS7	Sustainable building materials	
IS8	Sustainable installation materials	
IS9	Environmental (indoor) quality	
IS1	Communication	INTERDISCIPLINARY SKILLS
IS2	Information management	
IS3	Collaboration	
IS4	Quality assurance	
IS10	Economics	
IS11	Procurement	

Fig. 2 - Example of an outcome of the TIS approach for energy innovations, where each technology is categorised and accompanied with a code.

The methodology contains 5 skill levels. See Figure 3 for a description of levels, which was based on EU terms and the Bologna declaration of 2010 (Cromwijk et al., 2017). A potential complete skills mapping outcome for the civil engineering professional mentioned in the previous example is shown in Figure 4. Visualisations like these that come with the methodology can be helpful for communication and collaborative application.



SKILLS LEVELS

0	Not applicable/no knowledge and skills required
1	Has little knowledge and skills with respect to the relevant field/ technology (mostly outside the own field of expertise)
2	Understands basic knowledge and has pratical 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)
3	Has comprehensive, factual and theoretical knowledge and skills within the field/technology, is capable of solving problems within the field
4	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
5	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

Fig. 3 - Skills mapping levels and descriptions.

Additional to skills mapping is that the methodology enables the mapping of current skills gaps, using the same skill levels. This way, it can be further decided what technologies and skills require upskilling in the (near) future.

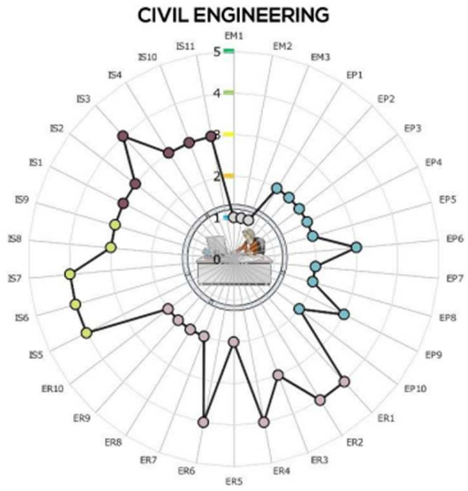
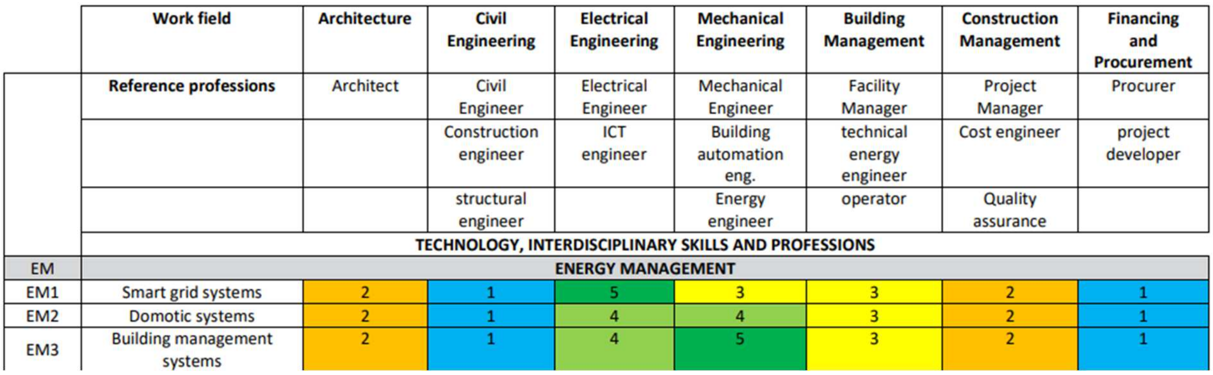


Fig. 4 - Example of a visualised skills mapping for the work field of civil engineering in nZEB. Each coloured circle marks the required skill level of the professional for that technology.

3.2 *Application of skills mapping*

In PROF/TRAC an H2020 funded project, the skills mapping methodology has been applied to white-collar professions in nearly-Zero Energy Building (nZEB). Execution of the method was organised with small groups of experts in work fields defined as relevant. They had all been working with nZEB skills before. The experts were trained in using the method, after which they executed the skills mapping in their own countries. As a validation, the results delivered by the expert groups were reviewed by consortium partners.

The outcome of the above mentioned process was a complete mapping of all the technologies and skills mentioned in Figure 1, for seven different work fields. Figure 5 shows one component of this



	Work field	Architecture	Civil Engineering	Electrical Engineering	Mechanical Engineering	Building Management	Construction Management	Financing and Procurement
	Reference professions	Architect	Civil Engineer	Electrical Engineer	Mechanical Engineer	Facility Manager	Project Manager	Procurer
			Construction engineer	ICT engineer	Building automation eng.	technical energy engineer	Cost engineer	project developer
			structural engineer		Energy engineer	operator	Quality assurance	
	TECHNOLOGY, INTERDISCIPLINARY SKILLS AND PROFESSIONS							
EM	ENERGY MANAGEMENT							
EM1	Smart grid systems	2	1	5	3	3	2	1
EM2	Domotic systems	2	1	4	4	3	2	1
EM3	Building management systems	2	1	4	5	3	2	1

Fig. 5 - Example of a skills mapping for energy management skills. Coloured cells represent applicable skill levels per technology for each profession.

project. The results, in turn, functioned as the origin for the development of a task-based qualification scheme, which will be elaborated upon in chapter 4.

3.3 Practical value of skills mapping

A practical experience from work in an additional H2020 funded project described the challenge of finding the right scope for establishing professions and specialisms in circular construction projects. This challenge simultaneously illustrates the flexibility and potential for wide applicability of the method. Project members found that the use of (guided) examples and collaboration helped in finding the right scope.

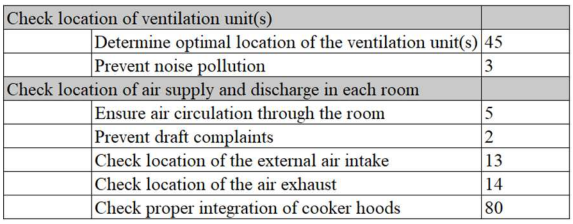
The skills mapping methodology can bring about a useful overview for each work field. From an EU perspective, broad work fields are considered for the mapping process to account for differences between job descriptions across countries. Results are mostly generalizable. Furthermore, the ability to use this method as a mapping of skills gaps between current and desired skill outcomes is a valuable addition to the applied TIS approach.

4. Task-based qualification framework

To create a task-based qualification framework with the input collected in executing the previous methods, more detailed competences and descriptions should be collected for each technology or interdisciplinary skill. Doing so will result in a set of specific competences. These are the so-called minimum qualifications per skill level. Here, it is decided what specific tasks and subtasks a professional should tend to and how. It focuses on the required knowledge, skills and behaviour.

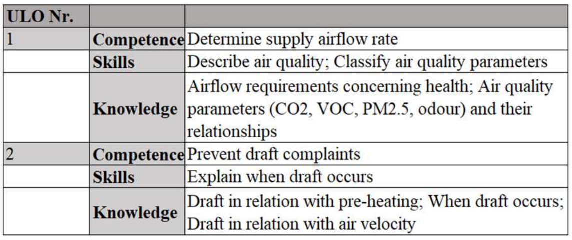
For this methodology, expert consultation is a key aspect. Professionals with expertise in a specific technology or innovation are to be interviewed about the exact steps to be conducted and the skills needed to become proficient within the subject. Each qualification is linked to a unique Unit of Learning Outcome (ULO) [4]. All ULO's are stored in a database. With the help of this method, ULO's can be easily labelled with locations of existing learning content.

Additionally, if a certain skill is applied to multiple tasks, the ULO has to be written only once. Eventually, all processed information will be revised by the experts who were interviewed at the beginning of the process. See Figure 5 and 6 for examples of tasks and subtasks and corresponding ULO's. Devising a task-based qualification framework enables decisions about what exact profile professionals should possess. It also provides input for training and upskilling programmes. Together with TIS and the skills mapping methodology, this is a stepping stone for learning on the job and recognition of skills.



Check location of ventilation unit(s)		
	Determine optimal location of the ventilation unit(s)	45
	Prevent noise pollution	3
Check location of air supply and discharge in each room		
	Ensure air circulation through the room	5
	Prevent draft complaints	2
	Check location of the external air intake	13
	Check location of the air exhaust	14
	Check proper integration of cooker hoods	80

Fig. 5 - Example of two tasks and related subtasks



ULO Nr.		
1	**Competence**	Determine supply airflow rate
	Skills	Describe air quality; Classify air quality parameters
	Knowledge	Airflow requirements concerning health; Air quality parameters (CO2, VOC, PM2.5, odour) and their relationships
2	**Competence**	Prevent draft complaints
	Skills	Explain when draft occurs
	Knowledge	Draft in relation with pre-heating; When draft occurs; Draft in relation with air velocity

Fig. 6 - Example of two detailed Unit of Learning Outcomes. Note that ULO 2 is applied to one of the subtasks in Fig 5.

4.2 Application of task-based qualifications

In a practical application, ULO's may be tied to ambitions that were set for each profession during the skills mapping. For instance, if a work field has received a required skill level 2 for the technology of micro climates, this could mean a professional is recommended to acquire fewer ULO's than someone who has a required skill level 4.

Final results of the skills mapping and qualifications from several projects were used for the *BUILD UP Skills Advisor app*. This application is being used by professionals to visualise their skills development possibilities and to gain new skills by taking part in e-learnings that are tailored to the professional profile they are recommended to acquire. In this manner, earning and recognition of skills is further stimulated digitally.

4.3 Practical value of task-based qualifications

Task-based descriptions help steer users' focus towards the actual competences of professionals, without being restrained by differences in professional titles between countries. Furthermore, the opportunity for recognition of skills can be connected to micro-learning and micro-credentials. Micro-credentials certify the outcomes of short learning experiences and address the skills gap between initial qualifications and emerging skills needs in the market [6]. Task-based qualifications can further facilitate development of micro-credentials and enhance transparency in terms of what they represent.

5. Enforcing recognition of skills

This chapter provides an overview of minimum requirements for the levelling of skills and implementation in architecture, engineering and construction (AEC) processes. The premise is that the management of skills requires that the information on the skills must be first made available, accessible, and usable. To make descriptors of skills usable to the desired extent, the following requirements are identified as essential. Descriptors should be a) easy to understand; b) applicable in a specific context; c) consistent in semantics and granularity; d) comparable across above given criteria and; e) transferable within and across domains. In the follow-up sub-sections, key requirements for levelling the skills and the usefulness of the mapping of the skills are identified.

5.1 Key requirements for levelling of skills

For the definition of minimum requirements for the levelling of the skills it is important to align three important concepts: taxonomy, toolkit and context.

In this paper, taxonomy is understood as a principle of classification that allows for items to be characterised into types. In our case, we are interested in the characteristics of the skills. Bloom's taxonomy [7] is a well-known taxonomy of knowledge types that uses principles of classifications by the characteristic of directionally chained levelled states of knowledge. These levels are as follows: remember, understand, apply, analyse, evaluate, and create. This approach is an easy-to-understand levelling of knowledge that can be further elaborated upon in the context of skills management.

Toolkits are used to facilitate management. Skills toolkits may include a set of tools, frameworks, templates and real-life examples and best practices [8]. There are no well-established toolkits that could facilitate targeted transition addressed in this paper.

The skills management context is defined by the market, by jobs meeting the market needs and by job performance. The EU building services market is heavily affected by EU policies, which require job profiles that possess specific knowledge and technical skills for the processing of information and material. Related job performance may often only be objectively assessed through the performance appraisal.

In the context of building services we would like to define a framework that allows for context specific skill levelling as depicted in Figure 9.

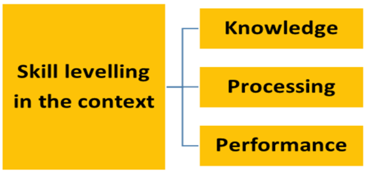


Fig. 9 - Skill levelling in the context

In a given context of levelling skills a number of factors should be addressed: supply chain, standardisation, unified granularity, process quality criteria, and feedback-loop assessment.

Regarding the supply chain, skills management should ensure that inter-organisational interoperability is more easily achieved in terms of the scope, required technical skills, objectives, performance and inter-task dependencies. In the context of building services and projects in the built environment, it is very important to control the supply chain across project stages, components and project-specifics.

Standardisation of the levelling should include the interplay of two critical contributing maturities with varying weight across project processes and results: (1) objectives of the technical skills, (2) and behavioural performance of individuals, teams and companies.

As we can see from the previous two items, there is a varying granularity in terms of the breakdown of processes, process results, subsystems, costs and more. Therefore, unification of granularity is important from several viewpoints, including, but not limited to the tasks.

The process quality criteria should be the base for the levelling of activities. Process quality criteria should include both process and process outcome assessment and how component and project-specific requirements are being met in the context of building or building services projects. This should include generic assessment, and component and project specific evaluation throughout project phases.

Regarding feedback-loop assessment, there are two essential intra and inter-related feedback loops: for individuals and for systems. The individual shall be assessed according to the job objectives (the difference between the targeted and actual objectives) and performance (the difference between the targeted and actual behaviour at job).

5.2 Usefulness of skill-level definitions for skills mapping

The task-based qualification scheme elaborated in the previous chapter project has been applied and further developed into a Competence Quality Standard (CQS) by the H2020 Train4Sustain project. The CQS allows to evaluate, score, and report the level of competence of professionals (white collars) and workers (blue collars) in sustainable building, expanding the original scope of the framework.

The CQS is formed by more than 100 Areas of Expertise, defined in relation to the most relevant innovations (as through the application of the TIS model), the main frameworks of sustainability indicators (e.g. Level(s), EN/ISO standards) and the most important assessment systems (e.g. DGNB, HQE, BREEAM).

In the CQS, the Areas of Expertise are organised in a hierarchic (5-levels: dimensions, thematic fields, macro areas of expertise, areas of expertise, learning outcomes) and modular (4 dimensions: environment, society, economy, and process) structure.

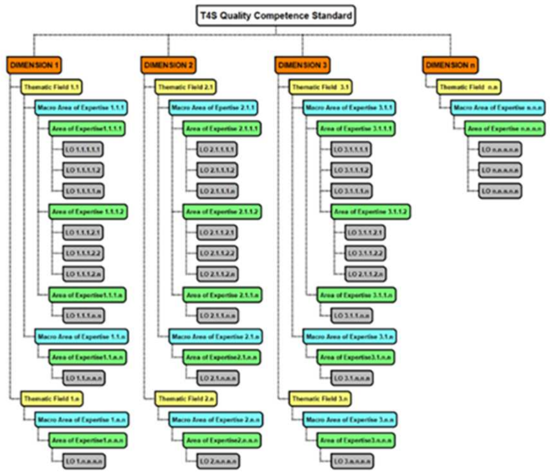


Fig. 10 - Structure of the Train4Sustain CQS, consisting of five levels and four dimensions. Areas of Expertise are represented by green boxes.

Each Area of Expertise is composed of a set of Learning Outcomes, described in terms of skill and knowledge. Each Learning Outcome is associated with a competence level using the same scoring scale adopted in the skills mapping, from 1 to 5, where 5 is the highest degree of competence.

To put this in a wider context, level 1 of the CQS requires learning outcomes similar to EQF 4. Level 2 and 3 correspond to learning outcomes of EQF 5 or 6, level 4 calls for learning outcomes comparable to EQF 6 or 7 and level 5 corresponds to EQF 7 or 8. The Train4Sustain competence levels are not related to the EHEA (European Higher Education Area) qualification or to vocational training qualification, meaning that each building professional has an official EQF level from 5 to 8 (i.e., the EQF range of white collars in terms of education). To their EQF, a Train4Sustain CQS level ranging from 1-5 can then be added. For instance, a professional with EQF level 7 on architecture without competences on renewable energy systems could achieve, through a training course, a CQS level 2 which is additional to the already present competence in architecture. Similarly, a blue-collar worker having a generic vocational qualification diploma (EQF level 3 or 4), can reach a CQS level 5 on a specific area of expertise (i.e. installation of insulation components) through participation in specific skills upgrading training courses or through work experiences.

Proven ability can be acquired by professionals and workers through training courses, and outside the formal learning context through work experience and independent study, provided that these learning outcomes satisfy the requirements of their qualifications. As in the skills mapping and task-based qualifications, the Areas of Expertise have been associated with different work fields for both professionals and workers. Depending on the Learning Outcomes acquired, a building professional receives a score for each Area of Expertise that is relevant to their work field. To reach a certain level of competence in an Area of Expertise, a professional has to be competent at all the necessary Learning Outcomes. For instance, if a professional wants to reach the competence level 4 in “ER1 Insulation”, he must acquire all the Learning Outcomes associated to level 4 and lower. The task-based qualification framework can be used to improve the quality and the applicability (in several contexts) of the Unit of Learning Outcomes.

The competence scores are reported in the Train4Sustain Skill Passport, which makes it possible to compare the level of competencies of building professionals through Europe, establishing a common reference methodology.

The CQS has been studied to support public authorities in the selection of competent professionals and craftsmen. Use of the CQS allows to integrate objective and measurable competence requirements in public tenders (GPP). Through the Skill Passport, professionals and craftsmen can easily demonstrate the fulfilment of requirements.

Any existing qualification scheme can be mapped using the CQS. The scoring system is useful to inform professionals of what level of competency is being provided by each qualification scheme and its relative level.

Train4Sustain CQS intends to be a tool to facilitate the request of qualified professionals and blue collar workers by public administrations and private clients. This will valorise, with a transparent common "reporting" system, the competences acquired through training courses and experience in the field. Train4Sustain CQS is an open and living system that will progress over time following the evolution of innovation, standards, and professional qualification schemes.

6. Conclusion and discussion

This paper demonstrated a structured approach for the cross-sectoral definition of skills registries applicable to the development of technical skills that could target specific key results areas and key performance indicators that allow for systematic definition of job objectives, target performances and appraisals.

Curricula resulting from the methodology mentioned in the current article are cross-sectoral, highlighting roles and responsibilities and the minimal set of knowledge and skills needed for assessing the applied value of a specific innovation or theme. The modularity of the methodology adds value. A lot of detail can be embedded, but the parts can also be isolated from the whole, and still be of practical value.

Furthermore, the method of task-based qualifications facilitates digital support for learning on the job and learning transaction-based recognition of successfully acquired knowledge and skills. It also enables sectoral and intersectoral skills registers or skills passports to take task-based knowledge and skill development into account.

Some limitations of this paper may be mentioned. The first is in terms of coverage of types of technical skills and applicability to particular job performance aspects. The depth of application of technical skills and behavioural competencies in the construction building projects, and in particular for the mechanical, electrical and plumbing systems, has several specifics that could not be covered holistically in the scope of the paper.

Second, the paper does not address the implementation of the presented approach in an organisational context in terms of jobs, their organisation, evaluation, importance for the specific market needs, key result areas, indicators and key performance indicators, nor does the paper address how specific skills collectively contribute to the overall target job objectives and specific job performance targets, achievements and appraisals.

Future developments should address the transorganisational implementation of the approach in the context of process performance standards and particular assessments. In addition, there is a potential to apply the approach to develop and advance transitional management of gaps in skills with evolving digital transition of the companies supporting next generation systems engineering AEC companies.

7. Acknowledgement

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