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INTRODUCTION TO A CERTIFICATION SYSTEM OF SKILLS OF WORKERS IN THE CONSTRUCTION SECTOR

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Author: Carlota Lloreda Aresti
Supervisor: Teresa Gallego Navarro

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Abstract

The construction sector is one of the most important sectors within the European Union as it provides building and infrastructure, which is the base of all the other sectors of the economy. Besides, it has been estimated that the construction sector influences, in one way or another, around 26 million workers in the European Union. At the same time, it is necessary to notice that the construction sector has always been characterized by a large share of Small and Medium enterprises. Even though most of these small companies related to the construction sector operate principally at a local or regional level, the markets' internationalisation is importantly influencing the industry.

In the recent years, the labour market has suffered significant alterations and factors such as the knowledge-based economy, the increasing speed of technological developments and the new technologies have influenced the need to improve people's working skills. As a result, certification systems of skills arise and become a necessary tool to suit the new trends of the labour market.

Furthermore, the construction sector influences considerably sustainability and climate change issues. So, as its environmental impact is quite important, sustainability can be seen as a long-term matter in terms of legislative and political demands in addition to the competitive factor for the companies. In this regard, sustainable related requirements will highly influence the skills demands of the sector.

Moreover, economic, social and environmental factors have to be considered when analysing the upcoming trends and needs of the construction industry as these problems are considerably affecting the construction industry. One of the consequences of the economic decline is a big impact on the supply of skills within the construction sector. The construction industry is facing a shortfall in terms of skills and labour so it is essential to address this issue if the industry wants to keep up with the current and future demand and trigger the desirable change towards sustainable development.

Therefore, there is a need of a qualified building workforce. It is essential to improve the skills of middle and senior level professionals and blue collar workers in the area of energy efficiency and sustainable construction. Workforces should be aware of new upcoming challenges related to nearly-zero energy buildings.

Consequently, this research seeks to come up with a solution to deal with the lack of knowledge of the labour force in relation to sustainability and energy efficient construction and, if possible, to create a connection with new methodologies as it is Building Information Modelling. It is

expected to create a EU-criteria for a certification scheme that can help workers to prove their competencies, no matter where they have been acquired, and improve their mobility within the European Union. Moreover, blue collar workers will be aware of the latest trends and technologies of the construction sector so it will improve their employability and productivity.

This research will be especially advantageous for the small and medium size enterprises as they need to improve their energy efficiency and BIM skills if they want to keep up with the digital and sustainable development of the construction industry.

To sum up and in order to clarify the outcomes obtained through the research, a list with the "10 golden rules for a Certifications System of skills" has been drafted.

Key words

Certification System of skills – Training programmes – Non-formal learning – Blue-collar workers – Sustainability – Energy efficiency – Small and Medium Enterprises – Building Information Modelling

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1. Introduction

1.1. Problem statement

The Architecture, Engineering and Construction (AEC) industry is nowadays moving towards sustainable development. It is becoming increasingly interested in environmentally friendly solutions that can contribute to achieving high performance and monetary savings so it is essential to develop mechanisms that will enable us to do it (Ilhan & Yaman, 2016).

When working in a construction project the main contractor usually selects a suitable number of subcontractors to carry out the project within time, cost and quality. Generally, the subcontractors are small and medium enterprises (SMEs) which frequently provide short-term workers and have to deal with the sustainable demands from the main contractors.

Economic, social and environmental factors have to be considered when analysing the global trend of sustainability in the construction industry. Several issues that affect this tendency, such as the ageing of workers, the skill mismatch or the lack of skilled labour and new operators have appeared in the last few years. As well as the unequal labour contract and the insufficiency of environmental and safety awareness. These problems are seriously affecting the AEC industry (BEC, 2013).

Consequently, there is a need of a qualified building workforce. It is essential to improve the skills of middle and senior level professionals and blue collar workers in the area of sustainable energy efficient construction. Workforces should be aware of new upcoming challenges related to nearly-zero energy buildings.

Moreover, there is no doubt that the uptake of Building Information Modelling (BIM) is now becoming more widespread (Trevelyan, 2016) so the use of BIM methodologies to improve the sustainability and energy saving knowledge of workers would be certainly beneficial for companies. Therefore, there is a need to work on improving BIM's capacity to integrate environmental analysis (Ilhan & Yaman, 2016) along with learning new sustainable technologies available in the sector.

The research is going to focus on the small and medium size enterprises as they need to improve their energy efficiency and BIM skills if they want to keep up with the digital and sustainable development of the construction industry.

1.2. Aim and objectives

This research is an introduction to the SusBimCo project, which works to answer a Construction Skills Call inside the Horizon 2020 programme. The Construction Skills Call states that it is necessary to improve the skills of blue collar workers in the area of sustainable energy efficient construction in order to reach the EU's energy and climate targets. SusBimCo's overall objective is to develop "A certification system of energy efficiency skills of workers in the construction sector using the BIM Methodologies".

Therefore, the main goal of this proposal is to create EU-criteria for a certification scheme that will enhance the learning and training competences within sustainable energy efficient buildings.

The research will be based on the new challenges related to nearly-zero energy buildings, such as new materials or renewable energies and the use of BIM tools to tackle them. Moreover, special importance will also be given to fact that the proposed system needs to be useful and recognised at a European level in order to facilitate labour mobility and ensure a public recognition of the workers' skills independently of the country where they were acquired.

The objective is to develop a guide to create a Certification System of skills of construction workers in energy efficient buildings using BIM methodology when possible. This "Smart-Sustainable Building Certificate" will fit in with the practices of the European construction industry and an audit procedure to evaluate the worker's skills based on it will be the ultimate target.

1.3. Research questions

It has already been stated that the aim of this research is to develop a criteria for a Certification System of skills of construction workers in energy efficient buildings using BIM methodology. In order to develop the appropriate certification scheme the investigation will try to give an answer to the following questions:

- How is it possible to keep up to date with the sustainable construction requirements and nearly zero energy buildings issues?
- Is it possible to tackle the skills mismatch of the sector through the implementation of BIM?
- Is it possible to certificate the competences through a single system when they have been acquired in a different way in each country?
- How is it possible to standardize a certification system if the training modules are not the same?
- How can a system be defined in such a flexible way that it can be adapted to the ongoing development of the construction industry?

1.4. Expected impact

Learning opportunities at the present are limitless. People learn new skills not only in through the traditional formal education way but also outside the classroom. Non-formal learning is becoming gradually more important nowadays. In the recent years, there has been a major change with regard to the required working skills due to the new social necessities. Empowering and involving workers with learning experiences is vital to deal with the current technological and economic changes. Supporting blue collar workers to improve their skills and learn new ones will help to increase productivity and economic growth. In this regard, the certification systems of skills arise and become a necessary tool to suit the new trends of the labour market.

It has been revealed that there is an important skills mismatch within the construction sector due to a lack of adequate investment in education-related activities such as training, innovation and research. Nevertheless, this kind of problems, as well as the lack of skilled workforce and the low level of awareness of the blue collar workers regarding the new upcoming challenges related to nearly-zero energy buildings can be tackled through the appropriate training systems.

This research seeks to come up with a solution to deal with the lack of knowledge of the labour force in relation to sustainable energy efficient construction and, if possible, to create a connection with new methodologies as it is Building Information Modelling. It is expected to

create a system that can help workers to prove their competencies, no matter where they have been acquired, and improve their mobility within the European Union. Moreover, blue collar workers will be aware of the latest trends and technologies of the construction sector so it will improve their employability and productivity.

To conclude, it seems necessary to clarify that this investigation is part of a wider proposal. This research just represents a first contact with the topic. There is still a wide gap with regard to the development and organisation of certification systems of skills. Besides, despite the numerous advantages derived from the use of Building Information Modelling it is not rooted in the regular processes of the construction sector. Therefore, it is necessary to carry out a deeper research in order to find out the appropriate system to introduce it into the routine work tasks of blue-collar workers in an effective and productive way, even more when working with energy efficiency and sustainable-related issues.

1.5. Methodology

It is essential to set the limits of the subject of the research. The definition of clear boundaries is especially important to mark out the area of the analysis, particularly because of the potential scope that the topic of this research may have. The process followed to carry out the research is described in *Figure 1.*

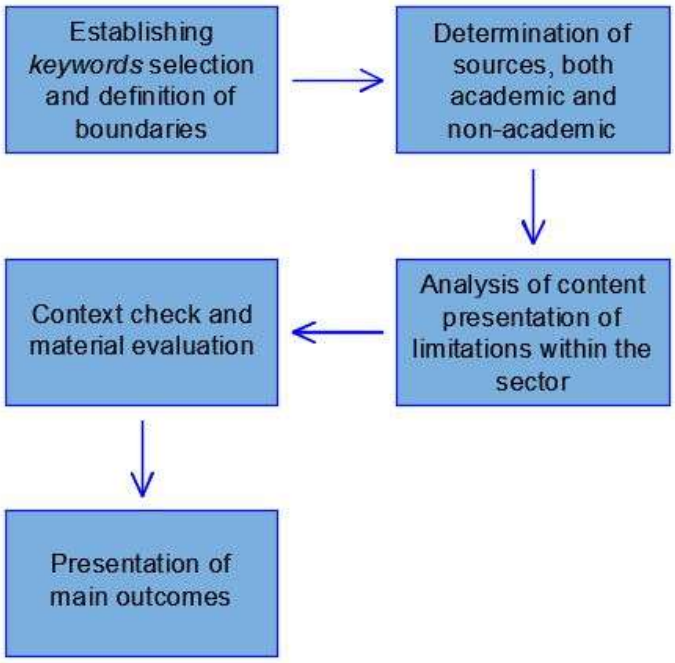

Figure 1.1. - Literature review workflow (adopted after Seuring & Muller, 2008).

Two type of materials have been used in order to ensure the reliability and validity of the data sources employed to gather the necessary information to carry out the research and compose the literature review. The first one consists of research papers published in recognised and high quality academic journals and the second one involves the compilation of government reports and publications developed by the construction industry. The search has been carried out using keywords in databases such as Google Scholar, Scopus and Science Direct. The keywords used to look for the required information were related to sustainability, BIM (Building Information Modelling), nearly zero energy buildings, sustainable materials and sustainable construction, SMEs (Small and Medium Enterprises), certification systems of skills,

construction skills, non-formal learning, training opportunities and training systems. Unfortunately, this search has made it clear that there is a poor variety of available articles that deal with the concerns previously exposed in the research questions. Several articles address issues related to sustainable construction and the importance and benefits derived from the use of BIM methodologies but not directly related to its implementation into the construction processes. The same thing happens with the Certification Systems of skills. There is a wide gap with regard to the development and organisation of these systems, the methodology that should be applied and the way to keep up to date to the latest construction trends and technologies.

The literature review of this research is focused on understanding the current situation of the construction sector with regard to sustainability and energy efficiency issues, the use and benefits of BIM and the role that the SMEs have nowadays in the construction industry.

2. Literature review

As it has been mentioned before, the AEC industry is currently moving towards sustainable development. The research will be focused on energy efficient buildings, the use of sustainable materials and renewable energies and the way they can be managed through BIM tools.

Small and medium enterprises, which are crucial to the strength of the economy, usually act as subcontractors in the construction industry. Generally, these companies have to deal with the sustainable requirements of the main contractors if they want to succeed in the sector.

In order to develop suitable criteria for a European certification scheme, the current situation related to sustainable construction and nearly-zero energy buildings, building information modelling and small and medium size enterprises has to be studied.

2.1. Sustainability in the construction industry – nearly-zero energy buildings

There is a strong link between cities, health and environment (Costello, et al., 2009). Cities are a key element in order to achieve a sustainable future and to develop a greener economy (Balaban & Puppim de Oliveira, 2016). A suitably built environment can yield significant benefits so working on developing green buildings is of the utmost importance.

Cities are account for around 70% of the global energy use and greenhouse gas emissions, which is reinforcing the two biggest issues nowadays in terms of sustainability: climate change and energy security, as more resources are needed to deal with the increasing demand due to the growth of the urban population (Puppim de Oliveira, et al., 2013). Therefore, it is of great relevance to study the mechanisms that can help to reduce this number in order to decrease in equal terms health and environmental problems.

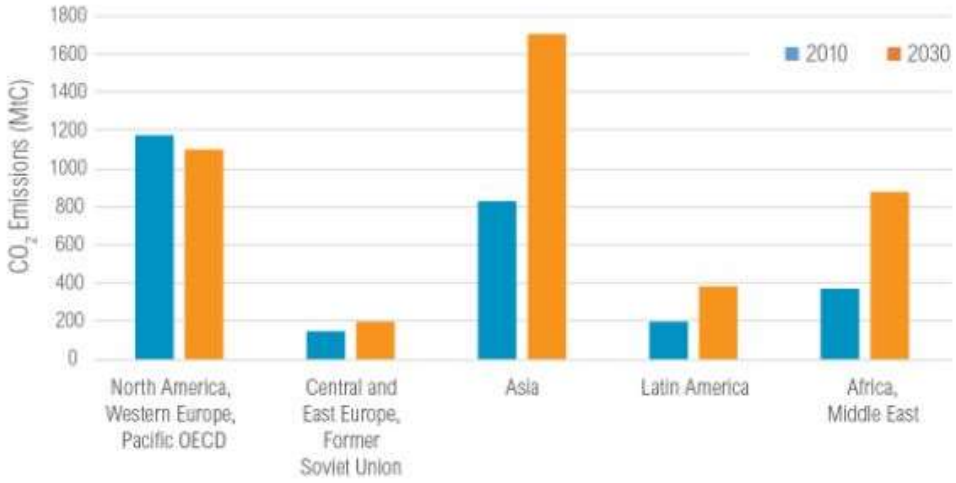

Figure 2.1. - Building sector emissions by world region, 2010 and 2030 projections (de la Rue & Price, 2011).

The research carried out by Balaban & Puppim de Oliveira (2016) points out that sustainable buildings can lead to substantial energy and CO2 reduction benefits, along with monetary

savings and health-related improvements, which is vital as CO2 emissions due to construction activities are forecast to increase in the near future *(Figure2.1.).*

Currently, the building sector is by far the biggest energy consumer, exceeding sectors such as industry and transport *(Figure 2.2.).* The global energy used by buildings is approximately 40% (Juan, et al., 2010) and a noteworthy part of it is wasted because of defects in the design or construction of the buildings and during the operation stages (Wang, et al., 2012). Moreover, analysis and projections shows that the energy use related to buildings will increase in the near future. By 2030, it will grow as much as 67% in the domestic sector and 34% in the non-domestic sector (Pérez-Lombard, et al., 2008).

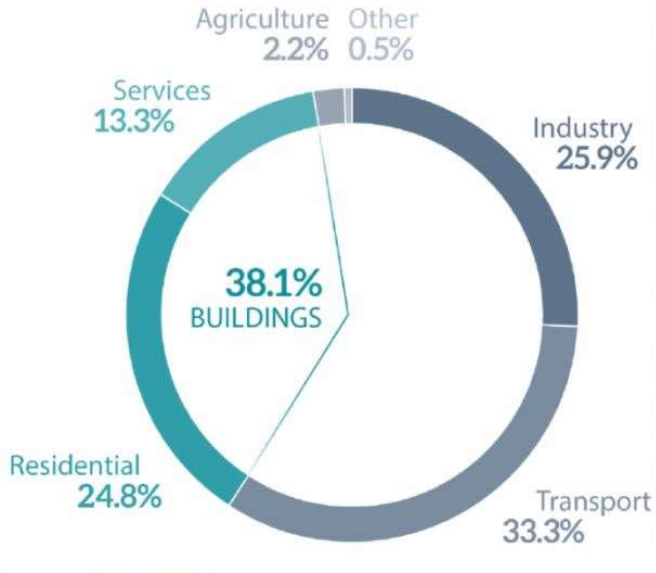

Figure 2.2. - Energy consumption by sector in the EU (Eurostat, 2014.)

In order to determine the energy use, the assessment of building energy performance is of vital importance. In addition, it is the basis on which to trigger any progress in energy efficiency (Wang, et al., 2012). Enhancing energy efficiency in buildings can lead to a better understanding of energy consumption by owners and users *(Figure 2.3.)*. Accordingly, this can motivate the owners to improve the energy performance of the buildings, as they will also recognise the possibility of having monetary savings due to the reduction of operations and maintenance costs derived from the drop of energy consumption (Ding, 2008).

Furthermore, the Energy Performance of Buildings Directive (EPBD) 2002/91/EC (and its recast 2010/31/EU) has established some requirements, related to the energy performance of buildings, which have to be met by all the countries of the European Union. This means that the construction industry has to be prepared to create energy efficient renovations and nearly zero energy buildings. The EPBD has offered a definition for nearly-zero energy buildings: "Nearly zero-energy building means a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby".

In order to achieve the European energy saving targets, energy efficiency in buildings is critical. Some studies (Labanca, et al., 2015) bear out the need of energy efficiency policies supporting energy efficient service (EES) markets in the residential sector and a robust collaboration at a national level between governments and banks to finance them. Moreover, the Energy

Efficiency (EE) 2012/27/EU Directives along with the Renewable Energy Sources (RES) 2009/28/EC establish goals to enhance the use of renewables and point out the value of training, and certifications.

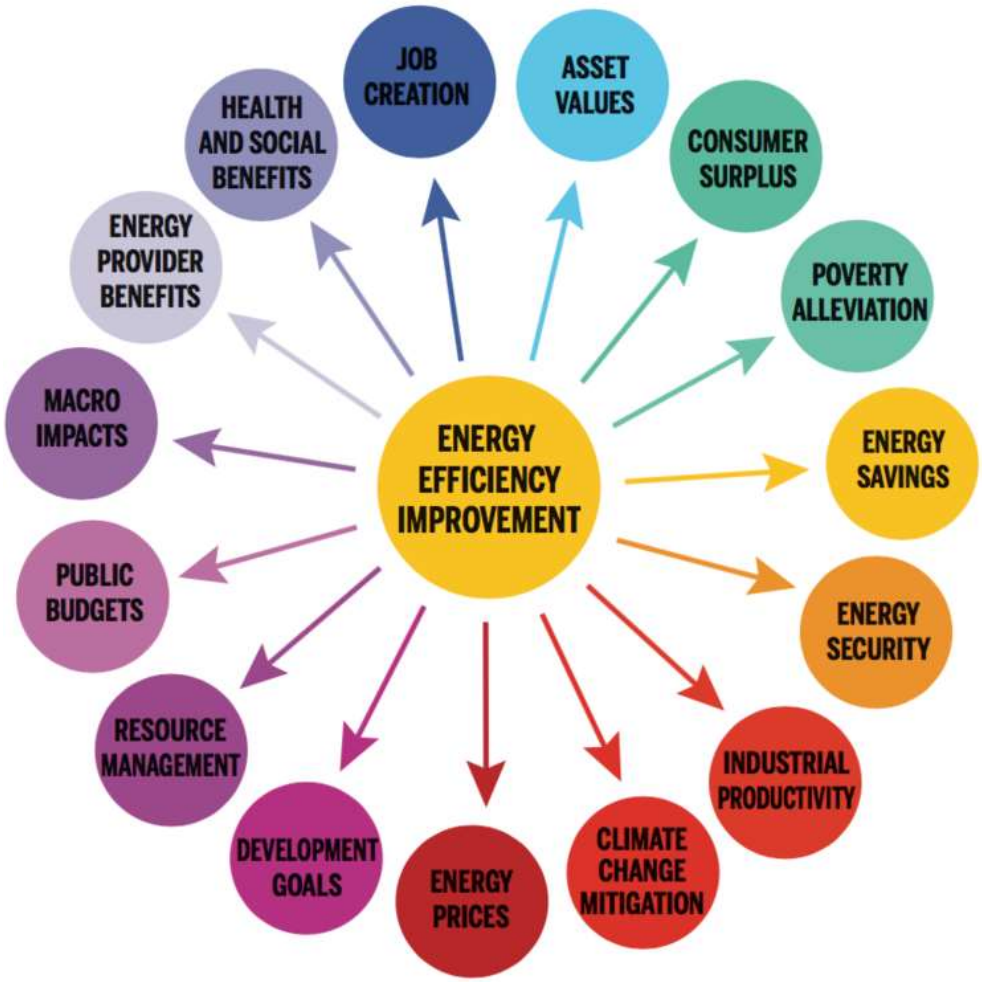

Figure 2.3. - The multiple benefits of energy efficiency (IEA, 2015).

Additionally, a suitably qualified labour force is recognized as a basic factor so as to achieve the goals previously mentioned so it is vital to enhance the qualifications of the blue-collar workers (Doukas, et al., 2016). Nevertheless, there is evidence that one of the main factors hindering the development of building renovations with high-energy performance is the under-qualification of the labour force in the construction sector regarding energy efficiency and systems of renewable energy. So, as it is highlighted in the research carried out by Doukas, et al. (2016), there is an imperative need to develop appropriate training methodologies and qualification frameworks so as to enhance the competitiveness of the building labour force.

At the present time, the idea of green buildings is getting stronger as there is a need to tackle health and environmental problems derived from buildings and diminish impact on the environment (Balaban & Puppim de Oliveira, 2016). Sustainable construction makes reference to the incorporation of environmental, economic and social considerations into construction practices. Sustainable building concerns the implementation of sustainable principles to the construction cycle, from the extraction of raw materials, through the design, construction and management, to the deconstruction and control of the waste of buildings to alleviate the

environmental footprints of the building sector and its surroundings (Tan, et al., 2011; Balaban, 2012).

Consequently, the use of green technologies in buildings has grown significantly in the past years. The main results of this tendency are the appearance of certification systems to assess environmental performance and the creation of green building councils (Balaban & Puppim de Oliveira, 2016). As it has been mentioned before, assessment of a building energy performance can be helpful to determine efficiency of energy use in buildings in addition to encouraging owners and occupants to improve the energy performance of their buildings.

To reduce the energy consumption, in addition to improving living conditions, green buildings are equipped with advanced integrated technologies and designed with specific strategies. When the measures taken are those of implementing new technology so as to improve energy efficiency and reduce the demand, the strategy adopted is called 'active design' (Burdett, et al., 2011). On the other hand, the 'passive design' approach is based on carrying out modifications on the site planning, the orientation of the building and the building envelope and aims at making the most of factors such as daylight and the natural ventilation (Chen, et al., 2017). In both cases, the objective of these strategies is to achieve a good thermal control, a good air quality or enough daylight, as these parameters influence in a positive way the wellbeing of the occupants of the building.

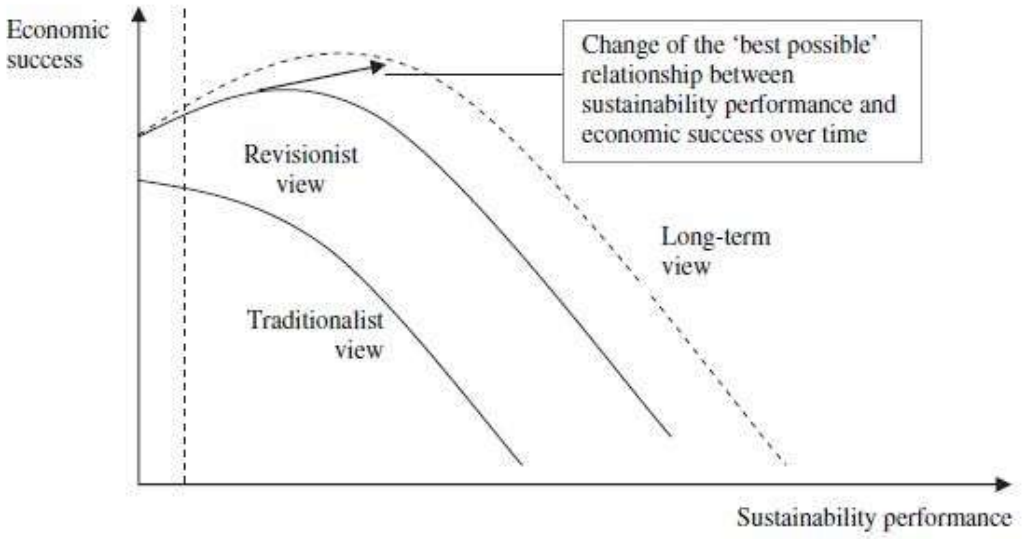

Figure 2.4. - Relationship between sustainability performance and economic success (Wagner & Schaltegger, 2003).

As it has been stated in different studies (Akter, et al., 2017; Gaterell & McEvoy, 2005), together with these health benefits, higher returns on investment in sustainable buildings are also very likely to happen *(Figure2.4.)*. In fact, several researchers state that sustainability in building construction and operation seeks the growth of utility and investment returns rather than the reduction of resources used and environmental impact (Ding, 2008). Even so, at the same time, the high initial investment needed for this type of building seems to be one of the main stoppers for its development (Darkoa, et al., 2017).

Different support mechanisms have to be developed to enhance companies with limited resources to progress in the construction of green buildings. Certification systems are a good starting point but they are not enough to trigger a widespread development of sustainable buildings (Balaban & Puppim de Oliveira, 2016).

2.2. Building Information Modelling (BIM)

Building Information Modelling (BIM) was introduced in the Architecture, Engineering & Construction (AEC) industry in the early 2000s as a means to increase efficiency and reduce costs, as well as an instrument to manage a project during the different stages of construction (Succar, 2009). BIM is not a tool but a collaborative work methodology created to manage a construction project through a digital model (esbim, 2017). This digital model is a 3D model, which includes a big database that allows supervising the project during its whole life cycle.

The use of BIM currently has a wide range of advantages such as the reduction of conflicts and project team benefits, the access to an easy way of obtaining and managing the building's information, the possibility of using a model during the whole life cycle of a project, the interoperability capabilities and the availability of a better cost control mechanism (Ghaffarianhoseini, et al., 2017). Due to BIM's implementation, designers, contractors, construction managers and owners can be easily involved in all the stages of the construction project (Ganah & John, 2015).

Currently, BIM is being used to tackle safety-related issues such as the prevention and identification of hazards (Zhang, et al., 2015) and the improvement of the behaviour-based safety approach for construction safety (Li, et al., 2015). Moreover, it is also being used for management purposes such as the improvement of productivity (Poirier, et al., 2015) and construction risk management (Tomek & Matějka, 2014).

Moreover, BIM can be useful to support safe facility management processes (Wetzel & Thabet, 2015), as it can easily provide broad information about the building's structure, electrical and mechanical systems or any kind of equipment. It can also be beneficial to reduce costs due to facility management (Zou, et al., 2016), ameliorate the maintenance processes and provide accurate cost estimations (Cheng & Ma, 2013).

In addition to the design, construction and management goals, BIM can be used with sustainable purposes, in order to create environmentally friendly constructions. Thanks to BIM tools' capability to develop complex models, architects can design with endless creativity and use real-time visualizations as a means of sharing ideas and information among the stakeholders involved in the project (Johansson, et al., 2015) . Nowadays, BIM is considered to be a strategic solution concerning the future development of intelligent buildings (Ghaffarianhoseini, et al., 2015).

Even so, at the present time, the use of BIM is not as widespread as desired. Even though there are several advantages in the use of BIM, its adoption is still limited. However, the implementation of BIM has experienced an impressive growth in recent years, being the architects the primary adopters of BIM, followed by engineers and contractors (SmartMarket Report, 2014; SmartMarket Report, 2011). However, there is a common tendency in almost all the countries, for a high concentration of low-level BIM capability, which is the use of BIM to produce models, as opposed to a low use in terms of collaboration and integration capabilities (Kassem & Succar, 2017). The different maturity levels of BIM methodology are exposed in *Figure 2.5.* 90% of BIM users are employing it to produce 3D visualizations of projects; clash detection is used for around 75% and only about a 50% use it to carry out structural, acoustic or energy consumption analysis on the model (NBS, 2016). In addition, the way the industry used to develop a project has been transformed owing to the new requirements in terms of

sustainability and the use of energy (Motawa & Carter, 2013). Around 40% of global carbon dioxide emissions and energy use are due to a building's operation (Schlueter & Thessling, 2009). Consequently, the highest importance has to be attached to this issue. Energy efficiency has become a main subject on building performance.

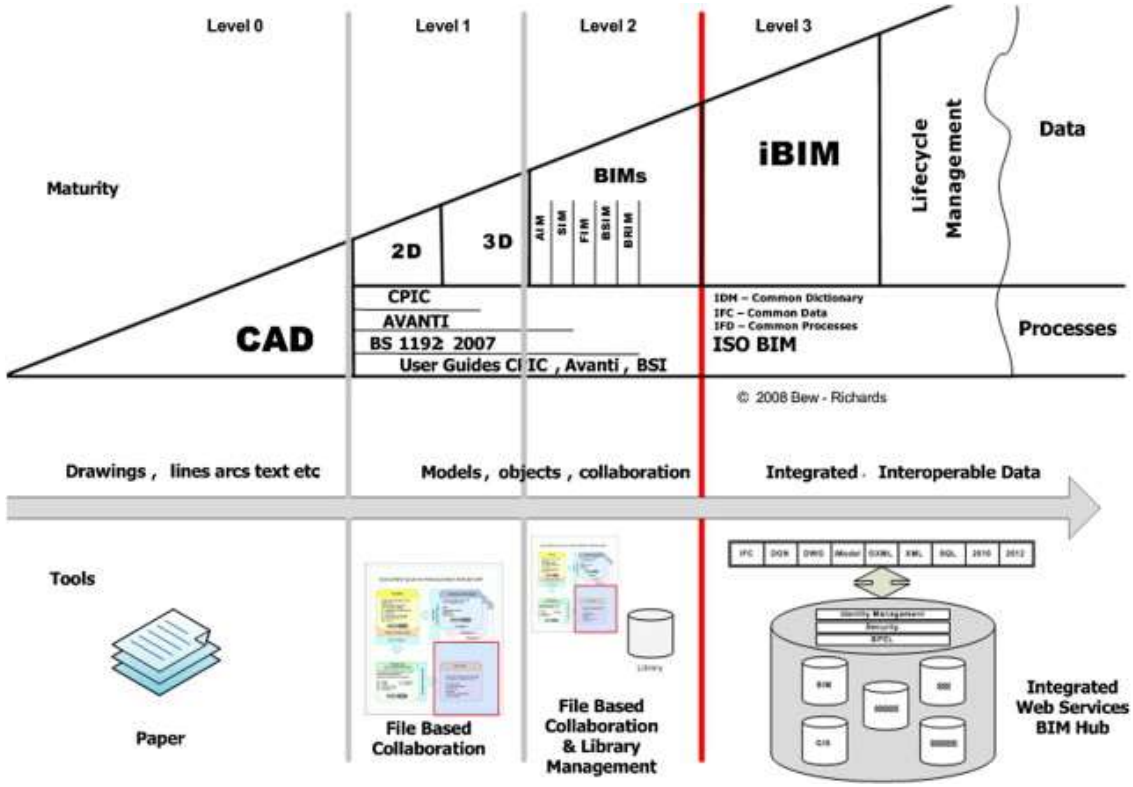

Figure 2.5. - BIM maturity map (Barlish & Sullivan, 2012).

Nowadays, there are a number of methods and technologies that can be used to meet the objectives for energy savings or CO2 emissions. BIM can be helpful to model the use of energy or lighting patterns, among other sustainability issues (Motawa & Carter, 2013). Most of the available technologies are developed in order to be implemented during the design stage of a construction project. In this phase of the project, the designers generally receive the information about the amount of energy that will be needed and the CO2 emissions. Moreover, buildings usually have to pass a certification in terms of sustainability and this has to be considered when starting the project (Schwartz & Raslan, 2013; Azhar, et al., 2011). Leadership in Energy and Environmental Design (LEED) and Building Research Establishment Environmental Assessment Method (BREEAM), are some examples of these performance criteria. However, even though the design phase is of the utmost importance when talking about sustainable-related concerns, the monitoring of the building performance after its completion also has to be taken into account as most of the energy consumption of a building is produced during the use phase. This energy use is aimed at maintaining the usability of the building, to keep a comfort level through heating or cooling and to operate building service systems, appliances and lighting (Schlueter & Thessling, 2009).

Thanks to BIM tools, it is possible to generate much more useful information, which can be used for simulations and visualizations, than with the traditional 2D software. Specifically, Green BIM tools allow the integration of all the available data in order to perform energy analysis of a whole building and simulate its performance, which provides designers with the

appropriate information to modify the building's design if needed so as to improve its performance during its lifecycle (SmartMarket Report, 2010). Energy simulation packages *(Figure 2.6.)* take into account both, local weather data and the design features of the building such as natural and mechanical ventilation, thermal insulation or shading (Motawa & Carter, 2013).

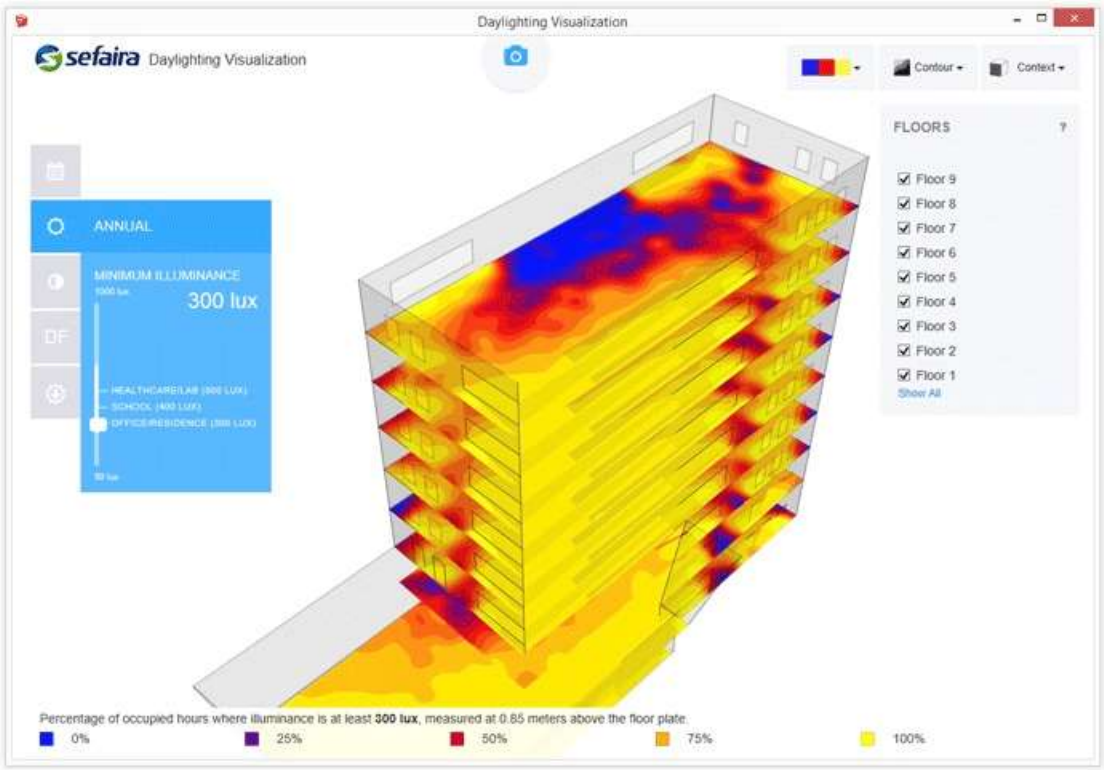

Figure 2.6. - Tool to develop an energy analysis to optimise a building's lighting design (Anon, 201?).

Therefore, it seems to be quite clear that BIM has a great potential to highly impact in a positive way the productivity of all the workers involved in the construction industry. BIM allows to develop a more efficient design and facilitates documentation processes, it provides managers with an easiest access to important information and helps to simplify inaccuracies and thus, avoid possible conflicts (Poirier, et al., 2015). In this regard, it would be necessary to offer further paid training to construction workers as well as education on multi-skills development (BEC, 2013).

2.3. Small and Medium enterprises (SME)

Small and medium enterprises are vital to the strength of the economy of cites and countries because of their amount and the high number of employees they have (Kirchhoff, 1994). Nonetheless, they usually demonstrate weaknesses tackling economic issues, which in turn leads to business failure. Their capability to change and improve their companies is limited owing to the lack of financial resources (BERR, 2008).

There are more than 23 million small and medium-sized enterprises in the European Union. These enterprises generate the 60% of the European gross domestic product (GPD) and they are employing more than 100 million employees (EC, 2012). Regarding the construction industry, there are more than 3 million small and medium-sized companies and more than 8 million workers. These SMEs construction companies represent the 80% of the industry's output *(Figure 2.7.).*

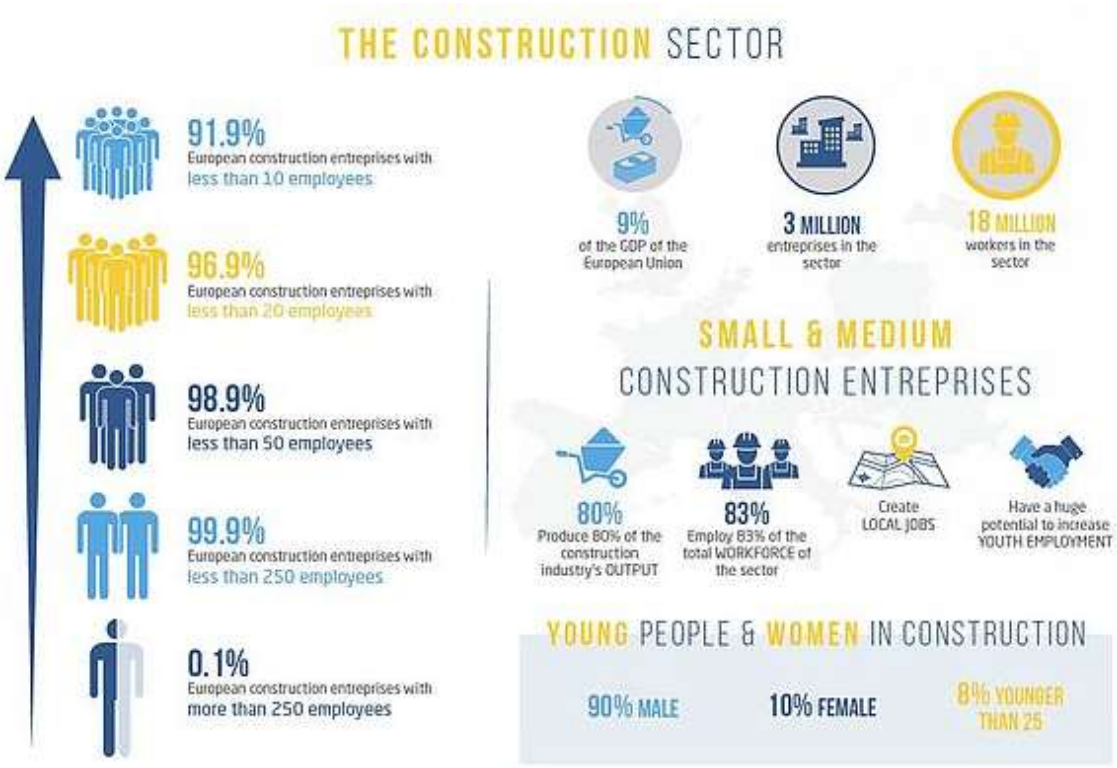

Figure 2.7. - Performance and trends of the construction sector (EBC, 2016).

Construction companies are being pushed to being different if they want to survive in the current industry. Sustainability has become the key point in this topic (Weng Lou, et al., 2012).

If a company wants to be competitive it has to be aware of the conditions needed to generate value and understand the way to create sustainable value by means of a strategy that meets its objectives (*Figure 2.8.)*. As sustainable practices are crucial for construction companies if they want to succeed in the sector, having sustainable goals in their strategies would become a source of competitive advantage (Lloret, 2016; Martinez-Conesa, et al., 2017).

The performance of a company in social responsibility can affect its competitiveness. Some of the factors related to this issue are, for example, the capability of the organisation to attract and keep workers, clients and users, the conservation of employees' optimism and the connection with other companies, suppliers, governments or the community in which the company is working (Lou, et al., 2011).

Corporate social responsibility (CSR) can be seen as the attempts of a company to influence social expectations for its behaviour, which is generally related to stakeholder management. It needs a responsible performance from the company towards the government, investors and consumers and a responsible management of the internal issues encouraging employees to create value (Easly & Lenox, 2006; Henriques & Sadorsky, 2008).

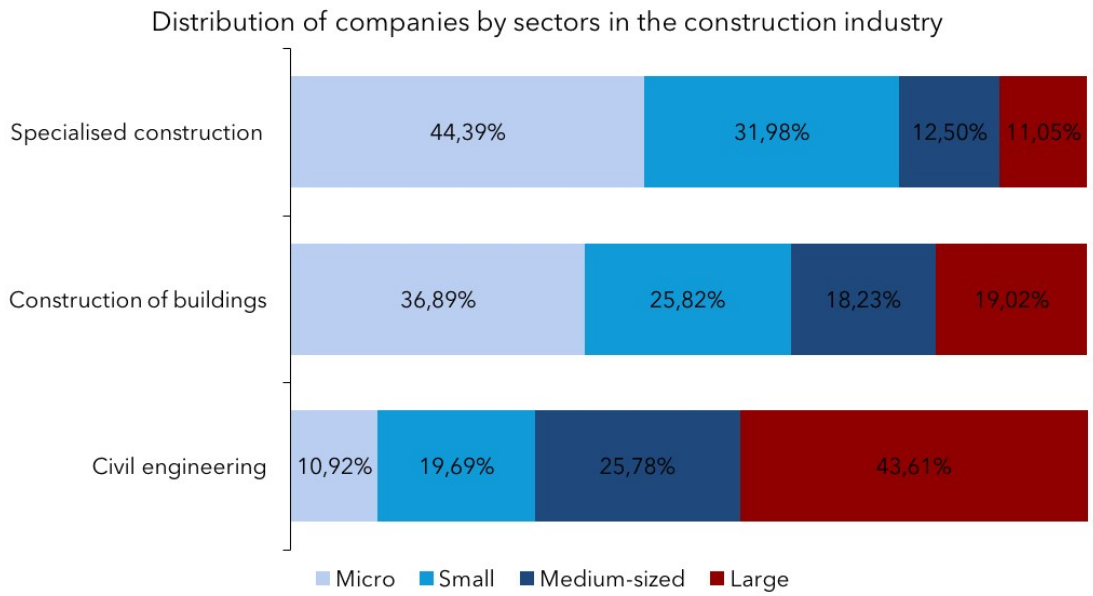

Figure 2.8. - Distribution of companies by sectors in the construction industry in Europe (Anon, 2016).

Corporate social responsibility involves society, the economy and the environment. The ISO standard (2010) states that: "the essential characteristic of social responsibility is the willingness of an organisation to incorporate social and environmental considerations in its decision making and to be accountable for the impact of its decisions and activities in society and the environment. This implies both transparent and ethical behaviour that contributes to sustainable development which should be in compliance with applicable law and be consistent with international norms of behaviour."

Construction SMEs increasingly have to deal with corporate sustainability (CS) requirements from the main contractors. In order to achieve it the proper balance among social responsibility, economic development and environmental protection has to be found (Bansal, 2005). Therefore, the management of corporate sustainability is the profit-driven way to address environmental and social issues derived from the company's activities (Salzmann, et al., 2005). Economic sustainability involves aspects that a company has to respect if it wants to remain active in the industry, including technology and innovation (Baumgartner & Ebner, 2010). The main construction actors such as the government, private developers, public organizations and main contractors are vital in stimulating the adoption of corporate sustainability with enough financial and human resources in order to enhance a sustainable future of the construction industry, as well as guiding the construction SMEs towards a sustainable construction (BEC, 2013).

In addition, energy efficiency in one of the main targets in the European strategy in order to achieve a smart and sustainable growth (EC, 2006). However, there exist some barriers that hinder this progress. There are financial barriers such as high investments cost and low profitability and capital availability (Fresner, et al., 2017) and non-financial barriers such as incomplete in-house skills, lack of knowledge in identifying and implementing energy saving projects (Tianni, et al., 2013a; Trianni, et al., 2013b; Fleiter & Eichhammer, 2011), and a non-appropriate way to manage external resources and time (Cagno, et al., 2013). As well as information issues such as unclear or insufficient information and unreliable information sources (Rohdin & Thollander, 2006; Trianni & Cagno, 2012).

SMEs play a passive role regarding sustainable construction and depend heavily on knowledge and guidance of corporate sustainability from supply chain partners such as the main contractors. Moreover, SMEs usually have several hurdles such as insufficient economic resources dedicated to CS practice, inadequate technological support and poor trainings (BEC, 2013). Even so, the majority of construction works are carried out by SMEs acting as subcontractors to the main contractors.

Subcontracting is a widespread practice in the construction industry because it allows a flexible use of the available resources and a wise use of skilled workers. The different activities that have to be carried out during construction work usually call for specialised workers. In this context, subcontracting is seen as an advantageous practice as is has economic benefits (Dainty, et al., 2001) and it allows, for example, indirect engagement to deal with fluctuations of demand for employment. Nevertheless, at the same time it is believed to being responsible for poor level of safety, health and work quality in the construction industry (Manu, et al., 2013).

Currently, there are grave concerns due to the lack of construction consultants such as engineers but also general and skilled workers. The number of new participants, especially among general workers, is not enough to meet the demand. The negative image of the industry is affecting the incorporation of new entrants. Transitory workplace, unsatisfactory working conditions (Abrey & Smallwood, 2014), short-term or uncertain workloads, the lack of formal contracts or the health and safety risks on the construction site (Danso, 2012) are some of the factors, which are holding back the attraction of workers.

The skill mismatch of workers in the construction sector is a problem that needs to be tackled as most of the activities require specialized labour. However, construction SMEs have to deal with their limited economic resources and providing the workforce with the appropriate training to enhance their capabilities is not an easy task (BEC, 2013).

3. Skills mismatch and future needs of the construction industry in Europe

The construction sector is one of the most important sectors within the European Union as it provides building and infrastructure, which is the base of all the other sectors of the economy. Its consumption and production are remarkable. More than 12 million people work in this sector and it has been estimated that around 26 million workers in the European Union are influenced by the construction sector in one way or another. In the same way, the use of resources of the sector is quite significant with regard to the environmental impact. 40% of the energy consumption in the EU is on account of buildings' construction, as well as the 25% of the material moved by the European economy (DTI, 2008). So, it can be concluded that the construction sector influences considerably sustainability and climate change issues. However, if the European Union wants to achieve a high standard of living and generate an economic growth the construction sector has to overcome some technological and economic threats.

Even though the level of employment within the construction sector has been seriously hurt by the recession, it is expected to grow a 3.9% during the period from 2013 to 2025 *(Figure 3.1.)*. The sector's profile is continuously evolving and new jobs are appearing, mostly related to technical occupations (ICF-GHK & Cedefop, 2014). The type of jobs carried out in the construction industry vary from routine duties, which require a significant physical effort to further skilled activities, which usually need considerable experience and training. With regard to this fact, the most common skills required to work within the construction industry nowadays are:

- Specific skills directly related to a job position such as knowing how to operate and understand the tools and equipment with accuracy, manual agility and physical strength.
- Personal qualities such as the capability to work easily as a team, versatility, problem-solving skills and honesty.

There is a forecast of more than 6 million job offers during this period, mainly to address the need for replacing workers that leaves the sector. However, this is mainly attributed to employees that stop working in the construction industry because of retirement or other type of reasons instead of the creation of new jobs. It is important to highlight that more than half of these replacements are going to be for craftsmen and related trades professions.

	Employment levels		% change	2013-2025		
	2013	2025	2013-2025	Change in total employment (jobs created/lost)	Replacement needs	Total number of job openings
Construction	14,986,000	15,573,000	3.9	586,000	5,512,000	6,097,000
All sectors	223,763,000	231,241,000	3.3	7,598,000	96,623,000	104,221,000

Figure 3.1. - EU-28 medium-term employment forecast 2013 to 2025 (Cedefop, 2014).

When looking closely at the national predictions, it can be seen that the results vary from one country to another. Several countries look forward to a noteworthy expansion even if they have suffered an enormous decline in the construction sector during the past few years, as is the case of Ireland and Greece. Some other countries, such as Denmark, Croatia and the United Kingdom have also forecasted an important growth in the sector for the following years. In Spain, yet, the growth will not be that significant. The employment in the

construction sector will start to rise by the end of the decade even though the magnitude of the sector by 2025 will be less than the half it was back in 2008. On the contrary, countries such as Romania, Italy and Austria will experience a decrease in employment rates by 2025 (ICF-GHK & Cedefop, 2014).

At the same time, it is necessary to notice that the construction sector has always been characterized by a large share of SMEs. Even though most of these small companies related to the construction sector operate principally at a local or regional level, the markets' internationalisation is importantly influencing the industry. The construction sector is more and more experiencing migration of companies and workers among the Member States, as well as an internationalisation of the labour market. In most cases, training within these SMEs usually does not go far enough because of the lack of time and a proper strategic direction. Besides, subcontracting is becoming an upward trend in the construction industry and especially in this kind of companies as it allows them to work with a higher flexibility, even if it may affect the creation of a long-term work team (DTI, 2008). As a consequence, incentives to support training should be provided to the SMEs in order to help construction firms to enlarge and strengthen its human capital.

Figure 3.2. - The collaborative planning for talent supply chain management (Makarius & Srinivasan, 2017).

Furthermore, as the environmental impact of the construction sector is quite important, sustainability can be seen as a long-term matter in terms of legislative and political demands in addition to the competitive factor for the companies. As a result, sustainable related requirements will highly influence the skills demands of the sector (DTI, 2008).

Otherwise, there exists the Energy Performance of Buildings Directive (EPBD), which has the clear objective of driving the transformation of the present market towards the development of more energy efficient buildings *(Figure 3.3.).* Energy efficiency is a factor that depends highly on the quality of the design and the construction of the building as well as on the use of the building. That is the reason why it is directly related to the skills and qualifications of the professionals involved in the process. Consequently, the European Commission wants the

national authorities to work together with the BUILD UP Skills Consortia in order to improve the skills and qualifications of the people working in the construction industry (Antinucci, et al., 2014). Due to this, a special body within the Concerted Action of the Energy Performance of Buildings Directive has been created and it is focus on:

- Promoting the dialogue about any possible discrepancy in legislative implementation and the development of skills.
- Bringing together stimulating examples among the measures of the BUILD UP Skills roadmap in order to make it easier EPBD implementation.
- Handing out motivating examples of the implementation of the EPBD recast connected to qualification actions for the on-site labour force.

To sum up, the main objective of this special Task Force is to create a connection between BUILD UP Skills and the Concerted Action on the Energy Performance of Buildings Directive so as to study how the market for construction works is being influenced by the existing regulations related to energy efficiency in buildings. Moreover, it works to smooth the way towards a collaboration through dialogue that would be beneficial to all parties concerned, the authorities applying the necessary regulations and the people that works on upskilling the construction workforce.

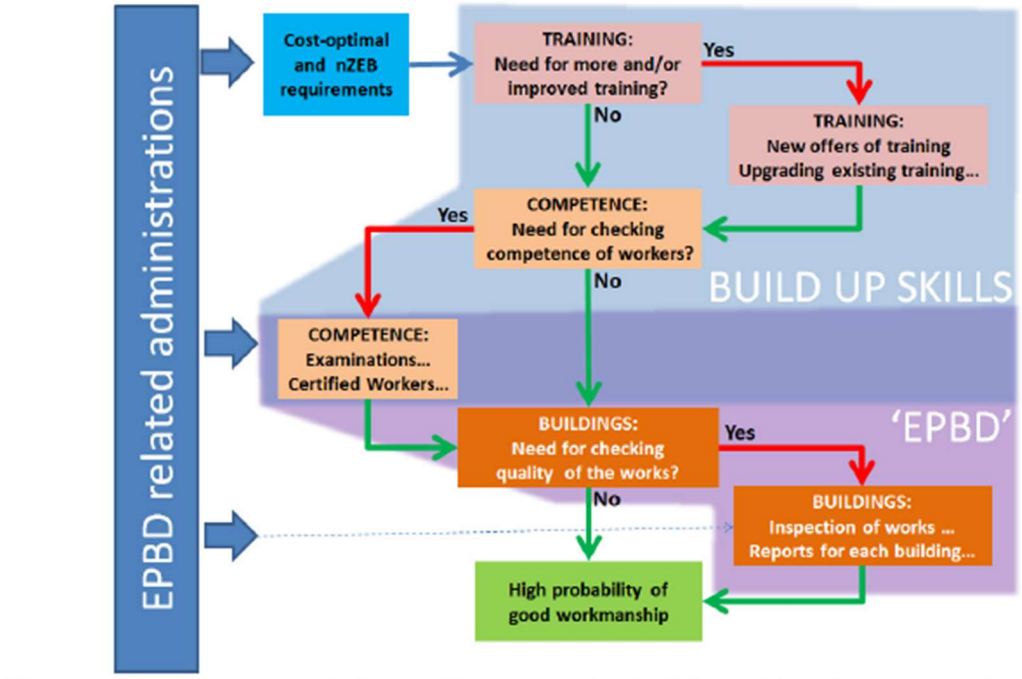

Figure 3.3. - Approach to ensure that capacity building produces an energy efficient building on site (Anon, 2014).

Besides, the European Commission officially launched the EU Skills Panorama in December 2012 to tackle skills mismatches. It is a website that shows quantitative and qualitative information related to short and medium-term skills needs, skills supply and skills mismatches. Based on information and predictions collected at EU and Member State level, the Panorama points out the fastest rising professions and the occupations that have the biggest number of vacancies unfilled. Even if there is a high level of unemployment in Europe, there are approximately 2 million job offers, so this website will help to deal with it providing specific and up to date information by countries, sectors and professions (Anon., 2017). When focusing

on construction, The Skills Panorama presents the challenges of ensuring enough provision of new entrants to the industry and improving the skills of the existing labour force (ICF-GHK & Cedefop, 2014).

3.1. Future skills needed in the construction sector

One of the consequences of the economic decline is a big impact on the supply of skills within the construction sector. Due to the significant fall in the construction of large- scale projects since 2008, a great number of workers have leave the industry. Nevertheless, the number of blue collar workers *(Figure 3.4.)* in the industry is forecast to increase in the next years *(Figure 3.5.).* Because of this, two important challenges arise:

- Ensure that there is an enough number of new entrants to the sector and, at the same time, learn to keep the existing employees. For instance, in Ireland the apprentice to employment ratio at the present is the lowest one since equivalent statistics appeared (McGrath & Shally, 2011).
- Improve the skills of the current workforce in the sector in order to meet the future needs of the industry. This includes management and planning skills and the capability to work with new technologies and understand sustainable construction processes (DTI, 2008).

	Low	Medium	High
Building trades workers	35.5%	59.7%	4.7%
All occupations	21.2%	48.1%	30.7%

Figure 3.4. - Share of building trades workers by qualification level compared to all occupations, EU-28, 2013 (Cedefop, 2014).

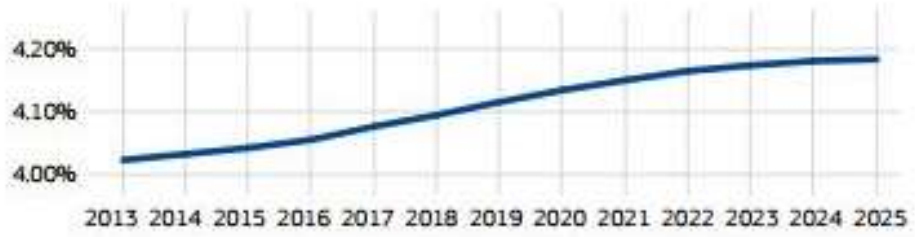

Figure 3.5. - Future share of building trades workers, EU-28 (Cedefop, 2014).

As an example, in countries like Austria there exists a need for technical skills such as construction planning and the use of CAD tools (Humpl & Kargl, 2013). On the other hand, in Denmark the demands are focused on innovation and increasing management skills. This has been led because of the increasing requests of energy-efficient construction (DTI, 2008). The global emphasis on energy efficiency and environmental consciousness competences is obvious in many European countries. Interdisciplinary skills are becoming increasingly important together with the focus on new materials and building physics so as to create an appropriate basis for energy-efficient construction.

In addition, the influence that the EPBD legislation has on skills development is studied by exploring the potential mismatches between both of them. This is prepared on the basis of an analysis that shows which of the requirements of the EPBD most influence building quality and

the development of skills. Some of these requirements are related to energy performance in general, certifications of energy performance and nearly zero energy buildings. It has been stated in several national reports that, in some countries, there is a need for a greater coordination between the legislation related to energy efficiency and the improvement of skills, even when both subjects are crossed in the same legislative acts. Numerous aspects seem to present a challenge for the current labour force skills, principally regarding the use of new technologies and renewable energy (Antinucci, et al., 2014).

After analysing different qualification schemes for blue collar workers, the EPBD has identify some overall tendencies:

- Due to the continuous changes in the offer of vocational courses for construction workers, it is difficult to determine its assortment.
- The shortage of resources because of the high pressure with regard to time and costs within the construction sector turns out to be an obstacle towards the development of vocational training for skilled workers.
- Traditionally, the construction sector has employed unskilled workers but the current economic difficulties in several European countries have worsened the job situation for these unskilled employees.
- Advertising campaigns and product related training usually contain information concerning energy performance issues even though these activities do not belong to the workers qualification. In fact, this kind of specific training usually offered by companies is focused on particular technologies, so there is not a guarantee that the new skills obtained can be used in a broader context.
- Even if there exists a wide range of programmes that guarantee training at university and post-graduate level for architects, designers and engineers, there is a lack of qualification systems related to energy efficiency for blue collar workers.

Thus, it can be stated that it is not easy to achieve the short-term modifications in the formal education system that are necessaries to meet the needs derived from the EPBD. The time schedule with this regard is quite challenging. On the one side, informal education might respond fast to the new market demands by means of courses promoted by private training organisations or suppliers, and sometimes with supplementary activities such as visits to conferences or exhibitions. Hence, capacity building seem to ask for a combination of informal and formal education systems. In this way, it would be necessary to evaluate and monitor the informal training and, at the same time, introduce some flexible component in the formal education (Antinucci, et al., 2014). Therefore, it is vital to understand buildings as integrated concepts where a cross-trade knowledge is essential. That is to say, blue collar workers should have the capability to expand their view and look beyond the limits of their own area of expertise. This results to be in accordance with the conclusion obtained from the BUILD UP Skills meetings.

On the other hand, the adoption of new technologies and the knowledge of sustainable construction processes seem to be key skills that are becoming increasingly important to face the present trends of the construction sector. The increasing tendency towards developing green buildings is forcing construction workers to better understand new technologies that allow to create sustainable constructions as well as energy efficiency and environmentally-friendly materials. Besides, an improved awareness is needed in order to reduce the negative effects that the construction activities produce on the environment. The construction of zero

carbon houses for example, involves technical skills that the current labour force might be lacking (ICF-GHK & Cedefop, 2014).

In addition buildings' refurbishments should also be taken into account as the environmental impact is not restricted just to new constructions. The rehabilitation of existing buildings is expected to create new jobs for renewable energy installers, inspectors of heating systems, auditors and certifiers, especially in Eastern and Central Europe, where the number of energy efficient buildings at the present is quite low (EuropeanCommission, 2008). In this respect, the BUILD UP Skills European initiative has carried out an analysis with regard to on-site workers and the conclusions predict that, in Europe, more than 3 million workers will need training on sources of renewable energy and energy efficiency before 2020 (EuropeanCommission, 2014). Hence, new training approaches have been found to fulfil this demand. Some examples of these methods are the adaptation of the training content for blue collar workers, which includes short durations, evening courses, practical activities and e-learning, or the training for the new roles that have arisen in the construction sector such as mentors and quality coaches, as well as training for the trainers.

On top of that, there is another essential challenge for the construction sector in the future related to the growing application of ICT (Information and communication technology) in construction processes. The development of this kind of technology for smart buildings and its application to reduce the energy consumption is strengthening the need for ICT skills (ConstructionSkills, 2013). The adoption of these new technologies and new practices is vital for the development of the competitiveness and productivity of the construction sector. Idyllically, technological development pushes forward the changes in the construction sector in the same way that research and development points the way to innovation and new technologies. Nevertheless, the speed at which these developments are being integrated in the construction industry is quite low, especially in the SMEs. Even if it has been proved that construction workers are reacting favourably to the new requirements some skills gaps are inevitably appearing due to this rapid change.

4. Certification Systems of skills

In the recent years, the labour market has suffered considerable alterations. There has been a major change with regard to the required working skills due to the new social necessities. Several factors, such as the knowledge-based economy, the increasing speed of technological developments and the new technologies, along with globalisation have influenced the need to improve people's working skills and competencies (Colardyn & Bjornavold, 2004). In this regard, the certification systems of skills arise and become a necessary tool to suit the new trends of the labour market (*Figure 4.1.).*

The skills' certification is the public, formal and temporary acknowledgement of the working capabilities demonstrated by a worker (Agudelo, 1993). It is carried out by means of the evaluation of the skills with regard to a standard and it does not need to be necessarily linked to the end of an educational process. Nowadays, certification systems of skills have gained importance due to a concern about improving the quality and productivity of the companies, the continuous evolution of construction techniques and technologies, the use of new materials and the commitment to ensure a sustainable development.

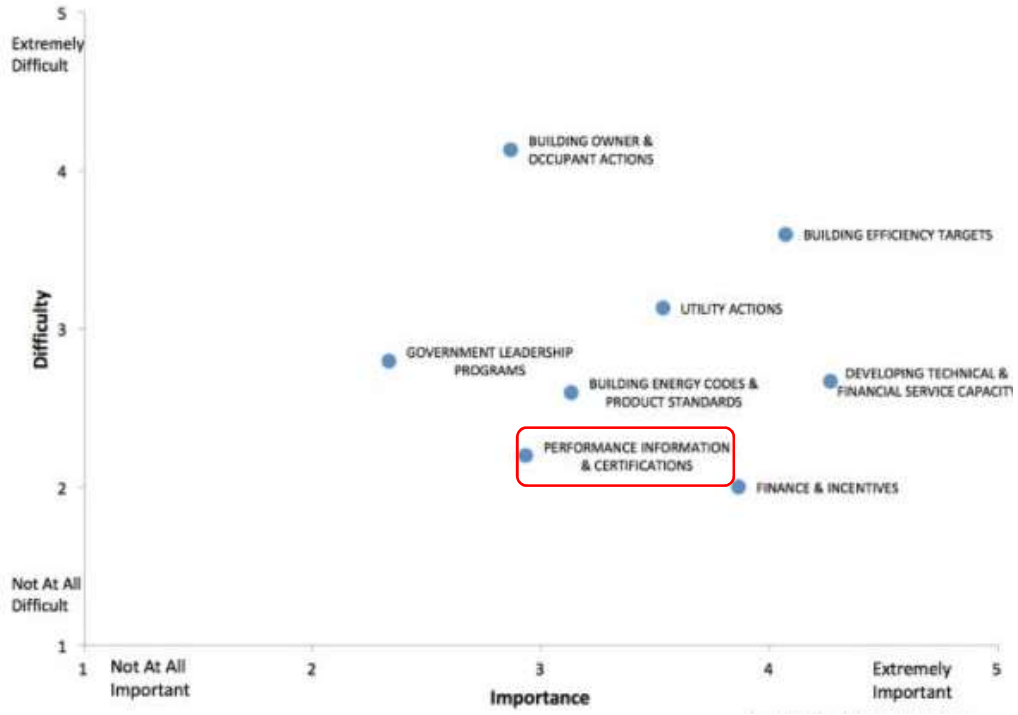

Figure 4.1. - Building efficiency policy map: Importance vs. Difficulty

In addition, there is a growing interest in providing greater transparency to the relationship between employers and workers, as well as facilitating better recruitment options (Irigoin & Vargas, 2002). As Bertrand (2000) states, all countries share their concern for the quality and effectiveness of training, for its transparency and adaptation to new demands of the economies and people's needs in a constantly evolving world. At the present, factors such as the changes in the labour market as well as the globalization, which is increasingly affecting the economic and socio-occupational changes and the necessity of new professional profiles driven by the appearance of new technologies have led to the need of continuous and flexible training and thus skill's certifications.

Certifications are driven by the need to recognize competencies of workers in an objective and formal way, independently of the how and where they were acquired. This recognition should facilitate labour mobility and guarantee equal opportunities to the access and maintenance of employment regardless the place or country where the work is carried out (Ruiz Bueno, 2006). It is placed at the end of the stages of work by competencies. It requires a previous identification of competencies, their standardization, and the evaluation of the candidate who is going to be certified.

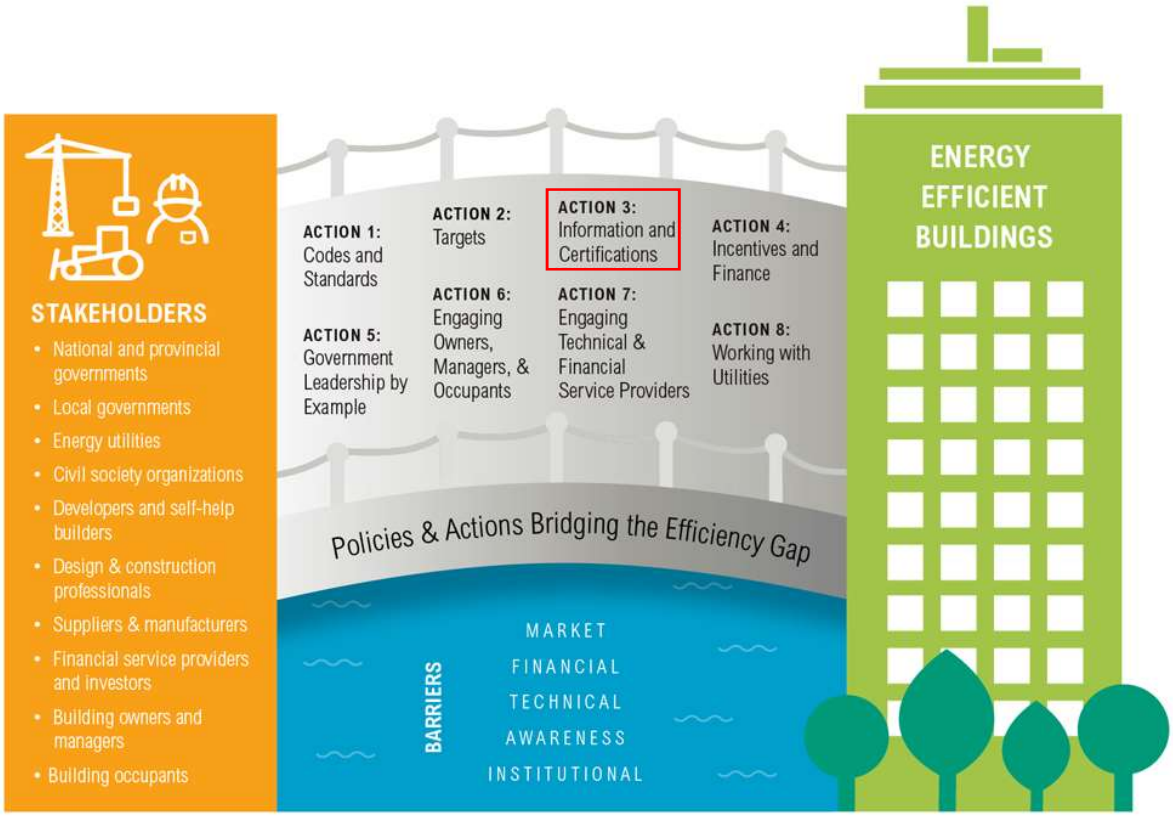

Figure 4.2. - Crossing the bridge to more efficient buildings (Anon, 201?).

In order to be valuable, a skills' certification needs to have some features such as meaning, validity, transparency and updating. The certificate has a high meaning for its labour implementation. It indicates the working capacities included in a standard and recognised by workers and employers. It is an expression of the knowledge a person has acquire throughout his life and that enable him to perform an activity. It has to be issued by a legitimate and recognised institution responsible for ensuring the quality and transparency of the certification process. This process is to be open and clear to all stakeholders so as to be credible to both employers and employees. Moreover, a certification has to be regularly updated as it should reflect the real skills of the workers. Besides, it has to ensure the adaptation to the constant transformations in the work contexts due to technological innovations or changes in the organization of works that lead to skills' modifications. Specifically, in the construction industry construction methodologies and technologies are continuously evolving so it is of the utmost importance to be privy to the latest trends.

Focusing on the construction industry, particularly the building sector has demonstrated to be essential in boosting a change in society towards sustainable development (Maliene & Malys, 2009; Tsai & Chang, 2012). Therefore, when talking about sustainable construction development, the way a leader manages a project (Tabassi, et al., 2012), along with the blue

collar workers, can modify the project driving it towards sustainability and lead to better productivity (Tabassi, et al., 2016). Conventional construction methods and technologies should be replaced by those new ones which help to reduce the environmental impact in order to achieve sustainable construction and activate the application of sustainable development concepts (Nelms, et al., 2005). Here is where the labour force plays a key role.

In summary, it can be concluded that there is a need of a properly prepared workforce to carry out these specialised construction activities (BEC, 2013) and trigger the desirable change towards sustainable development (*Figure 4.2*.). Certification systems are a good starting point regarding this issue (Balaban & Puppim de Oliveira, 2016) even though they should be complemented with other actions such as training programs.

4.1. Beneficiaries. Why get certified?

As it has been mentioned before, a skills' certification is a way to guarantee quality and to express the level of competencies achieved by a worker. Therefore, it has several benefits for both workers and employer companies.

A properly performed work is a must for all workers who want to make an ascending career. Workers will have a recognized qualification of their capabilities and experiences obtained during their lives. Moreover, a certification can facilitate career progression and development and improve job mobility options as it may include cross-cutting skills. It can also represent a guarantee for the investment in training (Irigoin & Vargas, 2002).

At the same time, companies expect their recruitment of staff may lead to better performance and productivity gains. Their workers will be better prepared for the present and future work's requirements; they will be able to make a better use of training opportunities and they will also have a quality indicator of that training.

Furthermore, the construction industry is also to be benefit from the certification of skills as it will help to improve the level of knowledge, technical skills and qualifications of its workers, to attract the brightest talents and to meet the client's needs regarding the future challenges (CITB, 2017).

The certification is the culmination of a process of formal recognition of workers' competencies. Therefore, it also implies the issuance of an accreditation of the skills possessed by an authorized institution (CIDEC, 1991).The Government is also involved in this process as it is often worried about employment-related issues or policies to improve the quality of education. As well as training institutions, which aspire to meet the needs of employers and, to this end, offer their training actions.

In addition, an important subject relating certification systems is the need of legitimacy, which is mainly earned by the participation of all the stakeholders involved in the process: employers, workers, government and training institutions. Legitimacy guarantees participation, credibility of the process and social recognition.

4.2. What should a certification system of skills include?

The methodology that is going to be followed to develop the worker's evaluation and the certification system should be reflected in a documented procedure so it can be applied in a systematic and consistent way with every single person and periodically reviewed for its

continuous improvement (ChileValora, 2015). The formal aspects of the standards, design and format, are a key element for the validation and effective acceptance of the certification by the different potential users (training and evaluation centres, workers and construction companies).

The process and methodology employed to evaluate the skills should cope with a number of requirements regardless of the centre or country where the evaluation takes place. It should ensure consistence and, at the same time, control de process variability so it is easy to understand, compare and improve if necessary. Besides, workers should have the certainty that the evaluation conditions and quality will always be the same independently from the certification centre. It is also important to guarantee the standardization of the process and the role and expertise of the evaluator.

The methodology that is going to be used in order to judge the working skills and the set of instruments that allow to evaluate all the components of the profile should be defined. It should include the necessary tools that will allow to collect direct evidences (generated in the process of evaluation), as well as those that allow to gather indirect or historical evidences (generated in the work experience or training of the candidate). Accordingly, each evaluation centre will be able to determine the performance of a person with respect to each unit of labor competence and / or the occupational profile in which it has been evaluated (ChileValora, 2015).

The standard that will be followed to carry out the evaluation and consequently will lead to the skill's certification should include:

- What the worker should be able to do.
- The way to decide whether what the worker has done is correct or not.
- The conditions under which the worker have to demonstrate his competencies.
- The type of evidences necessary and sufficient to ensure that what the worker has done was done consistently and based on an effective knowledge.

This is useful to state more than just the performance achieved in the form of results. It also allows to describe the ability to achieve quality results with an efficient and confident performance; the ability to solve emerging problems during the execution of an activity and; the ability to transfer knowledge and skills and to other work contexts (CIDEC, 1991).

The evaluation of the working skills and therefore the certification, acquires a much more objective dimension when workers are able to show accreditations about what they really know and what they can do and not just the hours of training and the name of the courses they attended.

4.3. Methodology. Which one should be followed to define the certification system?

A key point when creating a certification system is to define the methodology that is going to be followed so as to carry out the evaluation of the skills. It is important to ensure the quality of the process and clarify what it measures and how it is going to be measured. A valid image of training and working skills should be provided. It is necessary to admit that any evaluation process needs, inevitably, some simplification. Not only because of the complexity of the methodological materialization itself, but also because of the limits with regard to time and costs.

It is necessary to ponder the instruments that can be articulated in a certification process, as there are several options depending on the methodology that has been chosen. These instruments can be interviews, the analysis of tasks in the workplace, knowledge tests or the observation. As for the methodology, it has to be considered whether a qualitative or quantitative methodology will be more relevant, if only those observable and measurable competences will be evaluated directly, or if it is necessary to use a combination of both of them (Ruiz Bueno, 2006).

Evaluation methodologies are usually valued according to their validity, reliability, acceptability and credibility (O'Grady, 1991). The validity is a measure of the extent to which the evaluator's decision reflects, in an accurate way, the individual level of abilities with respect to a specific criterion. The reliability reflects the consistency of the scores that people would get if they were tested on several occasions. It is a sign of quality of the evaluation process and a measure of the degree to which a candidate would get the same results regardless where, how and who evaluates him.

Some European countries such as The Netherlands, France and the United Kingdom address the evaluation of non-formal learning through qualitative processes and experimental studies combining interviews, exams, diagnoses, self-assessments and checks. Within the dissimilarities, a common reference point is given by the fact that they are based on processes that use the dialogue as a method of evaluation. This technique takes into account the different methods of learning and their social contextualization. This is, it recognizes the individualized character and the specific context of every way of learning. Each candidate is, in this sense, unique and the evaluation methodology reflects it. However, there are three identifiable constraints in this kind of models: costs, capacity and objectivity. This type of methods that incorporates counselors eventually combined with evaluation tasks are generally considered expensive. Moreover, the complexity of processes limits the number of candidates that can be evaluated, therefore there is a reduction on the potential that these systems can offer. Finally, there exists some uncertainty in terms of reliability as the assessments are linked to the evaluators' subjectivity (CIDEC, 1991).

On the contrary, other methods such as one employed by the European System for recognition of skills and qualifications rely on an objective and delimited measurement conducted by means of electronic systems. Even though this is aimed to reduce costs and provide greater neutrality and a better capacity in terms of its application, these methods are quite focused on assessing theoretical knowledge.

In spite of the several achievements and contributions of this second type of methodologies in terms of validity and reliability of the assessments, it presents some limitations. These restrictions are clearly linked to the fact that the increase of both validity and reliability lose sense if they are not combined with a correct understanding of the training processes or the previous acquisition of competences, that is to say if the learning is not placed in the proper social context.

At the same time, in Europe, lifelong learning is nowadays considered to be an important course of action as it allows to improve employability, individual fulfilment and it is advantageous for the economic competitiveness. There exists an approach that examines the differences between formal and non-formal learning to determine if the relationships and links among the various types of learning could influence the design and implementation of lifelong learning policies (Colardyn & Bjornavold, 2004).

As change has become a main concept in the current working life, lifetime employment has turned out to be an exception. Most of the European workers will change their jobs numerous times during their work lifespan, either on a voluntary basis or not. The change on the labour market, that mainly shows the rapid evolution of technologies, needs that working skills can be relocated within an innovative working environment. Workers have to be able to transfer their knowledge and experience to a different company, a new sector or another country if needed. This is highly related to the validation of non-formal (and informal) learning as it is aimed to draw the attention to the experience held by a person and not just the theoretical knowledge, independently of where this learning has taken place (Colardyn & Bjornavold, 2004). The recognition of the non-formal learning has several benefits for employers, in terms of human resource management and for workers, as they can have a full collection of skills and competences valued. It is important to point out that as long as learning and skills developed outside formal education remain undetectable and not enough respected the desire of lifelong learning will not be achieved.

Thus, the importance of the validation of non-formal learning seems to be clear from an economic perspective. Intangible values, such as knowledge and competencies, have gained more significance in comparison with tangible values (machines, buildings, etc.) (Bjornavold, 1997). However, as long as there are no reliable methodologies to identify and validate these intangible values, their importance will tend to be underestimated.

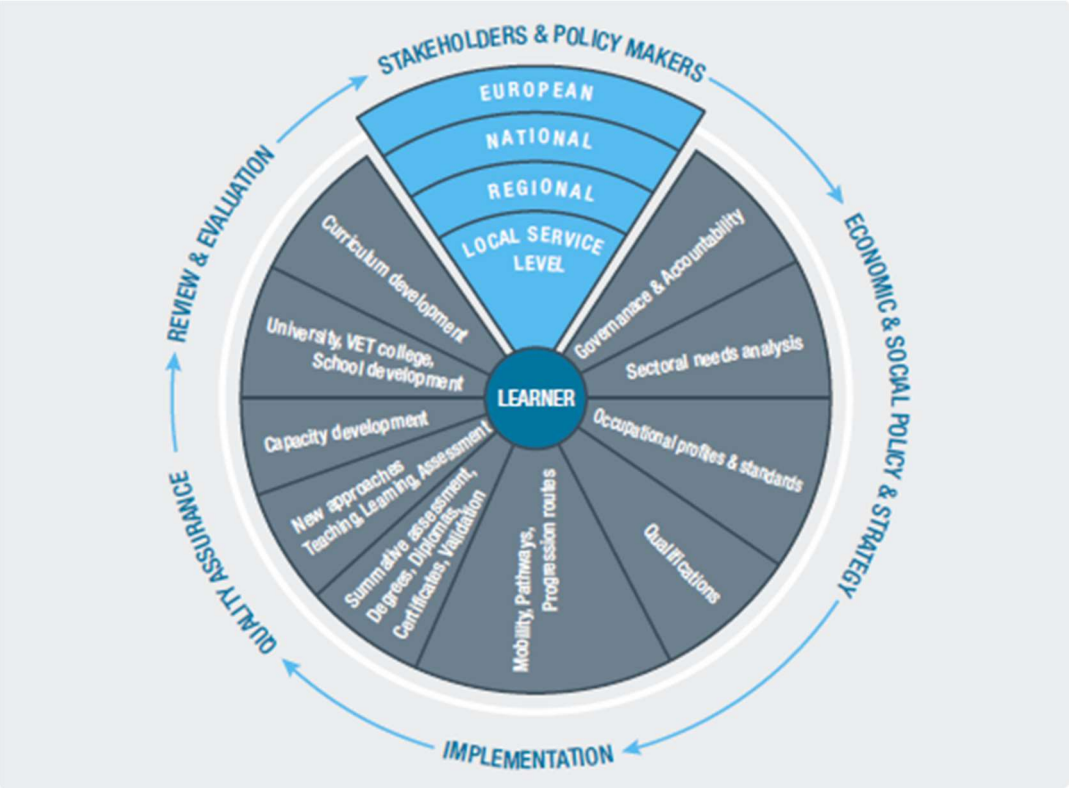

Figure 4.3. - Learning outcomes: users and uses (Cedefop, 2016).

From all of the above, it can be concluded that evaluation methodologies do not have to choose between different notions of learning, but have to consider their own limits regarding the evaluation of the different ways learning and the outcomes that have been obtained. Successful methodologies should take into account the specific nature of non-formal learning and provide guidance and limits for the design of assessments (Bjornavold, 1997). Therefore, the development of methodological combinations can be a suitable solution. Eclectic methods

would attempt to combine knowledge, understanding, problem solving, technical skills, attitudes, and ethics from a wide variety of methods to gather evaluation options such as performance observation, skill testing, simulation exercises, project or task completion, questions of oral response, written response questions, multiple choice test, etc. Moreover, the involvement of all the stakeholders at different levels is crucial to implanting learning outcomes approaches as it can be seen in *Figure 4.3.*

A properly designed certification system of skills has to be focused on providing an individualized evaluation, it should not compare individuals to others. In addition, the only judgment is whether the assessment test has been passed or not, that is, it is not classified by percentage or by graded assessments, a single scale should be used. Moreover, this lays the groundwork for lifelong learning processes, which will lead to new skills developments and new evaluations.

4.4. Existing Certification Systems

It has already been explained that economic, social and environmental factors have to be considered when analysing the upcoming trends and needs of the construction industry as these problems are considerably affecting the AEC industry (BEC, 2013). For this reason, it could be beneficial to analyse the different types of certification systems that already exist in Europe and look for their strengths and weaknesses in order to be able to design an appropriate certification systems that meets the needs of the workforce, the companies, the government and, in general, all the stakeholders involved in the construction industry.

4.4.1. UK

The construction sector in the United Kingdom is enormous; it represents 8% of GDP and 10% of employment. This is, there are currently 2.9 million people working in the construction sector in the United Kingdom *(Figure 4.4.).* Even if it has a global reputation regarding engineering and architectural skills and sustainable construction solutions, the sector still has to cope with some fundamental problems. The overall result is that the construction industry is not capable of sustaining the necessary investment in technology, innovation and skills required to achieve the desirable change in productivity needed to meet the objectives settled by the Construction Leadership Council (CLC). The CLC is an institution created in 2013 in order to work between the government and the industry. It is aimed to recognise and provide the necessary strategies to support the UK construction sector in developing greater efficiency, growth and skills (CSCS, 2017). Its objective is to drive industry enhancement by gathering business leaders from the sector and working on developing solutions to tackle issues such as the high rate of carbon emissions or the trade gap.

Leadership Councils in other sectors have already achieved an important improvement in terms of competitiveness and productivity so, taking them as an example of success, the CLC has established some routes to focus on. The most remarkable ones are the digitalization, focused on delivering better projects and using BIM to obtain more certain outcomes and the whole-life performance, dedicated to get more out of the present resources through the use of smart technologies. The Construction Leadership Council is organized in six work streams. To this research, the most important areas are: skills, green construction, smart technology and innovation in buildings. (CLC, 2017).

It is essential that the present and future workforce have the appropriate skills to match the needs of the construction sector. Workers should be able to help to develop a more productive, effective and innovative construction industry. That is why the skills work stream

of the CLC is focused on developing a common and sustainable framework that may provide the workforce with the adequate skills to meet the construction industry's needs.

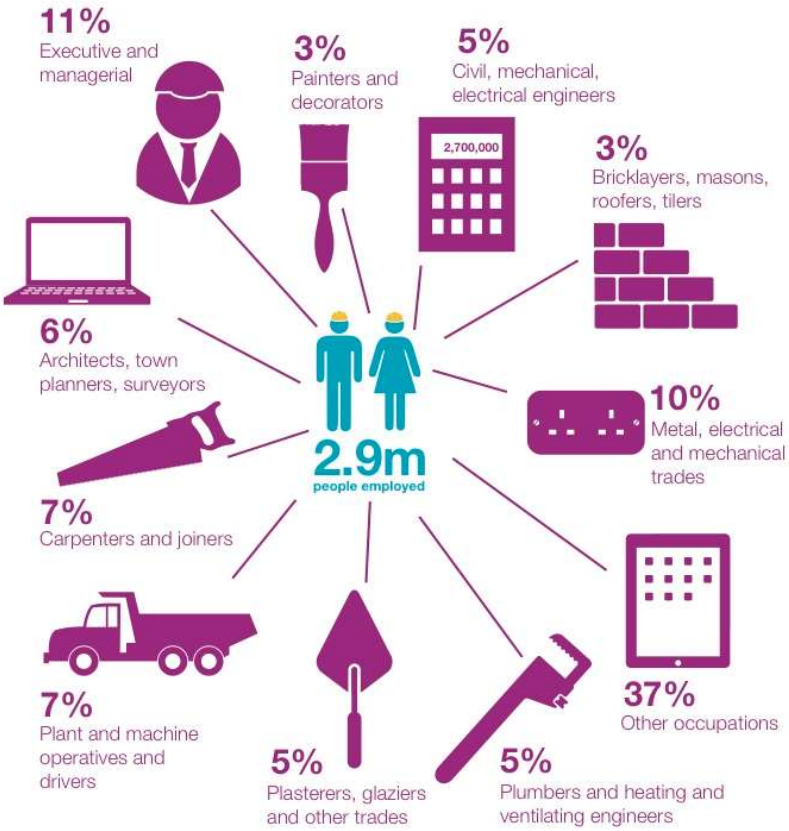

Figure 4.4. - Distribution of the 2.9 million people working in the UK's construction industry (Anon, 201?).

The main objective of the Green Construction Board is to help the whole value chain of the construction industry to increase productivity and become more environmentally sustainable. It deals with all the stakeholders involved in the sector: product manufacturers and suppliers, contractors, clients, designers, etc. This board has also settled an ambitious goal for 2025, achieving a 50% reduction in greenhouse gas emissions. In the same vein, the innovation in buildings work stream wants to incorporate innovative construction techniques to the sector so as to enhance productivity and quality and improve the whole-life performance of buildings.

In addition, there are several challenges, as well as opportunities, regarding the use of digital technologies in the building's design, construction and operation. The construction sector is becoming gradually more data-enable so, the way the digital data are managed can undoubtedly influence these factors.

Skills are highly related to innovation and smart construction. Bearing this in mind, the Construction Leadership Council has established a list of the main subjects that need to be tackled and the strategies that can be applied to deal with them. Some of these indications are:

- To endorse those new workers that have recently joined the construction industry so they can improve their qualifications and develop their careers.
- To create the necessary policies in order to retain workers in the sector over the long-term.
- To develop strategies to attract new entrants into the construction industry.

- To lead and support strategies to reduce greenhouse gas emissions.
- To define measures in order to improve the affordability and availability of buildings whose construction involves the use smart technologies.
- To support initiatives to speed up the adoption of smart technologies.
- To work with experts in order to make the best of the use of smart technologies that can be applied in the construction sector.

At the beginning of 2015, the CLC declared that all the stakeholders involved in the construction industry should require and endorse card schemes with the CSCS logo and no other equivalent would be recognised.

The Construction Skills Certification Scheme (CSCS) is the most important skills certification scheme in the UK construction industry. Its purpose is to guarantee that people working on construction sites have the necessary training and qualification to undertake the required type of job. Even though having this certification is not a legislative constraint, most major contractors and main house builders ask their workers to own it before being allowed to work on site. CSCS allows people working on construction sites to hold a card that proofs that they have the appropriate training, qualifications and experience for the type of work they are carrying out. Therefore, a CSCS card is a certification of the cardholder's identity, training and qualifications (CSCS, 2017).

4.4.2. Spain

In Spain, there is also a certification card for construction workers (Tarjeta Profesional de la Construcción). This card is issued by the construction labour foundation (Fundación Laboral de la Construcción) and it recognises the professional category of a worker and the experience he has gained during the periods he has been working in different companies, as well as all the training received by the worker. It is also useful to ensure that the worker has passed the necessary medical examinations. It is mandatory to have received the appropriate training in prevention of occupational hazards before applying for the certification card (TPC, 2017).

The Spanish construction labour foundation was created in 1992 with the objective of helping both companies and workers within the construction sector to face the challenging future (Anon., 2017). It is currently developing a system that it allows to certify the knowledge and skills of the workers of the construction sector in different areas, regardless of how they have acquired them: through training or through professional experience, which is directly related to the objective of this research. Vocational training certificates and professional certificates do not always cover every trades and professions in the construction sector, so this certification will demonstrate the skills of many of those workers who can not access to an official qualification but have a work experience that allows them to become competent professionals.

At present, in Spain there are 24 professional qualifications related to building and civil works. However, this is no enough to cover all trades in the sector, leaving helpless many workers in the construction sector. In addition, companies must face more and more demanding documentary requirements, both for public procurement and for subcontracting. Within these demands, the training of workers is the biggest problem. Apart from preventive training, required by the current legislation, many workers do not have a specific training that qualifies them to perform the functions related to their job. In this way, most workers in the sector can not reflect their know-how in a supporting document despite having extensive work experience.

The first certification available is addressed to machine operators (Certificación Profesional de la Construcción de operadores de maquinaria de construcción). The certification process is divided in three stages: a theoretical evaluation, an analysis of the documentation presented by the worker (work experience, training, courses, accreditations, etc.) and the completion of a test with a minimum of 20 minutes, which will consist of developing a series of practical tasks (Anon., 2017).

4.4.3. Sustainability Professional Certification

The International Society of Sustainability Professionals (ISSP) is a worldwide association of sustainability professionals that works to empower professionals to promote sustainability and make it become a standard practice. It seeks to improve the skills of sustainability experts through certifications, research, education, knowledge sharing and professional credentials. This association was created in 2007 and it has members from all around the world who want to improve professionally by sharing resources and best practices (ISSP, 2015). It is aimed to bring together professionals from different countries, to develop and maintain a source of peer reviewed materials and tools and to provide members, as well as the profession, with the suitable professional development (CSRwire, 2017).

The Sustainability Professional Certification program recognises the knowledge, skills and abilities of professionals in the field of sustainability. There are two types of certifications available: one for people who are new to sustainability and are thinking about incorporating it to their work (ISSP Sustainability Associate) and another one for sustainability professionals who have at least five years of experiences in this field (ISSP Certified Sustainability Professional).

The certification process is based on a job task analysis and it is aimed to evaluate the skills, abilities and knowledge of workers in any sector. This certification involves the documents of Continuing Education Units (CEU) to keep valid and assure the adaptation to the newest sustainability trends.

4.5. Existing Training opportunities

Because of the current composition of the construction industry, there is a lack of an appropriate investment in education-related activities such as training, innovation and research (Alwan, et al., 2017). It has been stated that failing to provide regular training and education leads to an underqualified labour force, which means that, for example, workers will just have the basic knowledge about sustainability issues and the worldwide consequences of construction emissions and waste (Saunders & Wynn, 2004).

If the construction industry wants to flourish, change and succeed, it is essential to attract new and talented people to join it. Moreover, it has to be able to ensure rewarding jobs to preserve the existing construction workers as well as the new entrants. The skills scenery is continuously evolving and new training should be provided in order to keep up to date with all the new requests. Innovation and smart construction may have the power to boost productivity within the construction industry along with improving the performance and quality of the buildings. This can help the industry by making a better use of resources, be it the use of materials or the workforce. Performance and quality can be improved in areas such as building comfort and energy efficiency. As long as the construction industry is empowered by smart technology, it will be able to deliver a better infrastructure capacity with a reduced amount of capital investment (CLC, 2017).

However, problems such as the skills mismatch, the lack of skilled labour and new operators and the low level of awareness of the blue collar workers regarding the new upcoming challenges related to nearly-zero energy buildings can be tackled through training systems. The aim of this research if to come up with a solution to deal with the lack of knowledge of the labour force in relation to sustainable energy efficient construction and, if possible, to create a connection with new methodologies as it is Building Information Modelling. To this extent, it is necessary to study the current training opportunities in Europe, find their gaps and their strong points and discover the common line that they share.

4.5.1. UK

In the UK, there exists a Construction Industry Training Board (CITB), which works together with the Construction Leadership Council and whose aim is to create a safe, professional and entirely qualified construction workforce.

The Construction Industry Training Board states that the development of the workers' skills in the construction sector is essential to maintain the UK economy so they work to provide the most competent construction workforce possible. Its role is to offer companies the adequate support and enough funding to help them enhance their productivity and competitiveness, reduce costs on site, improve their skills and recruit good talents, as well as to deal with factors such as the low carbon agenda (CITB, 2017).

New ways of working have appeared due to the infrastructure plan of the country, along with the housing boom and the development of the industry. So, in order to take advantage of it, the CITB has planned a strategic plan to endorse new technologies and learn to bring together all the resources so as to produce a demand for supplementary skills, innovative skills and higher level of skills. This has been done by consulting the industry with the intention of evaluating its priorities and meet its needs.

The Construction Industry Training Board use the Construction Skills Network labour market intelligence to create and distribute a wide range of services and products to construction employers and be able to maintain the skills of the labour force up to date. The Construction Skills Network (CSN) is responsible for providing market intelligence to the construction industry in the UK. It makes available data about the way the industry is changing and will change in the next few years and highlights the current trends so the sector can understand the present situation and make the necessary plans for the future in advance (Bryer, 2017). Accordingly, the CITB works to achieve some robust objectives:

- Sculpt the construction industry: In the UK there is around 2 million people working in the construction sector so it is important to have good links with the government to ensure that it appreciates and advocates for skills development and training. The CITB has worked hard to help employers from end to end during the recession. It has facilitated the maintenance of their interns, modified and designed qualifications, saved the National Vocational Qualification (NVQ) and stood up for initiatives carried out by employers to provide flexible learning to construction companies.
- Bring the best and most promising talents to the industry: Understanding that young interns are the engine of the industry, the CITB tries to motivate young people to join the industry and encourage companies to offer them more opportunities. It has also promoted a campaign to get funding for adult trainees.
- Training and more training: The National Construction College in the United Kingdom is the biggest construction college in Europe. It provides training to 30.000 workers per year. It is also important to create a link between trainees and companies. Providing quality and affordable training is essential. Thanks to it, in 2016, 81% of the apprentices completed their training, breaking by far the national average (14% for traineeship completion).

- Back up the existing workers: It is essential to invest in making grants available for employers in order to improve and enhance the skills of the workers and to increase their competitive advantage.
- Comprehend the legislation and discern its changes: It is of the utmost importance for construction companies to understand the current legislation and be aware of its changes so as not to miss any business opportunity.

4.5.2. Belgium

The construction sector in Belgium is mainly composed by small and medium enterprises (around 26.000). The sector in this country has to face an important challenge related to manual workers. The number of workers that leave the construction sector every year (in order to work in a different sector, to go into further training and education or even to become unemployed) is quite similar to the number of new entrants. The big issue is that these people who leave the sector have a higher level of skills than those entering into it. Therefore, this leads to an imperative need for constant training and education. Moreover, it has been identified that small and medium companies usually take on more beginners than large enterprises.

In order to address this situation, unions and employers have helped to create the Belgian Fund for Vocational Training in the Construction Sector. Several stakeholders, such as private companies, trade unions or training divisions of the regional labour exchange agencies, take part in this initiative.

This organization has developed quite a few policies and strategies so as to provide employers and employees with all the necessary information about training opportunities and the numerous advantages derived from them. It endorses the chance of carrying out branch specific education activities with the collaboration of various construction companies. It also provides with financial support, help to simplify the administrative burden, counselling, guidance for unemployed workers, supervision of courses and plans to incorporate new technologies or integrated health and safety training. The fund is aimed to offer training for both new entrants and existing workers.

Lifelong learning has progressively become part of the principles of the construction sector in Belgium. This has been possible by helping companies during the process of looking for other companies to work together in relation to training and by breaking down the barriers between the private and public sector. The Belgian Fund for Vocational Training in the Construction Sector has promoted this acceptance of lifelong learning and has shown that it is possible to provide workers with the necessary training at almost no extra charge through a careful planning. The success of this training strategy is also due to the agreement between the social partners.

4.5.3. France

The construction sector in France is accountable for 40% of the country's energy consumption and is one of the main responsible for greenhouse gas emissions (23%). Hence, the main objective is to reduce the energy consumption of buildings in order to meet the standards established by the European Commission. The main problem that France has to tackle is that only 35% of the existing buildings have been built after 1974. Therefore, it has been concluded that the construction sector needs to address this issue by improving and increasing the skills of the labour force.

Even though France is experiencing an increase in the number of construction workers, there is still a need to attract a bigger number of blue collar workers in order to cope with the future requirements and the demands of the Grenelle environment initiative. This shortage of workers is due to both the outflow of workers (because they retire, change the sector or continue with their education) and the creation of extra jobs. The Grenelle initiative was proposed in 2007 to improve sustainable development strategies in France. It states that the construction sector needs more skilled workers so it is necessary to up-skill and re-skill the current workers. With the Grenelle initiative, the French construction industry wants to promote the demand for sustainable buildings, improve the existing ones, and create new training programmes to enhance the skills of the existing labour force, as well as guarantee that students undertaking construction-related programmes are prepared to design sustainable buildings. Thus, all the educational programmes include energy efficient training as workers need to have the necessary skills to renovate buildings improving, among others, their acoustic, thermal and inside-air efficiency.

The target groups of the initiative are construction companies, workers and the owners of the buildings. Students entering in the construction sector are also part of these target groups. Additionally, it is important to highlight that the participation of educational and research institutions, sector organisations and social partners is crucial and they need to be aware of the consequences of this initiative.

4.5.4. Spain

The Spanish construction labour foundation works to provide training to the workers and offer them with the necessary information about innovation, sustainability and new technologies so they will not lag behind and they will be able to adapt to the challenging requirements of the construction sector in the near future (Anon., 2017). Besides, the foundation is continuously adapting to the latest learning technologies, including machine simulators, videoconferencing systems, video games and an advanced e-learning platform in order to continue offering the better training to workers and construction companies. It provides both on-line and on-site training in the numerous offices it has around the country.

The construction labour foundation has signed a collaboration agreement with the Spanish chapter of the international association buildingSMART, with the common goal of encouraging the use of the BIM methodology (Building Information Modelling) based on open standards, which allow increasing quality as well as reducing costs and lead times in the construction sector. Both institutions work together to develop different activities related to the BIM methodology, such as the organization of information days all around Spain or the development of training actions (EntornoBIM, 2017).

One example is the introduction course to BIM Methodology that foundation has designed, which is a classroom-based academic course with a duration of 15 hours. This is the first step to obtain the cultural and strategic basis of BIM and it allows the student to understand the methodology. It is useful to help the worker to take the decision to go deeper into the subject and continue training if he is interested and to consider the decision to implement the new methodology in the case of companies (Anon., 2017). Once this first movement has taken place, there are available several BIM courses that cover all the stages of a construction project, from the design to operation and maintenance of the building.

4.6. Gaps identified on the existing systems

After having analysed various kinds of certification systems and training programmes from different European countries some clear outcomes have been obtained. There are several common points in these systems that have already yielded good results and that should be imitated but also some weaknesses and shortcomings have been identified. Most of these weak points are due to the little emphasis given to sustainability and energy efficiency issues. The majority of the existing certifications and training systems are just focused on developing or proving the current skills of the workers that are directly related to construction activities and they forget about the near future needs of the industry.

As it has already been mentioned, sustainability is a key matter, especially concerning the future of the construction sector, as well as BIM methodologies, which have burst with force in the construction industry but remain invisible when talking about its inclusion in the blue collar workers' activities. There are also certifications directly focused on sustainability as is has been shown with the Sustainability Professional Certification. However, in this case, there is a lack of connection with construction activities.

Therefore, be it for one reason or another, certifications systems have failed to find a way to put together the present and future needs of the construction industry. It is essential to take into account the current needs of the industry, to support workers and new entrants and help them prove their skills as well as to improve them and gain new ones. Nonetheless, the future needs of the industry should not be forgotten. It is necessary to face the new requirements related to sustainable construction and the adaptation to new technologies and methodologies such as Building Information Modelling.

It has been shown that in Europe there exists a real concern about the importance of new technologies and the adoption of BIM methodologies. Nevertheless, even if many countries are aware of it, they still fail to incorporate it in the proper way. In most cases, the shortage of these kind of skills is tackled through theoretical courses and they fail to adapt the outcomes to the real tasks of the workers during their workday. It is necessary to find the appropriate manner to combine the current situation of the construction sector with regard to the level of skills and these new skills required. Sometimes, this failure is due to the lack of a clear methodology. Moreover, the different training actions provided should be connected and follow a common line that helps the workforce to put together the new information and adapt the skills learned to their job tasks. Once this has been defined, it is time to develop a certification system to conclude the process and evaluate the abilities of the workers.

It is essential to identify the skills needed to carry out any construction activity, both at the present and in the near future, and help the workers to obtain them. This would be highly useful in order to find a link among them and generate the easiest transition towards these new skills. It is complicated to introduce new technologies and methodologies in the daily routine of blue collar workers, so its implementation has to be slowly progressive. Moreover, sustainability issues need to be tackle as soon as possible. As it has been exposed, in many cases, sustainable related issues are mentioned but they are not included in the certification process. Some training actions also address it but in a superficial way.

It can also be concluded from the previous chapters that the participation of all the stakeholders (construction companies, workers, the government and evaluation and training

centres) involved in the construction processes is crucial in order to develop a suitable certification system and the necessary training actions.

To sum up, it can be stated that the main issue regarding certification and training systems concerning the skills of workers including energy efficiency and BIM is the lack of organization and a clear objective. There is an absence of a defined methodology and a suitable connection among the topics that need to be address nowadays. That is, the combination of skills related to construction activities, sustainability and new technologies, all of them focused on a common goal.

5. Findings

The construction industry is facing a shortfall in terms of skills and labour so it is essential to address this issue if it wants to keep up with the current and future demand. Running in parallel to the clear necessity to train the next generation of construction workers there is also the need to work with the current labour force in order to meet the upcoming challenges. If the construction industry wants to fulfil the current and future requirements, the skills of the existing workforce have to be improved and enlarged. One way of doing so is through apprenticeships and training of the current employees. This can be enhanced by backing up organisations, people and companies so as to cultivate new and better skills.

First and foremost, a plan for the future has to be properly designed. It is vital to work to meet the current needs but also to do the best to anticipate with the most accuracy possible the future requirements and cover these coming needs. If the construction industry wants to move forward it is important to contemplate what will be need to be done in the upcoming future and not just think about what needs to be done today. As one of the most important sectors for the society, the construction sector has to be proactive and forestall what is coming in order to close the skills supply gap that is suffering at the present.

Therefore, the definition of a properly organised and well supported and financed training programme will be extremely beneficial for the success and development of the construction industry. In addition, of course, to the basis, which is the creation of an appropriate certification system that allows to identify and demonstrate the workers' capabilities.

Sustainability and energy efficiency issues are at the forefront of the upcoming needs of the construction sector so it is of the utmost importance to address the lack of information and knowledge that the current workforce has about it. Besides, it is essential to introduce BIM methodology in the construction processes. It is particularly difficult to include BIM into the daily activities of the blue collar workers but make them understand its functions, use and benefits would be highly advantageous. It can be helpful to ease the communication among the stakeholders involved in the development of a project. Moreover, it can lay the foundation for a future introduction of BIM methodology into the area of expertise of the blue collar workers and make it part of their work routine.

To sum up and make more clear all the outcomes that have been obtained from this research, it has been drafted a list with the main points that a Certification System of skills of construction workers should follow nowadays.

" 10 GOLDEN RULES FOR A CERTIFICATION SYSTEM "

1- *International recognition*: Most European countries share a concern about the quality and effectiveness of training, as well as to its adaptation to the new requirements of the construction industry. Moreover, the growing changes in the labour market and globalization lead to the necessity of flexible training and certifications. To this extent, there is a need of an international recognition that facilitates labour mobility and guarantees equal opportunities in terms of access and maintenance of employment, regardless the country where the work is carried out.

2- *Transparency:* The process is to be open and clear to all stakeholders involved so as to be credible to both employers and employees. It has to be controlled so it is easy to understand, compare and improve if necessary. Variability should be avoided. Workers need to have the certainty that the evaluation conditions and quality will always be the same regardless of the centre or country where the evaluation takes place.

3- *Regularly updated*: A properly designed Certification System needs to be always up to date, as it should reflect the real skills of the workers. In addition, it has to guarantee the adaptation to the continuous changes in the work contexts due to technological innovations or modifications in the organization of works that lead to skills' adjustments. Particularly in the construction industry where methodologies and technologies are continuously evolving. Therefore, it is of the utmost importance to be privy to the latest trends.

4- *Documented procedure:* The methodology that is going to be used to carry out the evaluation needs to be clearly reflected in written document. In this way, it can be applied in a systematic and consistent way with every single person and periodically reviewed for its continuous improvement.

5- *Reliability:* The certification has to be issued by a legitimate, recognised and authorised institution responsible for ensuring the quality and transparency of the certification process. Legitimacy guarantees participation, credibility of the process and social recognition. Construction companies and workers, government and training institutions benefit from the advantages derived from certifications so it is important to ensure the consistency of the process. Reliability is a sign of quality of the evaluation process and a measure of the degree to which a candidate would get the same results no matter where, how and who evaluates him.

6- *Eclectic methodology:* It is essential to define the methodology that is going to be followed for the certification in order to clarify and simply the process. The most suitable option is the evaluation of a combination of formal and non-formal learning. It is interesting to consider the evaluation of non-formal learning as it takes into account the experience gained over the years, the different methods of learning and their social contextualization. This kind of methodology draws the attention to the experience held by a person and not just the theoretical knowledge, independently of where this learning has taken place. A combination of different methodologies can lead to a proper balance in terms of time, costs and reliability.

7- *Single scale:* It is useful to define measures that can help to simplify the certification process. In this respect, it is appropriate to define a single scale (passed or not passed) instead of creating a classification by percentage or by graded assessments.

8- Supportive training system: The certification of the skills held by a worker is the last step of the process. A properly designed Certification System has to consider the skills gained along the work life of the worker but further training is necessary in order to improve the abilities of the construction workers. It would be highly useful to have a training system that complements the certification. This training action would help the

workers to acquire the new skills demanded by the sector and they would be able to adapt their current abilities to the new trends embraced by the sector.

9- Mandatory energy efficiency chapter: It is undeniable that the construction industry hast to deal with sustainable-related issues and the most significant one at the present regarding building construction is the energy consumption. The importance of this subject has already been exposed. In order to be up to date and manage all the needs (future and present) of the sector, the Certification System should include a mandatory chapter of energy efficiency skills.

10- New technologies and methodologies: The construction sector is continuously evolving and it is incorporating new technologies and methodologies such as Building Information Modelling, which have burst with force in the construction processes. Consequently, the Certification System has to include a section that address this subject. This section would be directly related to the training system and they will be both constantly incorporating new updates.

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