BIM AS A DRIVER FOR INNOVATION AND EMPLOYMENT

Best Practices of BIM in Finland, Norway and Italy Comparative Report
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BIM4PLACEMENT is a European Union project which is co-funded by the Erasmus+ program. The countries: Italy, Norway and Finland are participating for the project to deepen the knowledge on building information modelling (BIM) implementation and BIM-related training in each country and at European level. Figure 1 illustrates the project coordinator and partners’ map.

**Figure 1:** Project coordinator and partners’ map.

### 1.1 Scope of the overall project: BIM4PLACEMENT

BIM software is used to plan, design, construct, operate and maintain many kinds of buildings and infrastructures. BIM has been implementing more, especially in architecture, engineering and construction (AEC) industry and the facility management (FM) industry. In addition, BIM related teaching and training has been initiated in universities, vocational education institutes and other private organizations. It has also created many employment opportunities for the civil or structural engineers and architects. Many countries in Europe have implemented BIM to improve the productivity of the industrial process. However, it may be not yet sufficiently known and spread in Italy. Finland and Norway can be considered as the earliest adopters of BIM in Europe, and it have been for years at the forefront of BIM. Moreover, Norway has started BIM research and development and nowadays Norway can be considered as one of the leading countries of those which are using BIM.

Although BIM has been implemented in AEC/FM industry, there are a lack of tools validated at European level for training in BIM. One of the aim of this project is to disseminate the BIM experiences, practices and knowledge between Northern Europe (i.e. Finland and Norway) and Southern Europe (i.e. Italy). Specifically, Italy will have the opportunity to learn from the European best experiences while Finland and Norway will have the opportunity to expand their international BIM-related network of institution and companies and update their knowledge from mutual exchange of best practices and innovation of training tools. Currently, BIM experiences/practices can be disseminated through transnational cooperation.

This project will help to deepen knowledge about BIM as a skills’ development training subject for employability goals, upgrading existing training tools and professional qualifications and creating a network to promote work-based learning with special attention to apprenticeship. For this project, Italy, Finland and Norway are participating as partners. The motivation of BIM partners to participate in the project is strongly connected to the observation of local needs and the acknowledgment about the necessity to try to cover the gap between skills’ qualifications levels and the requirements from job market. In addition, it is expected to upgrade and modify the existing training tools and training programs to improve the effectiveness of teaching and learning. The following intellectual output will be focused:

- Comparative research “BIM as driver for employment” (publication)
- Carrying out BIM training programs at each partners base in each country
- Development of serious game based learning tool for training beginners from various environments

### 1.2 Purpose of the report

BIM software is used to plan, design, construct, operate and maintain many kinds of buildings and infrastructures. BIM has been implementing more, especially in architecture, engineering and construction (AEC) industry and the facility management (FM) industry. In addition, BIM related teaching and training has been initiated in universities, vocational e
STATE OF THE ART OF BIM IN FINLAND
The publication of “Ten truths about BIM” (WSP Group) describes the BIM implementation status in Finland:

“BIM adoption is not complete in Finland, but it’s further advanced than anywhere else. Finland is often cited as a model for successful adoption of the technical core and this small northern country is rapidly turning into a BIM knowledge centre. Look no further than the decision of Skanska, a Swedish company, to base its global BIM think tank just outside Helsinki. Government action can go a long way in a small country. So what has it done right?

Finland is a technologically advanced nation with a comparatively small, agile construction industry. That’s a pretty good starting point, but the real catalyst for this success story was a timely government initiative. Senatsfastigheter (Senate Properties), the administrative body responsible for managing government facilities took an important step when it started to demand BIM in procurement in 2007. Compared to many other countries, the Finnish public sector is proportionately large and commands significant power, allowing it to push the industry towards the tipping point almost single-handedly with comparative ease. With a cooperative industry that has a long history of trust and relationships and takes open standards seriously, Finland has come a long way already. Everyday projects: valuable rather than glamorous BIM is used somewhat differently in Finland than in larger countries. While we might assume BIM can offer the greatest benefits on large, complex facilities, the Finnish example demonstrates its value to small, straightforward projects. Here BIM is harnessed for the purpose of standardization and efficiency in more mundane settings, reaping simple but valuable rewards. Perhaps this is the future of BIM worldwide – once we are no longer seduced by the flashy 3D renderings of “Hollywood BIM”.

BIM can also be considered separately for buildings, bridges, infra and cities.

Building BIM model (Fig. 2) can typically contains information about objects
• Can be used for intelligent information exchange and collaboration
• Can control efficiently design process
• Many detailing tasks can be automated
• Can generate quantities
• Can find any clashes and lacks automatically
• Can be applied for automated manufacturing of different parts
• Can be applied also for facilities management purposes (future)
2.1 General BIM organizations in Finland

BuildingSMART Finland is a collaboration forum founded by Finnish Property Owners, A/E Consultants, Software Vendors and Construction Companies. The Forum aims to disseminate information on BIM and support its member companies for implementing the BIM-based processes.

The goal is to help the member companies to recognize the benefits of BIM, and help them to develop and implement BIM-based business. Another aim is to promote the dialogue between the software vendors and end users. (www.buildingsmart.fi)

The Forum organizes BIM related seminars and member events. The Finnish buildingSMART Forum provides a link to the international BIM development and a way to influence into it. Building Information Modelling makes the operation of networks more efficient and improves the performance of the network. Our mission is to maintain the competitiveness and the development in BIM related business among Finnish companies. Forum offers a platform for these activities to our members. We provide you with additional information for example in (www.buildingsmart.fi):

- Building projects and organizations that make use of BIM
- How BIM processes, roles and tasks are developing
- Open BIM use cases and technology improvements development
- Development and implementation of IFC and other buildingSMART standards

In addition to local operations, buildingSMART and its members have the opportunity to influence international standards and process development. The local Forum offers also a channel to participate the activities in the international level. BuildingSMART International works in the global level in order to enhance the compatibility of different software and standards. As technology is developing all the time, the more important becomes also the development of common processes and practices. (www.buildingsmart.fi)

In the forum of BuildingSMART Finland, there are four different business groups; Building, City planning, Infrastructure and Education. Also there can be found the general BIM specifications and guidelines for buildings (YTV2012 or COBIM 2012 in English), infrastructure (YTV2015). The new guidelines for city modeling are to be developed. The specific BIM guidelines for bridges have been published by the Finnish Transport Agency. The City of Helsinki has its own more detailed BIM guidelines for bridges and other infra structures. Other major cities in Finland have applied these guidelines for the projects in their city areas.

2.2 Synthesis of national legislation about BIM

There is no national legislation in Finland, which directs, recommends or requires the use of BIM in building processes. Some clients, such as Senate Properties in building sector, Finnish Transport Agency in infra sector and Helsinki city in bridge sector do apply and even require the use of common BIM guidelines in projects.

There was a new development program called KIRA digi (Boosting digital transformation of the built environment) started in Finland 2016. Kira digi executes...
the tipping point project for digitizing public services. The funding for the KIRA-dig for the end of 2018 is approximately 16 million euros, half of which is paid by the state and half by the real estate and construction sectors.

The aim is to open up public information on construction and land-use for everyone’s ease of use, to develop smoothly functioning systems and unified modes of operation, and to launch a series of pilot projects to create new innovations and business. Legislation must also be developed to support digitalization in the field. This will create a fertile area for creating a digital business ecosystem in the KIRA sector in Finland.

23 Use of BIM in Finnish industry

BIM is very widely used in building sector including concrete, steel and wood materials and structures. There is no more accurate information available about the present situation. Senaatti Properties has been a key BIM Implementation activator as well as Skanska the building contractor. Considering infrastructures (roads, railways, metro lines, tunnels, bridges, fairways,…) the key client organizations (especially Finnish Transport Agency, City of Helsinki,…) have been very active and demanding of the use of BIM. The largest general contractors (Destia, Skansa Infra, Lemminkäinen, NCC Roads, YIT) as well as the most important design companies (WSP, Ramboll, Pöyry, Sito, Finnmap,…) have also adopted infra BIM into their work processes. Nowadays BIM is very probably utilized some way in near every infra projects in Finland, only smallest projects can be excluded.

Advantages and Difficulties of the Building BIM Implementation in Finland:

Advantages

• There are plenty of advanced BIM software and system providers available in Finland (Tekla, Solibri, Magicad, Vertex, SVS Innovations, …), that’s why it has been easy to get implementation support from the experts
• Many benefits have been found, especially through visualization, combination models, clash detections and quantity take-offs

Difficulties

• The implementation does not comprise the whole building industry, there are some active organizations (Senaatti, Skansa, Lemminkäinen, WSP, A-Insinöörit, …) that apply BIM more extensively, the group is however growing all the time
• After the previous Process Re-Engineering research program (PRE), the industry is seeking the next large research and development funding

In the bridge BIM sector, the following experiences and be see in the BIM implementation:

Advantages

• The “bridge expert group” of organizations and people has been rather small and compact, cooperation between the experts has been effective and continuous since 2001
• BIM based 3D design method for bridges has been found to be the “normal and efficient way of design”

Difficulties

• Design offices still use different ways for information classification (numbers and names)
• BIM utilization in bridge construction phase has remained at developing (undeveloped) level

In infra sector, infra BIM based design, construction and maintenance process, methods and tools most often used. Over 1500 automated 3D machine control systems in practical use. Open information transfer (InfraModel, IFC) supported and demanded. Open BIM based project coordination and management strongly developing.

BIM related employment opportunities in Finland

There are many employment opportunities available in Finland for people who have qualification/experiences/experts in BIM. BIM manager, BIM coordinator, BIM technician and BIM consultant are some of the job titles available largely in industry. We could even evaluate that without BIM skills it can be more difficult to find and get jobs from the industry. For international consultant projects, the BIM skills have often been one of the key expertise areas.
BIM related teaching in Finnish educational institutes

At university level, BIM is taught at any university (University of Oulu, Tampere University of Technology, Aalto University) that has own education line for civil engineering area. There are some differences in teaching depending what area the key researchers have recently studied or been active. At universities of applied science in Finland, BIM is also largely taught in Finland. Metropolia University of applied sciences may have been the most active. At secondary level of education especially infra bim and related 3-D machine control are largely taught in different organizations.

The university of Oulu has currently the following BIM courses:
- BIM in Building Design – Basic Course (CADS), 5 credits
- BIM for Structure Design (Tekla Structures), 5 credits
- Design of Cable Supported Bridges for International Projects – Bridge BIM, 5 credits
- Information modelling and automation in infrastructure construction and maintenance, 5 credits
- Information modelling and automation in building construction and maintenance, 5 credits

BuildingSMART Finland Education is carrying the public responsible to support BIM education development in Finland.

BIM related training and professional qualifications in Finland

There are no specific and widely accepted qualifications been yet developed in Finland. We have discussed with some universities and university of applied sciences that would that kind of qualifications be useful for the industry.

Metropolia University of applied sciences has quite actively arranged BIM workshops, seminars and courses. University of Oulu has arranged several infra BIM and automation workshops at Ouluzone center near Oulu.

BIM related research in Finland

There are three different universities in Finland that have done BIM research; the University of Oulu, Tampere University of Technology and Aalto University. University of Oulu has concentrated more on BIM for infra and bridges as well as on the integration of BIM with construction automation and robotics. Tampere University has done mostly research in the area of building BIM. The BIM research at Aalto university has been more theoretical and considering some global trends.

In addition, the VTT Technical research center of Finland has done research in the BIM area mostly concentrated on the Building Smart international cooperation, global BIM guidelines and open information transferring.

The newest trend in BIM research in Finland is looking for connections to facilities management as well as in infra sector looking for specific maintenance BIM model with some intelligent connection to smart traffic control and systems.

![Example - Maintenance BIM of a road.](image)
STATE OF THE ART OF BIM IN NORWAY
3.1 Importance of BIM

It is vital to raise the awareness of digitalization of architecture, engineering and construction (AEC) industry and facility management (FM) industry. BIM is one of the driver which helps to exchange the information and 3D visualization. There are various definitions given for BIM. In this report, BIM is defined as “Building Information Modelling (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward” [1]. Figure 9 shows how BIM is playing important role during the life cycle of a project.

There are various challenges faced by the AEC/FM industry due to lack of exchange of information among the participants in a project. According to the literature, in Norway, 25-30% of construction costs are due to fragmentation of processes and poor communication. The same information is entered on average at least 7 times in different systems until a building is handed over to the owner. About 40% of building damages in Norway can be related to mistakes or neglect in planning process. About 20% have a cause related to the absence of description/specification of requirements from the builder [2].

Use of BIM and the exchange of information among the participants in a project/organization is one of the efficient and productive ways to overcome the challenges in the AEC/FM industry. The participants are the construction professionals at all management levels and from across the entire construction supply chain infrastructure.

The professionals can be designers/architectures/constructor, suppliers, clients and operators. Moreover, BIM uses 3D models with attached data and information to connect and share information efficiently across the supply chain and hence, enhance the efficiency of activities around asset delivery and operation. Instead of 2D models, 3D models make it easier to communicate projects with stakeholders, actors and decision makers. Information about the building in 3D models gives a photorealistic representation. Even complete outsiders can understand and get into a 3D model.

In addition, the BIM maturity model in Figure 10 helps to understand the levels of competence expected, processes required and to highlight the supporting standards. The BIM Wedge or Figure 3 was developed by Mark Bew and Mervyn Richards. Furthermore, BIM maturity has been divided into four levels, such as Level 0, Level 1, Level 2 and level 3. Each maturity level can be explained as below) [4];

**Level 0**: 2D CAD drafting only is utilised, no collaboration. Nowadays, the majority of the AEC and FM industry are already well ahead of this stage.

**Level 1**: many companies are currently operating at this level. This consists a mixture of 3D CAD for concept work, and 2D for drafting of statutory approval documentation and production information.

**Level 2**: Collaborative working with all parties is done at this stage by using their own 3D CAD models, but not necessarily working on a single, shared model. The information is exchanged between different parties and is the crucial aspect of this level. The common data format is used to share design information. CAD software that each party used must be capable of exporting to one of the common file formats such as IFC (Industry Foundation Class).

**Level 3**: In this stage, it is expected to use a full collaboration between all disciplines by means of using a single, shared project model which is held in a centralized repository. Moreover, ‘Open BIM’ concept is implemented by giving access to all participants for the same model to modify model and removing the final layer of risk for conflicting information.

Currently, BIM implementation in AEC/FM industry in Norwegian lies between level 1 and level 2 and planning to reach level 3 according to Figure 10. However, some of the big companies lies between Level 2 and Level 3.
Using BIM, one can model 3 dimensional buildings and other structures consisting of objects with all details. The objects are assigned properties and have relationships between themselves.

This means that when an object changes, the program tells how this affects the relationship to other objects. During the design, a data model of the 3D building is prepared, which contains information on, for example, room, area and volume, name, type designations, materials and so on. It is also possible to enter information about doors, windows or fire and sound requirements in BIM. The BIM can be used as a quantity control and gives a clear overview of the items to be ordered in terms of type and quantity (i.e. enhancing the inventory control during the construction project implementation phase).

With the use of BIM, clash and conflicts between, for example, ventilation ducts, building engineering structures and electrical installations are visible and can be corrected during the design phase (i.e. physical arrangement and interaction of different items).

The advantage of this is that the model provides information about errors that would occur during the building itself and which can be rectified before building starts. Builder can save time and money waste by erecting errors at the initial stage instead of at the construction site (i.e. the process becomes leaner minimizing the non-value adding activities). In addition, BIM enables to increase the productivity of construction processes (see Figure 4) over the time.

Once a new technology is implemented in a project, it may cause a temporary loss in efficiency as the project team may not aligned with the overall project scope and project delivers negative performance until it comes up to anticipated delivery speed (see Figure 5).

In the case of implementing a BIM, capital expenses (i.e. CAPEX) are paid back in multiples as it enables significant reduction in time wasted. Moreover, implementation of BIM enables making better use of the transport, water supply systems, communication systems, energy systems, infrastructure, etc., and helps to increase value added activities (and/or further improving them) whilst minimi-
3.2 Synthesis of national legislation about BIM

From 2010 onwards, it is a national requirement to implement BIM in AEC industry/FM industry in Norway. The Norwegian government has established the national requirement of implementing BIM to reduce errors, improve coordination, and increase energy efficiency of its buildings and in general gain efficiencies [7]. The Norwegian Defense Estates Agency and Statsbygg (i.e. Public-Sector Administration Company and the Norwegian government’s key advisor in building projects) have started to implement BIM in all new projects to follow up the government requirement. Moreover, Statsbygg requires IFC-compatible BIM for all new building projects in life cycle of the building and has started several R&D projects that focused on BIM for efficient building, indoor navigation, location-based simulation, and energy calculations [8].

The public sector in Norway have been releasing their BIM standards since 2008. BIM guidelines in Norway are called BIM manual, which are based on the experiences from the different projects. “Statsbygg Building Information Modelling Manual - version 1.2.1” [9] has been released in 2013, which gives generic requirements for Building Information Modelling (BIM) in projects and at facilities. The manual is based on the previous versions 1.0, 1.1 and 1.2 of the manual, experience acquired from actual Statsbygg building projects and R&D projects. Statsbygg has defined the following set of “Basic BIM” requirements that apply to all BIM deliverables, regardless of the BIM objective, phase, discipline, etc. – unless otherwise agreed in the project. One of the basic BIM requirement is delivery of a digital 3D building information model based on object-based design (using objects with properties and relationships) and using open BIM standards/formats. It has also been mentioned in the manual that the BIM authoring tool must efficiently support import and export in the open Industry Foundation Classes (IFC) BIM format where the core model of IFC is an ISO specification – ISO/PAS 16739.

It is important to have a common understanding of construction processes and the information that they use and provide among the different participants in the construction process. To find a solution for this issue, Statsbygg involved in preparation of the Information Delivery Manual (IDM). Currently, ISO 29481-1: Building information modelling – Information delivery manual, Part 1: Methodology and format has been adopted in Norway. In general, IDM identifies discrete processes undertaken within building construction, the information required for their execution and the results of that activity. The components of the IDM can be [10];

- Process maps that discuss the evolution of information for key topics throughout the project lifecycle
- Identification of the requirements of each process map for sharing the information and roles of each personnel in the project
- Requirement of each process for information exchange
- Description of BIM user and the second at the BIM solution provider.
- For the BIM user, information is described in non-technical terms that do not need a knowledge of the IFC schema.
- For BIM solution providers, descriptions break down the IFC schema into reusable “functional parts” (commonly occurring sets of data that may be used by any number of processes).

In addition to that, The Norwegian Home Builder’s Association, which is a non-profit organization, also started the boligBIM project to develop a BIM-manual guideline. In 2011, they released their first BIM manual and the second version of the manual was released in 2012 [10].

The manual summarizes general modelling methodology, independently of the software.

In addition, the manual describes in more depth the four main areas (calculations, roof trusses, energy calculation and ventilation) in the boligBIM Project and documented ‘best practices’ originating from it [11].

“Norwegian IAI Forum is developing the definitions of the requirements on the information exchange under IDM (Information Delivery Manual) (IAI Forum Norway, 2007). The aim of the IDM is to support the information exchange requirements for business processes within the building construction industry. Through IDM, the parts of the IFC model that is necessary for information exchange between identified processes can be specified” [12].

BuildingSMART Norway is a non-governmental organization relied on the memberships from the industry. However, some of the governmental bodies have become members of BuildingSMART and contributing to implement BIM [13]. In addition, BuildingSMART Norway develops and maintains the standards for digitalization of building industry on open formats and has three international standards that describe and support AEC industrial projects [13]. BuildingSMART will work to ensure that the buildingSMART standards become implemented in software and put into use in Norwegian construction industry and in public administration. These are essential for coping with openBIM in practice and are visualized in the openBIM triangle as illustrated in Figure 6 [13].
The buildingSMART vision is to achieve an efficient flow of all building information in the AEC/FM Industry. The open international standards have been developed are as follows based on open BIM triangle:

- **Industry Foundation Classes (IFC):** to define how to share or exchange building information using common data format,
- **International Framework for Dictionaries (IFD):** to define what building information that are being sharing or exchanging and to define terminology.
- **Information Delivery Manual/Model View Definition (IDM/MVD):** to define which building information to share or exchange, when to share and what are the process in business.

Considering the open international standards, the buildingSMART in Norway has released three standards named; buildingSMART Data Model (bs datamodell), buildingSMART Data Dictionary (bS Dataordbok) and buildingSMART process (bs process) as shown in Figure 7 [13].

**BuildingSMART Data Model** is a file format, called industry foundation classes (IFC), which allows the participants in the AEC industry value chain to exchange complex models with each other, regardless of the software used. BuildingSMART Data model, together with buildingSMART Data Dictionary and buildingSMART Process, enables the use of openBIM (Building Information Model). OpenBIM allows all the participants in a project to use and exchange 3D models with essential information, unambiguous descriptions of building objects and support processes such as quality assurance projects.

The member countries of buildingSMART International have their own development teams called Model Support Group (MSG) and implementation groups called ISG (Implement Support Group). These work with the development of buildingSMART Data model and its implementation in software. BuildingSMART Data model is implemented in a wide range of software available in the market. IFC format is based on ISO, ISO 16739 standard. Unique interpretation of features and product specifications is important so that the software automatically understands the content and characteristics of the models being exchanged.

**BuildingSMART Data Dictionary** (previously called IFD Library, the International Framework for Data Dictionaries) provides the basis for common terminology in the use of openBIM, so that all models are interpreted unambiguously by actors and resellers. BuildingSMART Data dictionary automates and streamlines a number of processes such as product search, product specification, merchandising and FDV documentation. The different member country data dictionaries are defined against each other so openBIM information is automatically translated from country to country without errors and data loss. IFD Library Group is responsible for the development of the buildingSMART Data Dictionary. BuildingSMART Data dictionary is based on ISO, ISO 12006-3 standard. About 22% of the AEC/FM (facility management) companies in Norway have used or implemented BIM or IFC enabled BIM [12].
Use of BIM in Norwegian industry

According to the literature, the Norwegian industry can be considered one of the world’s early adopters of BIM. BIM is widely used in the Norwegian construction industry to exchange information using 3D visualization aspect. For example, Norwegian Public Road Authority in Norway (NPRA) (i.e. Staten Vegvesen in Norwegian) has recently implemented BIM at the Bjørnafjorden crossing project based on the experiences from Netherlands [14]. Before implementation of BIM, NPRA used 2D drawings which were not based on object modelling. According to their experiences, BIM model has provided an online environment where contractor and client can view the BIM and visualize desired information of attributes. NPRA has established their Information Management principles such as Information model (decomposition of the structure into manageable elements, define the attributes (e.g. sizes, strength, coating, material etc.) of for each elements or element group based on the information demand, use of common data format i.e. Industrial Foundation Classes to exchange information, use of handbook guidelines when preparing 3D geometry, etc. Figure 8 shows their BIM work flow and Figure 9 shows the 3D model of the bridge. Tekla, Revit, AVENA, ArchiCAD and AutoCAD are some of the software used.

CF Møller’s is part of the Danish Architecture Company which is located in Norway. The company implemented BIM for two projects. One of the project was “A-Hus” hospital in Norway, Oslo [15]. According to the literature, currently, the company has implemented BIM completely for many projects and they are replacing the use of AutoCAD, to Revit. Many architects in the company are using Revit for their mass modelling (creating models with less constrains and be able to form advanced shapes), and this is something firms are usually afraid of, because Revit is more advanced in use, compared to a software like Rhino. They also use Revit Vasari is a type of ”Revit light” for making masses. Furthermore, with implementation of BIM, the company expects to improve the productivity by aiming for one less person per project, for every 5th person. (5 persons without BIM at a project = 4 persons with BIM) [15]. The company has carried out lectures about Revit and BIM, at a daily basis for the employees. So, the employers can take courses during the working hours, while still getting paid. They even have workshops every 3rd week, during the whole year that is mandatory.

BIM has been implemented for the project of Østfold Hospital, Sarpsborg, around 100km south-east of Oslo [13]. The South-Eastern Norway Regional Health Authority is the client and they have used an open BIM strategy to reduce time and cost. During design phase, the BIM has been used to simulate life-cycle costs, energy consumption and carbon footprint; it will also form an essential part of operation and FM. In addition, a decision was also taken to adopt an open BIM strategy in the project, in the belief that it would improve quality and efficiency. In the tendering process for the engineering design, open BIM was made a requirement.

Østensjøveien 27 is a six-storey office building with strong environmental credentials from property developer and Construction Company called NCC. The company uses ‘virtual design and construction’ (VDC) for numerous functions, including acoustic simulation – which, in this project, revealed that the noise from the open-plan ground-floor canteen might prove a nuisance. The answer was to insert a mezzanine area of office space immediately above the canteen to dampen the sound. Oslo city council has recognized the project as a low impact ‘Future-Built’ project.

Skanska is a multinational construction and development company based in Sweden, which involves significant construction projects in Norway. According to the Construction Global magazine, Skanska is one of the largest construction companies in the world. The company has implemented BIM on many types of projects including buildings, roads, bridges, tunnels and industrial plants. Hence, the company improved their communication amongst project stakeholders, enhanced
3. STATE OF THE ART OF BIM IN NORWAY

In this project, all designers were asked to use 3-D models to design and coordinate their models to make this a BIM project. The shopping center and residential blocks have been modeled by two architects. Altogether, seven different design firms featured modeling on this project. As production started, members of the project team used the models for quantity take-off to order materials for production on a day-to-day basis. In addition to that, the models were used to create excavation plans in 3-D for import to the excavation contractor’s machine guidance system. This pioneering use of BIM models saved several weeks of work due to traditional 2-D project by 3 dimensional technologies.

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Skanska Norway has also integrated 4D and the latest planning system. The meaning of 4D is adding the dimension of time to the 3D model by linking project efficiencies, had greater certainty for both schedule and cost conformance and the reduction of risk. In Norway, Skanska operations have four focus areas: construction, planning, property development and consultant. Skanska Norway has implemented BIM for the KBS shopping center in Trondheim [16] which has residential apartment blocks on top of the shopping mall. The BIM implementation helped to replace traditional 2-D project by 3 dimensional technologies.

This project was established as a BIM project and the ambition level was initially set to collision control and quantity take-off. The participants of the project team were keen for the adoption of BIM. Therefore, the ambition level has been expanded to include visualization both to aid decision making from the client and to sell both retail and residential spaces. Skanska organized workshops for the designers from all disciplines [16]. The workshops helped to agree on the routines and methods for modeling, model requirements, file exchange, delivery dates and collaboration. In addition, the workshop was carried out to check for correct coordination of each discipline’s model within the merged multidiscipline model. During this project, the BIM coordinator has given very good support to Skansa Norway for ensuring that all designers on the project are taken care of on all technical levels. They have also cut down the unnecessary delay in the process due to software challenges by using the software competence in the BIM department.

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3. STATE OF THE ART OF BIM IN NORWAY

BIM related teaching in Norwegian educational institutes

Norwegian education systems are shown in Figure 10 [21]. Basically, it consists of four levels, kindergarten, primary and lower secondary education, upper secondary education and tertiary education. It is obligatory to complete compulsory education which is from kindergarten level to the end of primary and lower secondary education. In addition, once the upper secondary education is completed, they can either meet the admission requirements for university/university College (høyskole), or result in tertiary vocational education or folk high schools. The tertiary vocational education is a short vocational alternative to higher education. It is regulated by national legislation [21]. Currently, BIM related teaching is carried out at the university level (bachelor/master and a few PhD projects), folk high schools, vocational educational institutes (i.e. fagskole in Norwegian) as marked in red box in Figure 10.

Some of the universities in Norway conduct BIM courses and several university colleges have special BIM studies. For example, NTNU (Norwegian University of Science and Technology) and Gjøvik University College offer one year course in BIM (Intelligent Modelling) [23]. In addition to that, the university colleges in Norway, BIM is taught as a part of the course for civil engineering students. There is no central government requirement for BIM education at a tertiary level until 2015. A few engaged teachers are driving BIM education in colleges and universities [24].
Although, it is a national requirement to use BIM in construction industry in Norway, teaching and providing the training to students at the university level seems to be at an immature stage. For example, in University of Stavanger, civil engineering students learn basics of BIM using software (i.e. solibri, Revit, Novapoint). Moreover, during bachelor and master thesis period, some students study how industry uses BIM in their projects and recent development in the BIM. Therefore, it is essential to collaborate with industry to understand recent developments in BIM.

Vocational education is one of the option in Norwegian education system that offers courses for the students who are not interested to do formal university education or not completed. In this report, the vocational education institutes that offer technical course are discussed. As of today, three of the vocational schools in Eastern Norway - Fagskolen Oslo Akershus (FOA), Tinius Olsen Academy of Fine Arts and Fagskolen in Østfold - offer openBIM education and key tools. For example, Fagskolen Oslo Akershus offers BIM technician recess construction (BIM-K) and BIM technician recess Installation (BIM) for one-year study in the fields of construction and electrical engineering, now total 40 students. However, this is not near enough to meet the demand in the industry. A BIM technician has work assignments in the areas of 3D modelling of building construction, installation and quality assurance of digital building / installation models for the consultant, contractor, architectural and engineering industry. The other technical schools, which offer the courses, are given in Table 1.

### Table 1: Tertiary vocational education in Norway

<table>
<thead>
<tr>
<th>Vocational education</th>
<th>Type of courses</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fagskolen Oslo Akershus (FOA)</td>
<td>BIM technician course (construction/installations) Software training: ArchiCAD, Revit, AutoCAD Solibri, SketchUp, Autocad, Excel, Magicad, DDS</td>
<td>One year</td>
</tr>
<tr>
<td>Fagskolen i Østfold (ØF)</td>
<td>BIM-tekniker, konstruksjon Software training: ArchiCAD, Revit, Solibri</td>
<td>Two years</td>
</tr>
<tr>
<td>Fagskolen i Tinius Olsen (FTO)</td>
<td>BIM construction Software training: ArchiCAD, Revit, Solibri</td>
<td>One year</td>
</tr>
<tr>
<td>Fagskolen Innlandet</td>
<td>Software training: ArchiCAD, Revit, Solibri</td>
<td>One year</td>
</tr>
</tbody>
</table>

The vocational schools offer today the most comprehensive BIM education in Norway. Several of Norway’s colleges also teach some degree in BIM, but the methodology is less clear and, more or less, sporadically spread to other subjects. At three vocational schools, FOA, FTO and ØF, there are BIM technician lines that are driven by the principles of openBIM [13].
Curricula and certificates ensure minimum competence for participation in a project. Courses and certificates do not replace practical experience, but ensure that the certified person has the competence not to act inappropriately and generally knows its role in interaction with other subjects about BIM. Certificate is in line with practical experience assessed in connection with job application and contracting of services.

**Student seminar**

Student seminars are organized by buildingSMART Norway to share the new knowledge about openBIM among member companies and students [13]. The whole-day seminar provides students with a basic understanding of openBIM and buildingSMART. Last year students and students who work with BIM related tasks are given priority. It motivates students to include openBIM / buildingSMART in solving professional issues in their subject. The seminar is free for students - all costs are covered by buildingSMART Norway. Members of buildingSMART Norway also give presentations to the participants.

**BIM training in industry**

There are various companies in private sector which offer BIM course/training at different prices. Sweco is Europe’s leading consulting engineering company. The company offers BIM courses (i.e. BIM methods and tools) which are tailored to suit the prior knowledge and everyday working requirements of course participants [26]. These courses can provide organizations or projects with the extra “lift” that might be required for embarking efficiently on new working processes and using new technology. Sweco offers general BIM courses, courses on buildingSMART certification and courses on current BIM software such as Solibri, Revit, Archicad, Novapoint and Infraworks. Their BIM experts possess considerable expertise on teaching and holding BIM courses for companies, project organizations and educational institutions.

Graphisoft Norway is company which offers a range of services that can simplify and streamline the design. It also offers BIM courses and software training course (ArchicAD, Solibri, etc.). The courses are practical and will provide the necessary foundation needed to initiate and implement a BIM project, in an efficient and good way. The following is an example of the course content of openBIM course which is proposed by Graphisoft Norway [26]. These courses are accepted by building SMART Norway. The target group for the following course are architects, designers, contractors and others involved in BIM projects, either in their own subjects or interdisciplinary. The course can also be a supplement to those who wish to have a future role as BIM coordinator in interdisciplinary environment. The objective of the course; the participant should be able to use BIM as a practical and active tool in large and small projects. Be confident of

![Figure 18: Overview of the Training curricula and certification](image)
3. STATE OF THE ART OF BIM IN NORWAY

3.7 BIM related research in Norway

Many companies in AEC industry have replaced two-dimensional computer aided design tools by three-dimensional technologies to implement BIM. Therefore, adoption and use of BIM in AEC industry and the diffusion of BIM into organizations and challenges are some of the research topics currently in literature. In Norway, SINTEF is the leading organization conducting research in BIM and it is also working on several internal and cross-department projects under buildingSMART initiative besides developing BIM Guidelines. Currently, SINTEF has a research project (i.e. SamBIM) which aims to develop and establish processes and interaction models supported by BIM to increase value creation in construction projects, construction industry and own companies [27]. SamBIM research focuses in particular on the interface between programming, design and the production phase. This research project also focuses on [27];

- Identification of barriers and drivers for collaboration/integrated concurrent engineering in the design phase of a construction project and challenges/opportunities for mutual adaption of technology.
- Opportunities and challenges of lean construction tools such as integrated concurrent engineering, co-location of the design team, use of a so-called planning matrix and items. The aim of this research is for collaboration with Lean construction Norway network to disseminate the knowledge.
- Development of a common process model for building process from cradle to grave.

For this project, Skanska (Project Owner), State Building, LINK Architecture and Multiconsult have participated as partners from the industry. Fafo, NTNU and SINTEF Byggforsk have participated as research and development partners. SamBIM is based on follow-up research in five construction projects as shown in Table 2.

<table>
<thead>
<tr>
<th>Case</th>
<th>Rolaks</th>
<th>Forneit</th>
<th>Dalsmenneske</th>
<th>Urbygningen</th>
<th>Eliefford</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>Road authority building (refurbishment)</td>
<td>School building (new)</td>
<td>Public library (new)</td>
<td>University building (refurbishment)</td>
<td>School building (new)</td>
</tr>
<tr>
<td>Project delivery</td>
<td>D-B</td>
<td>PPP</td>
<td>D-B-B</td>
<td>D-B</td>
<td>D-B with owner participation</td>
</tr>
<tr>
<td>SamBIM actor involved</td>
<td>Statsbygg</td>
<td>Skanska &amp; LINK arkitekter</td>
<td>Multiconsult</td>
<td>Statsbygg &amp; Skanska</td>
<td>Skanska</td>
</tr>
<tr>
<td>SamBIM focus/initiative</td>
<td>BIM, ICE</td>
<td>BIM, PPP</td>
<td>BIM, process model</td>
<td>BIM, ICE, Lean, “BIM krenka” (on-site)</td>
<td>Procurement, BIM, collab. model, lean, big-room</td>
</tr>
</tbody>
</table>

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In addition to that, researches have been carried out for identification of inter-organizational factors driving the diffusion of BIM technology at the project level. Merschbrock and Munkvold [28] has identified the diffusion factors include the establishment of BIM ‘change agents’, putting in place a cloud computing infrastructure, appointing software, developers, establishing solid BIM contracts, a systematic approach to information system learning, and the establishment of new roles and responsibilities. They have also studied the individual, managerial, envi-
3. STATE OF THE ART OF BIM IN NORWAY

Environmental, and technological challenges typically experienced by construction firms in BIM diffusion using case studies from healthcare construction projects. Båthen and Moun [29] have proposed a theoretical framework to examine the significant factors for successful BIM implementation at project level in the AEC industry. They have also discussed challenges faced while implementing BIM and lean construction work principles (co-location, big room-organizations, integrated concurrent engineering) in the design phase of medium sized project using a real-life project from Statsbygg in Norway. It has been also found that successfulness of the BIM implementation highly depends upon a participative and co-operative process.

Under Norwegian University of Science and Technology (NTNU), several student projects and thesis proposals are focused on buildingSMART technology and are being conducted in collaboration with industry and research organizations to develop student courses. In addition to that, some of bachelor and master projects in other universities are carried out by collaborating with industry as well.

In private sector Selvaag-Bluethink has involved in developing BIM and ICT solutions. Erabuild has carried out research focusing on sustainable tools to improve construction and operation of buildings. Erabuild includes funding organizations from Austria, Denmark, Finland, France, Germany, the Netherlands, Sweden, Norway and the United Kingdom. The Norwegian Research Council is the funding for Erabuild’s research. The research areas focuses on identification of obstacles for integrated BIM and the possible means to overcome the problems, obstacles and shortcomings in the current technology and business processes, which have delayed the adoption of IFC compliant, integrated BIM.
STATE OF THE ART OF BIM IN ITALY
Focus on national situations

The initially “silent” revolution brought about by Building Information Modeling in the construction industry tremendously speeded up in the last few years, thanks to the efforts of several countries that have already seen the great economic potential. Since 2014, when the EUPPD was approved, the digitisation of building construction processes became one of the most important goals for European countries, in order to make the works more effective and efficient.

Rules applicable to communication

“For public works contracts and design contests, Member States may require the use of specific electronic tools, such as of building information electronic modeling tools or similar. In such cases the contracting authorities shall offer alternative means of access, as provided for in paragraph 5, until such time as those tools become generally available within the meaning of the second sentence of the first subparagraph of paragraph 1.”

Cited by 2014/24/CE Euppd - European Union Public Procurement directive

The citation of the EUPPD, in the English version, clearly addresses to the adoption of BIM electronic tools while in the Italian translation the reference is not so outspoken. Anyway, Italy is still far away from the most advanced results reached in the field, even if it was involved in the major international discussion forums on standardization and regulation on the topic. Actually, our country is now struggling to meet the expectations on time, due to the need for a reviewing process of actual methodologies. Indeed, the heterogeneous heritage of a very long history requires the need for the integration of technologies able to deal with existing buildings and not only with the new ones: a situation that doesn’t really differ from other countries like France, Germany or Spain.

For these reasons, in order to match these requirements, Italy began a discussion process in order to find out the best solution. Thus, in parallel with the definition of national laws and regulations, several public authorities, ministries and NGO associations started different projects in order to make professionals more aware of changes that they will face in the next few years. First of all, the BSI - BuildingSMART Italian chapter, hosted by the ABC Department of the Polytechnic of Milan, was significantly involved in the dissemination of the most advanced digital solution for construction industry and it is one of the most important association for the Italian BIM sector. Furthermore, the consortium established by the INNOvance project can be also considered one of the main players in this process. Funded by the Ministry of Economic Development and the National Association of Builders, the project already set up a standard for:

- a common coding system for products, services, activities and resources in the construction industry;
- a standard technical sheet;
- a web portal to access all coded information for each phase of the building process.

This chapter will present the state of the art of Italian laws, still under development to meet the European requests, as well as the construction industry background in terms of existing assets and technological capabilities.

Synthesis of national legislation about BIM

Starting from such background, the first legislative steps of our country were performed by:

- Law (Legge delega) n.11 of 28 January 2016, in order to implement the EUPPD;
- Legislative Decree (Decreto Legislativo) 18 April 2016, n.50, in order to modify the Public Procurement Code (Codice dei Contratti Pubblici - D.lgs. 163/2006) and its implementing regulation (d.P.R. 207/2010);
- A web portal to access all coded information for each phase of the building process.

These Europe-based ordinances are the basis of a broader strategy for renewal of regulatory processes through the use of IT tools. For the first time, the need to introduce into national laws the use of “specific electronic instruments such as information modelling tools for building and infrastructure” appears. Nevertheless, the real potentialities of BIM’s philosophy become true only when the entire construction industry is involved, a goal that requires further regulatory changes at a local level.

National laws

On one side, the Law (Legge delega) no. 11/2016 took almost all the two years set by the European legislator for the implementation of the public procurement directive. However, this becomes an occasion for a complete rethinking of the public procurement system in Italy, combining flexibility and rigor with the aim of simplifying and accelerating procedures, safeguarding the values of transparency,
prevention of corruption and the infiltration of organized crime, environmental and social protection.

Formally, the law requires the adoption of a single regulatory text by reorganizing the regulatory framework and drastically reducing and rationalizing the whole set of provisions, in order to reach a better level of legal certainty and simplification of procedures.

Thus, the law mandates the government to transpose the directives operating some exemptions and introducing some more rigorous management principles, and the flexible regulatory instruments introduced by the directive.

These efforts led to the New Public Procurement Code (Legislative Decree no. 50/2016). The Code governs nationally the public contracting for the acquisition of services, supplies and works, as well as public design contests. The update proposed by the Code aims to stimulate and reward the use of electronic methods and tools in all phases, from design to construction, requiring involved parties to collaborate by introducing the BIM. In the same Code, a significant chapter focuses on tools requirements, asking for interoperable platforms, as well as open standards and file formats.

The new Code of Conduct still does not foresee an obligation, but pushes the progressive introduction of BIM’s mandatory and electronic modelling tools for building and infrastructure, which will become compulsory.

**National standards**

In order to go more in details and ensure a real applicability of BIM tools to the Italian building process, the Italian Organization for Standardization (UNI) is going to release a new complete standard set called UNI 11377 “Digital Management of Building Information Processes”.

The UNI 11337 standard deals with the digital management of building information processes and specifically deals with the evolution and development of information models, elaborations, objects and information flows for digitized products and processes. The standard is split into 5 parts:

- **Part 1:** Models, Processes and Information Items for Products and Processes;
- **Part 2:** Designation and classification criteria for models, products and processes;
- **Part 3:** Digital Product and Process Information Databases;
- **Part 4:** Evolution and information development of models, elaborations and objects;
- **Part 5:** Information flows in digitized processes.

The new parts 1, 4, and 5, published on January 26, 2017, replacing the first part of the previous UNI 11337: 2009 standard, are the cornerstone of the Italian legislation on BIM and specifically address the following issues:

- UNI 11337-1: 2017 “Models, Processes and Product Information Processes” focuses on the digital management of the information process in the construction sector, such as the information technology structure and the process and product information structure.
- UNI 11337-4: 2017 “Evolving and Developing Information on Models, Objects and Objects” concerns the qualitative and quantitative aspects of digitized management of the information process to support decision-making with the aim of specifying the objectives of each of the phases of a process (numbered 0 to 7) introduced in UNI 11337-1. The model, the objects and the elaborated information are instrumental in defining a common level of information development level of model objects, and of a common scale of processing and approving information content.

The Working committee has simultaneously approved the insertion of new parts (6, 7 and 8), addressed to the information specification, to the figures of the industry and to the information flows, and intended to further deepen the subject in all its implications.

Particularly significant is the work that will be part of the planned part 7 on the professional figures involved in the BIM model, including the BIM Manager, the BIM Coordinator and the Information Modeler (BIM Modeler). The underlying processes of Building Information Modelling are located between the building industry and the IT sector, as automated information management. Figures for managing and coordinating information processes must be in possession of necessarily multidisciplinary requirements, on whose training Europe is developing paths and plans only in recent years.

With this standard, Italy aims to propose, for such professionalism, requirements and characteristics that can guide the market to the search for figures that are suitable to accompany it in the digital transition.


As for Part 3, published earlier in 2015 under UNI/TS 11337-3: 2015 “Models for the collection, organization and storage of technical information for construction products”, it is expected to be revised. It is a Technical Specification, with a guide and address, with the purpose of indicating a structured operating model for collecting and storing data and technical information on construction products. We
are talking about products and aggregates of several products, not just geometric information, whose coding should be the subject of part 2, still under development, to which the UNI / CT 033 / GL 05 group works with the trade associations and the public administration. In particular, for any construction product there is a qualitative and quantitative description, with reference to its typological, technological, performance and commercial characteristics. The model can be used by various categories of construction, construction and plant operators, together with the guide model for proper installation, installation, maintenance, transportation, handling and disposal of the product.

Data about building and construction sector
Since 2015, the Italian economy has started to grow again after the crisis that deeply affected the world economy during the last 10 years. Looking at the research carried out by the Italian survey institute (ISTAT), we can already see a significant improvement between +1.2% and 1.6% of the GDP. Nevertheless, the construction industry is improving its performance if compared with the past few years, but anyway it shows an important reduction in terms of investments into new buildings.

Furthermore, it clearly emerges how the economic cycle of the construction industry could affect the employment scenario. It was proved that a 1 billion Euro investment in construction can boost the employment with 17,000 new job positions, 11,000 directly involved in the building sector and 6,000 of linked activities. Thus, a consistent strategy addressed to the innovation of the building process can allow and promote new investments, helping the economic recovery.

Italian construction industry analysis
The slowdown in investment in construction began in 2007 and was later identified as one of the signs of the economic and financial downturn that, one year later, would have disrupted the global market. The value added of the Construction sector in 2012 has dropped to the levels of the beginning of the last decade, losing almost entirely the increments produced since then.

In just seven years, from 2008 to 2015, the sector would have lost -35% of its investment reaching the levels of the first half of the 1970s, despite the slow down in the last two years.

The fall in investments in the construction sector was mitigated in 2015 by the extension of tax incentives for building renovation and energy efficiency (as provided for by the Stability Law for 2015) until December. Likewise, some measures affect public works, which, although they did not reverse the negative sign of the market, have mitigated the downturn.

The “new housing” sector recorded the largest loss, down from a drop of 80% since 2005. Only in the last year can be recorded a contraction of -6% compared to the previous one, measured on the number of permits to build; these are the historical levels since 1936 (excluding the period of World War II). The data not only highlights the strong incidence of the crisis in this sector, but also outlines an important trend reversal of the market.

“Extraordinary maintenance” and housing upgrading, which amounted to 36.3% of the value of investment in construction in 2015, represent the only sector that continues to show a hold on production levels. Despite the slowdown in investment growth in the 2011-2012 business year, there has never been a decrease, compared to 2014, a further increase of almost 1%.

At the same time, the residential real estate market has shown elements of critical importance over the years as it can be seen from Figure B below. Housing sales declined: between 2007 and 2013 the number of homes sold was more than halved (-53.6%). The volume of bargaining, according to the Territorial Agency, was 50% less than in 2004 at the end of 2012.

The resumption of sales volume, which has been in place since 2014, saw a consolidation in 2015 and a significant 10.8% increase over the previous year, still below the values recorded in the late 1980s. According to Ance data, there are about 440,000 homes sold in the last year and the number is expected to increase in 2016. The positive trend involves both the capital and the non-capital cities, and disaggregating data at the geographic area level. As home sales are growing across the country. North Italy continues to be the largest growth area (+13%), followed by the Center in line with national rates (+10.7%) and South Queens (+7%). North and South are likewise aligned between the city and the rest of the territory, in favour of the former, while in the Center the most significant figure is found in non-capital cities (+12.4%).

However, the data should be read without neglecting some interpretive keys:
- for home use, it is necessary to take into account that the needs at the base of the purchase will sooner or later make the sale of the sale;
- it is shown that, in the light of a picture of greater confidence in households, the re-established viability of the credit channel is one of the main driving forces behind the re-establishment of the real estate market;
- interest rates have further decreased and banks’ credit has increased, albeit retaining a more selective nature than existing practices before the 2008-2009 crisis;
- the fall in house nominal prices in 2014 has led to increased purchasing preference.

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6 AA.VV., Osservatorio Conjunturale sull’Industria delle Costruzioni in Italia, ANCE, 2015
The existing building stock and the need for renewal
Retraining interventions are not only a driving force for the exit of the building sector from the economic crisis, but increasingly becoming a pressing need. According to Ispra data, Italian soil cementing in the last five years stood at a rate of 8mq/second, with an occupation of 7% of the entire territory in 2014, an increase of 4.5 percentage points compared to in the 1950s: a worrying fact seen in the projection but above all unsustainable when faced with market absorption capacity. In absolute terms, soil consumption can be considered as 21,000 square miles of our territory.

Over the last few years, along with the economic crisis, a slowdown in the rate of growth of this parameter has been registered, but due to the simultaneous contraction of market absorption capacity, such an extension would require about 130 thousand unsold housing, putting in account those finished, and those on sale ‘on paper’ according to the Real Estate Scenarios survey conducted for the weekly “Edilizia e Territorio”. A very varied picture emerges in the Regions and the four major cities (Rome, Milan, Turin, Bologna), but with a total value of one fifth of residential sales registered in 2011.

If the unsold property is constantly growing, in parallel, existing assets are subject to an increasing obsolescence. More than 70% of residential buildings on the ground are built before the 1970s and are inadequate to meet current needs and standards. One quarter of the entire residential estate is made up of buildings built before 1946; in particular, 1,832,504 buildings, or 15% of the total, were built before 1919; of these, 4.1% are in a bad state of conservation. The North West (over 21%) and the Center of the Country (18.5%) prevail in terms of the amount of dated buildings, while the South and Islands have the highest percentages of buildings in a bad state of conservation.

As noted in the 6th Annual Report on Security in Italy (2009), developed by Cnipa and Censis, energy waste in the residential sector alone amounts to over 8 billion euros. In particular, the Enea notes, the energy consumed in residential buildings for heating environments and hot water represents about 25% of national energy consumption and produces about 25% of national carbon dioxide emissions. The result is that the energy used in a season to heat at 20°C and condition the ground are built before the 1970s and are inadequate to meet current needs and standards.

The reclamation process is characterized by the use of materials and components in BIM involving the integration of the built with innovative low environmental impact mobility systems or intelligent collection of waste characterizing the intelligent urban scale impact. The promotion of a new model of living also involves the integration of the built with innovative low environmental impact characteristics to ensure transparency, cost and performance level, of intervention. In addition, despite the upgrading process being characterized by a growing use of innovative dry technology and composite materials, the market is not fully exploiting the potential of these technologies to operate in accordance with transparency and cost optimization criteria. This limitation is also due to the lack of a system available to process actors, enabling the transparent management of the retraining process.

In addition to process transparency and facilitation of access to market rules, the implementation of digital communication technologies in the construction sector would contribute to achieving a greater level of participation and social inclusion, necessary for cultural growth by the citizen, which can gain a greater degree of awareness and conscience. To this end, the transparency of existing information is, in terms of accessibility, usability and usability of data, an important lever for the relaunch of business in the sector.

Regeneration intervention should not only be considered as its spatial transformation, but it is necessary to consider the potential of triggering virtuous behaviour logic with urban scale impact. The promotion of a new model of living also involves the integration of the built with innovative low environmental impact mobility systems or intelligent collection of waste characterizing the intelligent city, as well as finding technical solutions, to systems belonging to the industry of the ICT, aimed at the goals of greater security and accessibility to facilitate different user groups.

Data about employment opportunities in relation to professional competences in BIM
Referring to Anfayo’s survey on economic BIM value in Italy, we can state that its approximately 1bln euros in 2015, among public procurements and big projects, carried out by relevant national enterprises. Furthermore, we have to underline that collected data only refers to projects where guidelines or bid documentations explicitly cite BIM procedures. That means the number could be

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\[\text{4. STATE OF THE ART OF BIM IN ITALY} \]
even higher considering design phases where BIM models were produced even without an explicit request by the owner.

In this restricted framework, 450 procurements have been analysed and either buildings and infrastructures are considered. The average project amount is 76mln euros with peaks of 120mln or more for healthcare buildings. Even if the BIM procedure is still new for the Italian construction industries, the first results already show clear economic benefits proportionally with the size and the value of the building. Less encouraging is the geographic distribution of the data, since 80% of the experiences have been carried out in the northern Italy, while in the southern part are completely unexploited, as shown by the picture. Anyway, due to this analysis and accordingly with the brand new Italian legislation, we can expect an impressive growth in the next few years.

The project use analysis shows that 60% of the total relates to public utilities; 35% of them are healthcare services and, with scaled percentages, public buildings and infrastructure. The remaining 40% refers to private use destinations such as offices, residences and the tertiary sector in general.

If we analyse the economic aspect of the projects, the numbers change sensibly in favour of healthcare buildings that occupies almost 50% of the total, followed by 35% office space and later from exhibition spaces, residences, schools and tertiary buildings.

Furthermore, it is important to note that 66% of the projects of this analysis concern new buildings, 19% for construction works and 15% for mixed construction (new constructions and interventions on the existing ones). In many situations, there was a clear division between the demolition and construction phase, which has relegated BIM only to construction. The lots in which only the demolition was contracted, has been excluded from the count as not significant. Demolition cost estimates and a series of graphical references to validate project leaks using multidisciplinary integrated models have been requested in both the built and mixed works.
Focus on BIM-related training

In this chapter, we focus in particular on Italian education and training system related to BIM. For this reason, we have a short summary of the national education system and vocational training system.

The first compulsory cycle of schooling takes place over an 8-year period and includes primary school (5 years) and secondary school (3 years), finishing with a final examination.

Pupils can then choose:

- To continue their studies in the upper secondary school for 5 years ending with the final examination enabling pupils to enter higher education.
- To enrol for vocational training under the aegis of the regions for 3 years in order to prepare a vocational qualification. This enables them to start working or to go to upper secondary school to continue their studies or specialise in a post-qualification course. This specialisation gives students the possibility to join the IFTS (non-university higher technical training) and the ITS (Istituti tecnici superiori).
- To enrol in vocational training which alternates between work experience and the classroom and allows young people to acquire basic knowledge plus skills they will be able to put into practice on the job market.

Horizontal mobility in both directions is possible between the mainstream education system and vocational training.

Vocational training centres have been set up in the regions where schools, universities, enterprises and research teams collaborate on the same theme. Higher technician diplomas can be awarded after 4 to 6 semesters of courses according to the speciality studied in the higher technical institutes (ITS - Istituti tecnici superiori). Higher vocational training leading to a diploma (2 semesters) is offered by the regions in relation to local and regional requirements in the frame of the IFTS (Istruzione Formazione tecnica superiore). Universities carry out the traditional general tertiary education but, even more often, propose vocational diplomas in the field of health, paramedical sciences and the arts, over a variable duration, and also profession-oriented Master’s degrees.

In this framework, we’ll focus on how BIM training is performed in Italy. It mandatory to underline, once again, how the BIM topics is still new on our country and, for this reason, the training system on the same topic is still underdeveloped as well.

Background overview of BIM-related training in the Country

Even if the BIM training topic is quite a new challenge in Italy, we can easily find that the development of the first training programmes date back more than 15 years ago. At University level, due to the exploitation of research results into courses, departments of Architecture and Civil Engineering introduced the teaching of BIM techniques several years ago. One among others, the Department of Architecture of the University of Ferrara started teaching BIM software and methodologies within the course of Representation Techniques in the 2000.

Nowadays, even if the BIM-related teaching system is not yet consistently structured, several experiences can be identified at different levels.

Secondary education

National programmes for secondary education and regional programmes for
vocational training do not yet consider the BIM teaching. Nevertheless, several experiences have been carried out in the last few years even if collecting structured data on the topic seems to be not feasible. Since such experiences are more often up to a single teacher rather than to school guideline, they can be easily limited in time.

Thanks to data collected on the skills of first-year students at Department of Architecture of the University of Ferrara, it’s possible to notice a growing number of student that have already experienced the use of BIM software during their high school education. Even if the skills are more focused on the software usage rather than on the methodological approach, data are encouraging.

Students already knowing BIM software are from two different schools.
- Vocational school for surveyors (building technicians) – from low to high skills in BIM authoring (architecture) in one or more software; Frequency: frequently.
- Scientific high school – from low to medium skills in BIM authoring (architecture) in one software; Frequency: from rarely to quite frequently.

Tertiary education

Higher vocational schools in the field of building technologies are probably more focused on the exploitation of BIM teaching due to a deeper connection with market opportunities. BIM skills, as showed in the previous chapter, are more and more appreciated and requested by the construction industry. Higher vocational schools have to teach to young professionals, more addressed to the practical use of BIM rather than the methodological approach. As well, it’s easy to expect that professionals from higher vocational schools will have the BIM specialist’s skills. For this reason, a common definition at regional level is really needed and higher vocational schools have to constantly develop and upgrade their programmes looking at either the national construction sector and most advanced international experiences.

On the University side, we can easily state that we have the most widespread training in the BIM field. Indeed, almost every Department in Architecture or Civil Engineering already have at least a course where BIM methodology is introduced. Moreover, a lot of them go deeper in details bringing into courses remarkable results of recent research. Furthermore, due to the Italian architectural heritage, some departments are also trying to integrate into the teaching new approaches on how to use BIM for existing buildings and the built environment.

Up to the bachelor and master degrees the BIM related training is often related only to the drawing tradition, exploiting only a little of the BIM benefits along the entire building life cycle. The architectural authoring is still the most recognised BIM usage, while a most advanced exploitation of data on buildings is yet to come. We would like to say that, up to this education level, the system is still fragmented and need for a better integration.

Instead, the situation in the post-graduate education is significantly different. It could be not surprising the necessity for a top-down approach. Indeed, since the BIM revolution is a methodological approach even with consistent practical changes, the Italian construction sector needs to redefine the requirements for new job positions. In this framework, the early development of more structured post-graduate education system seems to be more natural as well as necessary.

In the last few years, indeed, different post-graduate masters have been established, each one with its specific focus. Anyway, every programme is methodologically structured to cover the whole building life cycle as well as BIM data authoring, processing and checking. Furthermore, since the post-graduate education is addressed even to professionals who have already experienced the construction industry and aim at managing the building process in a better way, high attention is reserved for the teaching of management techniques. Post-graduate master courses can be divided into two different level, as following.
- 1° level master: it can be developed by Universities or private bodies; bachelor degree is an enrolment requirement; it is equivalent to a master degree.
- 2° level master: it can be developed only by Universities; master degree is an enrolment requirement; it has no equivalency to international qualification.

The charts below summarize the available 2° level Master courses, developed by Universities and addressed to the training of the highest competencies in the field of BIM for our country.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Topic / Title</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Politecnico di Milano Scuola Master Fratelli Pesenti</td>
<td>BIM manager</td>
<td>1 year</td>
</tr>
<tr>
<td>Università degli Studi di Brescia</td>
<td>BIM-Based Construction Project Management</td>
<td>1 year</td>
</tr>
<tr>
<td>Università di Roma - La Sapienza</td>
<td>B.I.M. Building Information Modeling</td>
<td>1 year</td>
</tr>
<tr>
<td>Università degli Studi di Ferrara</td>
<td>eBIM: existing Building Information Modeling for the project management on the built environment</td>
<td>1 year</td>
</tr>
<tr>
<td>Università di Pisa</td>
<td>Master B.I.M. (Building Information Modeling)</td>
<td>1 year</td>
</tr>
</tbody>
</table>

Others public and private bodies and organizations dealing with BIM training

Since the implementation of BIM technologies and methodologies became a highly-discussed issue among professionals of the construction sector, several dif-
different training have been developed in the last few years by private bodies with quite good successful results. The lack of training in the past decade, indeed, has left the majority of professionals that are operating in the sector, without any competencies.

Furthermore, every professional association recently introduced a mandatory “continuous training”. This means that every professional who needs to be enrolled into an association to provide his services to the public has to apply to different courses during time and improve his competencies. Even if some courses are directly developed by professional association, most of the times private bodies arrange such courses looking for an accreditation.

Due to this framework, listing each single training agency seems impossible because, looking at the BIM topic, several bodies have rearranged themselves in order to offer better courses, from training agency with no previous experience on BIM to BIM consultants or vendors with no previous experience on training. This variety of situations asked for a deep quality control by professional association, who need to verify in details the expertise and skills of the promoting agency in order to ensure a qualitative training for its associates. Actually, the professional association more involved into BIM training are architects, engineers and surveyors. Existing professional qualifications regarding BIM in the Country

As cited in the previous chapter on the development of National standards, since now there is no official definition of professional qualification by law. The release of the UNI 11337-7 will be particularly significant, because it will define the professional figures involved in the BIM process, including the BIM Manager, the BIM Coordinator and the BIM Modeller/specialist.

Anyway, the commonly recognized figures are expected to be defined and implemented to be compliant with Italian requirements by law and market. Waiting for the national standards, Italian professionals can voluntarily apply to private body’s certification. For instance, the ICMQ certification agency, based in Milan, already offers a procedure to certify competencies in the BIM process. The certification has been developed in collaboration with the Italian chapter of Building Smart, referring as much as possible to laws and standards already published. In the ICMQ schema, the following three professional qualification are recognized.

**BIM SPECIALIST**: is able to use the software for the realization of a BIM project according to its disciplinary competence (architectural, structural, plant and environmental) and to understand and use the technical and operational documentation for the production of the works and of the models (standards and procedures).

**BIM COORDINATOR**: is able to manage and coordinate multidisciplinary BIM projects according to the resources, standards and business procedures and use the software tools needed to coordinate the BIM project’s drafting, control and management activities. He also knows how to use software for editing BIM models for one or more disciplines. It is able to understand, use, and update the technical and operational documentation of the work order and template production (standard and procedures).

**BIM MANAGER**: is able to manage and coordinate multidisciplinary BIM projects according to the resources, standards and business processes. He is responsible for managing and coordinating information for suppliers involved in project design, implementation and management services. He is also responsible for the implementation of the BIM process and strategy within the company and the preparation of the technical and operational documentation of the work order and template production (standards and procedures).

The first two levels are divided into two “Building” and “Infrastructure” specializations that deal with the design, implementation and management of different works:

**BUILDING**: construction works in the residential, cultural and administrative field, sports and entertainment, productive and commercial and territorial planning.

**INFRASTRUCTURE**: infrastructural works such as roads, railways, works of river barriers, technological networks, port works and all works that have a strong interconnection with the territory in which they are inserted.

The BIM MANAGER profile is a transversal figure in Building and Infrastructure specializations, as it deals with the management and coordination of multidisciplinary working groups in the field of construction and infrastructure projects in the various fields of engineering and architecture. Certification is issued upon passing an examination, accessible by demonstrating that the requirements specified in the table are met.

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### Table: Professionals in construction industry (architects, engineers and surveyors) by associations.

<table>
<thead>
<tr>
<th>Professional association</th>
<th>Number of associates (Cresme 2010)</th>
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</thead>
<tbody>
<tr>
<td>National Council of Architects and its regional association</td>
<td>149,893</td>
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<tr>
<td>National Council of Engineers and its regional association</td>
<td>213,399</td>
</tr>
<tr>
<td>National Council of Architects and its regional association</td>
<td>111,145</td>
</tr>
</tbody>
</table>
Focus on BIM-related research

Since BIM methodologies and technologies were developed in order to meet the requirements for new buildings, the Italian research on BIM topic is focused on how to make these technologies compliant with a widespread panorama of existing buildings. In order to match this expectation, several universities and research centres have started to develop their own researches on BIM, differently focusing on specific topics. Due to a growing interest in BIM research, having an exhaustive overview seems not achievable.

The following chart tries to summarize some of the main research experiences that have been developed and disseminated since now.

<table>
<thead>
<tr>
<th>University</th>
<th>Department</th>
<th>Main topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Politecnico Milano – Department of Architecture, Built Environment and Construction engineering (ABC)</td>
<td>BIM application and standardization, BIM for existing buildings. The Italian chapter of Building Smart is hosted at ABC department.</td>
<td></td>
</tr>
<tr>
<td>Politecnico Torino - DRAWING TO THE FUTURE research centre</td>
<td>BIM application, data interoperability, Facility Management BIM based, VR/AR.</td>
<td></td>
</tr>
<tr>
<td>University of Aquila – Department of Civil Engineering, Architecture and Environment</td>
<td>Building Information Modelling for historical buildings, integration of seismic data and structural survey.</td>
<td></td>
</tr>
<tr>
<td>University of Brescia - Department of Civil, Environmental, Architectural Engineering and Mathematics</td>
<td>BIM-based construction project management, BIM for sustainable buildings, BIM impact on the bid process.</td>
<td></td>
</tr>
<tr>
<td>University of Ferrara – Department of Architecture, DIAProReM/TekneHub research centre</td>
<td>BIM for existing building, BIM process management, H-BIM for accessing and understanding Cultural Heritage, H-BIM semantic, VR/AR.</td>
<td></td>
</tr>
<tr>
<td>University of Marche – Department of Civil Engineering and Architecture</td>
<td>BIM for historical building, survey integration, metadata analysis and semantic for historical heritage preservation.</td>
<td></td>
</tr>
<tr>
<td>University of Rome “La Sapienza” – CITERA research centre</td>
<td>BIM for historical buildings and BIM-based Facility Management.</td>
<td></td>
</tr>
</tbody>
</table>

Among others, the INCEPTION project, started in June 2015 and lasting four years, led by the Department of Architecture of the University of Ferrara, should be mentioned.

The INCEPTION project

The project has been applied under the Work Programme Europe in a changing world – inclusive, innovative and reflective Societies (Call - Reflective Societies: Cultural Heritage and European Identities, Reflective-7-2014, Advanced 3D modelling for accessing and understanding European cultural assets). This research project has received funding from the European Union’s H2020 Framework Programme for research and innovation under Grant agreement no 665220.

The INCEPTION project aims at developing advanced 3D modelling for accessing and understanding European cultural assets. The main innovations proposed by the project are related to innovative technologies for creating 3D models with an inclusive approach to Cultural Heritage; the possibility to achieve interoperable models able to enrich the interdisciplinary knowledge of European cultural identity by different users; the development of an open standard platform to “contain”, implement and share the digital models.

One of the most widespread approach for historical buildings is related to a 3D digital semantic model, based on BIM technologies. The expectations on this are quite broad, but the architectural differences make the task quite difficult. Furthermore, what is the added value of applying a linguistic resource to the architectural problem is still an open question, as well as how to identify an effective BIM approach for cultural heritage knowledge semantic enrichment and model management.
So far, the INCEPTION project has defined the approach and the methodology for semantic organization and data management toward H-BIM modelling, as well as a preliminary nomenclature for semantic enrichment of heritage 3D models has been set up. The organization of consolidated knowledge is performed following a specific workflow in order to get them suitable for their reuse into H-BIM semantic model, accordingly to digital documentation and capturing protocols that has been developed. Nevertheless, developing an H-BIM is a complicated “reverse engineering” process. According to the INCEPTION workflow, it starts with documenting user needs, including and engaging not only experts but also non-experts. The demand led to “how” and “what” surveying information should be included in H-BIM.

Starting from the standardization for H-BIM modelling, the methodology for merging IFC models and semantic data has been defined. The identification of the Cultural Heritage buildings semantic ontology and data structure for information cataloguing will allow the integration of semantic attributes with hierarchically and mutually aggregated 3D digital geometric models for management of heritage information. The development of a semantic 3D reconstructions, integrated with intangible information and social environment, structuring digital representation of buildings and sites will lead to the creation of models more accessible and implementable in a Heritage-BIM environment, based on Open BIM standard (IFC, IFD, etc.).
CONCLUSION
Comparative analysis of the existing professional qualification in the 3 participating countries (Italy, Finland and Norway), analysis of the state of the art regarding BIM application in the 3 countries and exchange of good practices.

BIM has been implemented in Finland largely without any government based demand. BIM guidelines/manuals have been developed in several separate research and development programs or projects, and nowadays belong to the development umbrella of buildingSMART Finland with collaboration of industry and public-sector organizations. Medium or small-scale industries are still not fully implemented the BIM whereas the most big companies have implemented BIM and have received benefits. Industry is practicing and interested to carry out more research and development activities towards BIM and lean construction.

In Finland, BIM related teaching/training is mostly carried out at the secondary (vocational) level of the education system. There are also many courses and study programs available at university level to give basic understanding about the subject. In private sector, there are courses/BIM software training available.

Some of the mostly discussed research topics relate to BIM in Finland; study the challenges to utilize BIM for city planning as well as for facilities management for buildings and bridges.

As a conclusion,
- BIM Guidelines describes what information has to be modeled, how to do that, and to which accuracy level in different phases - the basement for the implementation
- In the implementation, pilot projects are very important, “nothing” happens with the industry without piloting
- BIM Education is needed a lot and needs to be developed too
- Clients and builder consultants are the key important managers for the BIM implementation

The BIM is developing, the implementation work will be continuous.

BIM has been implemented in Norwegian AEC and FM industry as it is a government requirement from 2010. BIM guidelines/manuals have been mainly developed by buildingSMART Norway with collaboration of industry and public-sector organizations. Moreover, BIM implementation has given benefits to the AEC and FM by increasing productivity of process, reducing errors and exchanging information. However, medium scale industries are still not fully implemented the BIM whereas big companies have implemented BIM and have received benefits. Industry is practicing and interested to carry out research and development activities towards BIM and lean construction. In addition, Norwegian industry utilized Lean construction principles such as the Last Planner, Pull Scheduling, Concurrent Engineering and Virtual Design Construction (VDC), co-location with BIM. Some of the big companies are interested to implement lean construction principles with BIM.

In Norway, BIM related teaching/training is mostly carried out at the tertiary level of the education system. There are few courses and few study programs available at university level to give basic understanding about the subject. However, some courses are offered at the vocational educational institutes. In addition to that, buildingSMART Norway has introduced a web based certification process to document the knowledge of the expertise. This process does not cover BIM software training. In private sector, there are courses/BIM software training available.

Some of the mostly discussed research topics relate to BIM in Norway; study the challenges faced after implementing BIM in an organizations and application of lean construction tools with BIM. Moreover, BIM related research work is mostly case study based research and lessons learned from each case studies has documented.

In Italy, the BIM topic is increasingly discussing among construction industry players, and ultimately the Government. From this research, however, there is still some confusion about BIM. Not everyone is still aware about the real potentialities that this methodology offers. While starting to use BIM tools and technology, we are still far from what can be called a proper use of the Building Information Modelling.

Owners do not have a clear picture of the benefits that could result from a greater involvement of BIM in the procurement. There seems to be a perception of a potentially useful innovation, but there is still some fear. There is probably an adequate number of cases that can be identified as example of good practices.

Furthermore, it should also be considered the constant and appreciable engagement of Italian research, even if poorly funded at national level, in furthering the application of BIM to the panorama of existing buildings. The finalization of specific standards as well as the achievement of academic maturity can lead Italy to quickly recover the gap with other nations. Anyway, only the knowledge and experience of owner and construction industry players will solve the dangerous dichotomy between tools and processes for the benefit of a shared methodological definition.

In conclusion, the need for improving training programs at every level, in order to make construction industry players more aware, seems to be one of the most important task to be performed in the next future.
## Comparative chart

<table>
<thead>
<tr>
<th></th>
<th>Finland</th>
<th>Norway</th>
<th>Italy</th>
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</thead>
<tbody>
<tr>
<td><strong>Legislation</strong></td>
<td>There are not legal obligations</td>
<td>There isn’t a specific legislation even if the</td>
<td>BIM is a government requirement from 2010</td>
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<tr>
<td></td>
<td></td>
<td>new procurement legislation introduce the</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>utilization of BIM in public procurement</td>
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<tr>
<td><strong>Guidelines</strong></td>
<td>There are guidelines defined by researchers and</td>
<td>BIM guidelines/ manuals have been mainly</td>
<td>BIM guidelines/ manuals have been mainly</td>
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<td>industries - buildingSMART Finland</td>
<td>developed by buildingSMART Norway with</td>
<td>developed by buildingSMART Norway with</td>
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<td>collaboration of industry and public sector</td>
<td>collaboration of industry and public sector</td>
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<td>organizations. The public sector in</td>
<td>organizations. The public sector in</td>
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<td></td>
<td>Norway have been releasing their BIM</td>
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<td></td>
<td></td>
<td>standards since 2008</td>
<td>standards since 2008</td>
</tr>
<tr>
<td><strong>Level of implementation in industry</strong></td>
<td>High level of implementation</td>
<td>High level of implementation</td>
<td>Small level of implementation</td>
</tr>
<tr>
<td><strong>Professions related to the use of BIM</strong></td>
<td>BIM manager, BIM coordinator, BIM technician and BIM consultant</td>
<td>BIM guidelines/ manuals have been mainly developed by buildingSMART Norway with collaboration of industry and public sector organizations. The public sector in Norway have been releasing their BIM standards since 2008</td>
<td>Bim Specialist, Bim Coordinator, Bim Manager. The first two levels are divided into two 'Building' and 'Infrastructure' specializations</td>
</tr>
<tr>
<td><strong>Education and Training courses</strong></td>
<td>University At university level BIM is taught at any university that has own education line for civil engineering area. Exemple of courses at Dulu University: BIM in Building Design – Basic Course (CADS), 5 credits.</td>
<td>University Some of the universities in Norway conduct BIM courses and several university colleges have special BIM studies.</td>
<td>Secondary education National programmes for secondary education and regional programmes for vocational training do not yet consider the BIM teaching. Nevertheless, several experiences have been carried out in the last few years even if collecting structured data on the topic seems to be not feasible.</td>
</tr>
<tr>
<td></td>
<td>Courses offered by companies: 5 credits Information modelling and automation in infrastructure construction and maintenance, 5 credits</td>
<td>Student seminars are organized by buildingSMART Norway to share the new knowledge about openBIM among member companies and students</td>
<td>Courses offered by private companies</td>
</tr>
<tr>
<td></td>
<td>Courses offered by companies: 5 credits Information modelling and automation in building construction and maintenance, 5 credits</td>
<td>VET There are no specific and widely accepted qualifications been yet developed in Finland. We have discussed with some universities and university of applied sciences that would that kind of qualifications be useful for the industry.</td>
<td>VET Higher vocational schools in the field of building technologies are probably more focused on the exploitation of BIM teaching due to a deeper connection with market opportunities.</td>
</tr>
<tr>
<td></td>
<td>Courses offered by companies: 5 credits InfraWorks.</td>
<td>Seminars Metropolia University of applied sciences has quite actively arranges BIM workshops, seminars and courses. University of Dulu has arranged several infra BIM and automation workshops at Ouluzone center near Oulu.</td>
<td>Courses offered by private companies</td>
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<td>Courses offered by companies: 5 credits and automation Information modelling and automation Information modelling and automation</td>
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<td>Courses offered by companies: 5 credits Information modelling and automation in infrastructure construction and maintenance, 5 credits</td>
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