Co-funded by the
Erasmus+ Programme
of the European Union

# PR1 – Industry requirements on BIM-GIS training programs and courses

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**Short Description:**

Deliverable PR1 is a report that describes the Industry requirements on BIM-GIS training programs and courses. PR1 contains three tasks: T1.1: Review of existing courses and learning material, T1.2: Survey of industry needs and T1.3: Specification of VET courses.

**Keywords:**

BIRGIT Project, BIM and GIS integration, vocational training, industry requirements

| **Dissemination Level** | | |
|---|---|---|
| PU | Public | X |
| RE | Restricted to other programme participants (including Commission services and project reviewers) | |
| CO | Confidential, only for members of the consortium (including EACEA and Commission services and project reviewers) | |

Revision History:

| Revision | Date | Author(s) | Status | Description |
|---|---|---|---|---|
| 0.1 | 2022-04-25 | A. Östman | Draft | Table of Contents |
| 0.2 | 2022-06-30 | A. Östman, R. Molina, S., Mendoza | Draft | Chapter 3 added |
| 0.3 | 2022-09-07 | V. Cetl | Draft | Introduction modified |
| 0.4 | 2022-10-03 | A Östman | Draft | Chapter 1.3 and 2 modified |
| 1.0 | 2022-10-31 | V. Cetl | Final draft | Overall editing |
| 1.1 | 2023-01-20 | A Östman, H. Hauska, O. Bjelotomić Oršulić | Quality check | Overall check |
| 2.0 | 2023-01-30 | V. Cetl | Final | Final editing |

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# 1. Introduction

The objective of this report is to describe the results of BIRGIT Project results 1 (PR1) activities about Industry requirements on BIM-GIS training programs and courses. PR1 is divided into three tasks, namely T1.1: Review of existing courses and learning material, T1.2: Survey of industry needs and T1.3: Specification of Vocational Education and Training (VET) courses.

## 1.1. The BIRGIT project

Both in the public and private sectors, the construction and geospatial (mapping) industries are demanding new approaches for urban planning, asset design and management. Digitization is one of the key developments to reduce costs, environmental impact and carbon footprints. One of the fundamental approaches in this development is bringing together Building Information Modelling (BIM) and Geographic Information Systems (GIS) technologies. By connecting the construction and geospatial information management, an increased improvement of the construction processes, asset management, including buildings, roads, and other essential public facilities, will be provided.

There is a lack of skilled personnel, especially in VET courses, addressing the competencies required to achieve BIM-GIS integration. Existing VET programs across Europe for civil engineers, architects, land surveyors, geographers and other professionals working in the built environment and urban management, usually include separate courses in BIM or GIS, but not their integration. As a consequence, professionals in these domains rarely know how to solve problems where a unified approach to BIM and GIS data management is needed.

The industry, however, is moving fast and new technologies are now being implemented within private companies and public authorities. This development clearly characterises one structural problem in the current education system, namely that new technologies and collaboration patterns put new requirements on education providers, who often have difficulties in coping with these requirements and a fast-changing society.

The main objective of this project is to bridge the gap between supply and demand of these skills by improving the quality of the existing VET offers by providing new courses. New learning materials aiming at developing the necessary skills to integrate BIM and GIS will be developed. These materials will specify learning outcomes addressing the achievement of knowledge on methods and mechanisms (mostly software tools and data modelling) but also on practical application cases. The expected general impact will be the improvement of quality of the VET programmes within the partnership and the possibility of using these courses by other training providers as well.

The Project results (PRs) are:

- PR1 Industry requirements on BIM-GIS training programs and courses
- PR2 Localization of existing courses
- PR3 Development of new courses
- PR4 Testing and updating of learning material

## 1.2. PR1 Industry Requirements on BIM-GIS training programs and courses

The goal of PR1 is to specify the requirements on integrated BIM-GIS training. Some requirements have already been implemented within existing VET programs and courses, but due to societal development with increased levels of digitisation, additional requirements have been formulated. The main target group of this project result is VET courses providers, both project partners and external providers. Companies working in the sector are expected to make use of the requirement analysis, for instance when modifying their business offers. Requirements were collected through a dedicated survey[1] and interviews with BIM-GIS industry representatives in partner countries within this project. The specified industry requirements will be used further in the project, when specifying and creating new VET training courses. By tradition, new topics in education and training are often introduced in higher academic study programs as a result of scientific research. This training is often scientific oriented and after some time, when the technological development is mature and the societal ability to respond to the proposed changes, VET oriented training programs are created. One innovative element of this activity is that this flow is shortened, through faster adoption of new technologies within the VET programs. This is made possible through the increased levels of standardisation within the industry, shorter development cycles within the software industry and a higher societal readiness due to the increased attention to the digitisation possibilities. Also, countries having a less developed private sector in BIM and GIS technologies can benefit from such an approach. The innovative parts of this activity are related to both the results itself as well as the methodology. The methodology, of course, is of interest also for other sectors, facing similar challenges. The results (requirements on courses) are of interest for VET providers as well as for the industry. The expected impact is that VET providers outside the partnership will have better opportunities in providing new BIM-GIS courses in their programs.

## 1.3. Structure of the document

The document is organised as follows. Chapter 2 describes, at a general level, the methodology used for specifying the requirements on integrated BIM-GIS training.

The development work is structured into three different activities. The first activity, led by Novogit, (T1.1 – Review of existing courses and learning material) is described in chapter 3. The second activity (T1.2 – Survey of industry needs), led by GISIG, is described in chapter 4. The third activity (T1.3 – Specification of VET courses) is described in chapter 5 and the activity leader is AIN. In chapters 3 – 5, the methodologies applied in each activity are described in more detail, as well as their results and conclusions.

Finally, in chapter 6, the entire results are summarised and discussed together with main conclusions.

[1] https://birgitproject.eu/survey/

# 2. Methodology

As mentioned, the goal of PR1 is to specify the requirements on integrated BIM-GIS training. This goal is achieved by executing the following tasks:

T1.1: Review of existing courses and learning materials. Scientific research on integrated BIM-GIS applications has been carried out by different research institutes. In some cases, academic courses have been prepared, although not yet in the countries of this project. Moreover, existing VET programs across Europe, also provided by leading companies in the field, for civil engineers, architects, geographers and other professionals, include courses on BIM and on GIS. The objective of this task was to identify relevant courses and give recommendations about any parts of each course (including learning objectives) which may be included in the educational offer of the project. The leader of this task is Novogit, with contributions by UniNorth, GISIG, AIN and EfVET.

T1.2: Survey of industry needs. The objective of this task is twofold. On the one hand, investigate the status of maturity within the countries participating in the project with respect to adoption of BIM-GIS integration techniques. On the other hand, study and describe the training needs (required knowledge, skills and competences) of the industry and end users in each country with respect to BIM-GIS integration. To achieve these objectives, the task follows a methodology used in other projects based on two techniques for data collection: First, the creation of an open online survey targeting all relevant BIM-GIS stakeholders and promoted by all the partners of the project. And, second, conducting a series of structured interviews with selected relevant people in the world of BIM and GIS from each of the participating countries. Data gathered is analysed and the results are used to support the definition of the BIRGIT training curriculum. The leader of this task is GISIG, with contributions by UniNorth, Ocellus and AIN.

T1.3: Specification of VET courses. Based on the results in T1.1 and T1.2, a set of existing VET courses was specified. In the first level of specification, the main content of each course is specified. Then, based on national context and availability of data, more detailed course specifications will be elaborated in later stages of the project, including recommendations about equipment (laser scanners, GNSS, etc), software tools and datasets to be used in the training. The leader of this task is AIN, with contributions by Novogit, GISIG, UniNorth and Ocellus.

# 3. Review of existing courses and learning material

## 3.1. Methodology

The objective of this task is to identify courses and other types of learning material (syllabus, on-line lectures, books, documents, recorded webinars, etc.) which may be included in our learning offers. It is a requirement that the learning material developed or improved by the project, shall be available on open licence (such as Creative Commons) and free of charge.

To identify learning material of interest, two different approaches were applied. Firstly, existing learning resources within the partnership were evaluated and described in a shared

spreadsheet. Secondly, learning resources outside the partnership were identified using web search methods.

For the web search, it was assumed that some learning material was only available in the local languages. For that reason, the web search was divided into country specific searches (ES, IT, HR and SE), where the partners from one specific country were responsible for searching the corresponding web sites. Of course, available resources at European level outside these countries were also analysed. Most attention was paid to searching for courses and materials at web sites of well renowned universities. In addition to this, a general search for learning material has also been carried out using specific keywords and common search engines, such as Google.

Two different types of courses were identified as being relevant for the purposes of the project, namely general courses on BIM and GIS respectively and courses where both technologies are integrated. The overall situation within the consortium was that the education partners already providing GIS training were lacking basic courses in BIM while the opposite holds true for the partners providing training in BIM.

## 3.2. Results

The contents of the training courses and learning material identified as being of potential interest to the project partners were specified in a spreadsheet, filled in by the partners involved in this task. Each item was described using characteristics like type of resource (course, lecture etc), ownership, date of creation, URL, credits, language, EQF level, target group, prerequisites, main topic, learning outcomes, syllabus, software used, licences etc.

Basic learning resources, such as courses, lectures, study programs etc, on BIM or GIS, are already available within the partnership. The learning resources being of primary interest to be reused in BIRGIT are described in tables 3.1 and 3.2.

**Sweden**

Web-based search for courses and learning materials where BIM and GIS are integrated, provided limited results. The Swedish partners analysed material from the major Swedish higher education institutes, namely Royal Institute of Technology (KTH), Luleå University of Technology, University of Gävle, Uppsala University, Stockholm University, Umeå University, Karlstad University, Linköping University, Jönköping University, Lund University of Technology and Chalmers University of Technology. The outcome was negative, i.e., training courses in BIM or GIS were found, but no course where the subjects were integrated with each other. In several exceptions, the possibility to use GIS is mentioned/demonstrated in BIM courses (according to syllabi), but not in an integrated manner. The only exception to this is a VET course provided by Gävle Folkuniversitet on 3D-GIS and BIM. In this case, only the syllabus of the course is available for public use. Similar to other countries, e.g. Italy (see below), ESRI

*Table 3.1. Summary of basic learning resources in BIM or GIS within the partnership. YH is the credit unit used in Sweden for vocational training*

| **Provider** | **Name of learning resource** | **Type of learning resource** | **Usage licence** | **Length/Credits** |
|---|---|---|---|---|
| Ocellus | Databasteknik och GIS | Course | TBD | 10 YH = 3 ECVET |
| Ocellus | Mobile communication | Course | TBD | 20 YH = 6 ECVET |
| Ocellus | Web publishing tools | Course | TBD | 15 YH = 4,5 ECVET |
| University North | Geographic information system | Course | CC-BY SA | 60 classroom hours = 6 ECTS |
| University North | Photogrammetry | Course | CC-BY SA | 45 classroom hours = 4 ECTS |
| University North | Construction Monitoring and Building Condition Assessment | Course | CC-BY SA | 30 classroom hours = 3 ECTS |
| University North | Applied Geomatics | Course | CC-BY SA | 60 classroom hours = 6 ECTS |
| University North | Spatial Planning | Course | CC-BY SA | 30 classroom hours = 3 ECTS |
| AIN | BIM Fundamentals | Course | Copyright | |
| FORMA.Azione | BIM Coordinator | Program | Programme structure CC-BY SA / trainers' resources copyright | ECTS not applicable. 350 hours + 480 hours of internship |

| | | | | |
|---|---|---|---|---|
| GISIG | Introduction to BIM | Lecture | CC-BY SA | 32 slides - No credits specified. |

*Table 3.2. Summary of integrated BIM-GIS learning resources, with focus on open licences*

| **Provider** | **Course name** | **Type of learning resource** | **URL** | **Usage licence** | **Length/Credits** |
|---|---|---|---|---|---|
| Folkuniversitetet Gävle | 3D GIS och BIM | Syllabus | https://www.folkuniversitetet.se/vara-skolor/yh-utbildningar/alla-yh-utbildningar/samhallsbyggnad-byggteknik/gis-med-inslag-av-bim/ | N/A | 10 YH = 4,5 ECVET |
| Sapienza - University of Rome | GISBIM International Summer School | Lectures with notes | https://www.researchgate.net/publication/348497464_BIM-GIS_INTERNATIONAL_SUMMER_SCHOOL_Lectures_and_notes_for_a_digital_integrated_design | Probably Open Licence | 3 ECTS |
| 3D art / ARCHICAD | BIM modelling | Syllabus | https://www.3dart.hr/ | N/A | 2 days/12 hours |
| PREHNIT | GIS in urban planning | Syllabus | https://prehnit.hr/hr/consulting/gise/ | Student licence or free trial | 3 days/24 hours |
| GoPillar Academy | BIM Architecture | Syllabus | https://www.gopillaracademy.com/?v=fd4c638da5f8 | Student licence or free trial | 6 lessons, working of a software |
| PRIOR | Revit Test Drive Workshop | Lectures with notes | https://www.prior.hr/bim-kit/ | Student licence or free trial | Half day |

**Sweden**

Web-based search for courses and learning materials where BIM and GIS are integrated, provided limited results. The Swedish partners analysed material from the major Swedish higher education institutes, namely Royal Institute of Technology (KTH), Luleå University of Technology, University of Gävle, Uppsala University, Stockholm University, Umeå University, Karlstad University, Linköping University, Jönköping University, Lund University of Technology and Chalmers University of Technology. The outcome was negative, i.e., training courses in BIM or GIS were found, but no course where the subjects were integrated with each other. In several exceptions, the possibility to use GIS is mentioned/demonstrated in BIM courses (according to syllabi), but not in an integrated manner. The only exception to this is a VET course provided by Gävle Folkuniversitet on 3D-GIS and BIM. In this case, only the syllabus of the course is available for public use. Similar to other countries, e.g. Italy (see below), ESRI Sweden provides paid courses on the integration, having a maximum length of 2 days and with an approach similar to the Italian one.

There are seven private VET providers offering education in BIM, usually 2-years long, but without reference to GIS and without open licences.

**Italy**

Regarding the situation in Italy, desk research was also primarily based on web-based search and unfortunately the results, as in the case of Sweden, were also limited. The training offered in terms of courses dedicated to GIS and BIM separately is obviously extensive, both from Universities and from private training providers. It is worth noting the large number of advanced training programs such as master's degrees, other postgraduate studies or summer schools dedicated to both disciplines.

The desk study was focused on open training resources regarding GIS and BIM integration. We can say in general that the training offers in this regard, even if they exist, are quite limited. Existing resources are mostly provided on demand, in hybrid mode (class and or online) and carried out by consulting companies and private VET centres which offer training to companies in the AEC sector interested in adding GIS/BIM integrated workflows to their existing work. It should be noted that most providers that offer this type of training are linked in one way or another to important vendors in the sector, such as Autodesk and ESRI, and that the courses offered are certified by these software providers, based on the practical use of their products and offer some kind of certification. It goes without saying that these kind of training resources are not openly available and therefore we can only analyse them from the point of view of their structure and syllabus.

In this sense, a course that can be taken as an example is the 8 hours course offered by the Italian consulting company One Team. This course[2] (in Italian) is called “Training path: Interaction between BIM and GIS'' and it has the ultimate goal of allowing participants to create

[2] https://www.oneteam.it/formazione-eventi/percorso-formativo-interazione-tra-bim-e-gis/

a GIS project integrated with BIM data to perform spatial analysis and be able to exploit the sharing tools made available by the ESRI ArcGIS Pro platform. The course is dedicated to technicians who wish to import BIM models into a GIS environment, with particular reference to open data formats (IFC) and Autodesk applications (Revit and Civil3D).

Regarding training resources on GIS/BIM integration offered by Italian Universities, the situation is very limited. Some resources are available but unfortunately we were not able to clearly identify reusable materials with open licences.

The International Summer School "GIS and BIM for a digital integrated design", organised by the Sapienza University in Rome[3] is probably the most advanced academic training program in the subject currently offered in Italy. This summer school is currently on the third edition and offers a quality training on two topics of great relevance, namely the digital twin and the innovative solutions in the management of the design process of green infrastructure. Lessons are held in mixed mode and the course proposes case studies in various innovative fields (Architecture, Linear Infrastructure, Cultural Heritage) in Europe, Central America and Asia. Students learn how to operate within an integrated BIM & GIS process, how to manage BIM models and the interaction with GIS.

The University Politecnico Milano currently offers a BIM manager MSc[4] that includes one unit dedicated to the integration of GIS BIM. In this unit, BIM is applied on a local scale with reference to GIS, and on an infrastructural scale. Procedures and tools aiming to design and integrate infrastructures in the territory will be presented with Infraworks, Civil 3D and other tools.

Finally, we can make reference to a MSc program "BIM e DIGITAL Earth per Ingegneria e Architettura[5]" offered by a specialised VET provider in the Basilicata region and currently on its second edition. This master program is offered by a private training provider and is aimed at young graduates in engineering, architecture and similar degrees. The course provides the basics to manage and develop a BIM project and generate photogrammetric data from drones for subsequent manipulation in the GIS environment. The intention is to create professionals able to work on BIM contracts and to prepare professionals capable of appropriately using interdisciplinary approaches, technological solutions and geographical information in addressing complex territorial issues.

It is important to highlight that the interviews carried out in the context of task 1.2 with Italian specialists in BIM-GIS have helped us a lot to understand the state of the training offered in Italy.

[3] https://www.uniroma1.it/en/offerta-formativa/summer-and-winter-school/2022/summer-school-gis-and-bim-digital-integrated-design

[4] https://www.masterpesenti.polimi.it/master-universitari/bim-management-in-construction-works.php

[5] https://www.philoikos.it/2066-2/

**Spain**

The investigation about external training resources in Spain was done mainly on the Internet. During the search, it was found that the offers for these kinds of courses were very limited. As in the Croatian case, one can find a lot of courses about BIM and GIS separately, but when it comes to integrated courses, there is barely anything. A couple of training courses and MSc's were discovered, but the majority of the content found throughout the net were blogs and webinars explaining the importance and advantages of integrating BIM and GIS. Another issue in the pursuit of this type of training was the ambition of finding open licence content. All the resources which were discovered were paid ones. This means that only their syllabus can be analysed.

The webinars being discovered are all in Spanish, and are primarily focussing on the problems the industry are facing when integrating BIM-GIS, including explaining how it works, the different approaches to integrating BIM methodology and GIS, use cases and the benefits of the integration.

Some universities were also contacted, but this approach wasn't really successful as there was no feedback received.

**Croatia**

The investigation for courses dealing with the integration of BIM and GIS in Croatia went in two different directions. The first direction was to search courses held by private companies, while the second was to search for programs/courses available at universities in Croatia.

For private companies we used the Croatian BIM register[6]. The BIM register publishes in one place information about companies that apply, sell, implement, and provide support or in some other form use BIM in their work or offer it as a service on the market.

The first clearly visible case is that there are courses for BIM and courses for GIS, but courses that provide BIM and GIS integration do not exist. We noticed the same problems while searching courses at the universities.

Another fact that is clearly visible in private companies involved in education is that they do not provide wider knowledge about BIM or GIS, but exclusively knowledge regarding specific software needed to work on projects related to BIM and/or GIS. This hasn´t been observed in universities. The courses mainly contain the theoretical and practical applications of GIS. We did not find any courses that teach exclusively about BIM. Basic BIM knowledge is often integrated within other courses. It made our investigation difficult because it required reading the syllabuses of a large number of courses.

In addition, the lack of existing learning material shows up. They almost don't exist (except internal university scripts and presentations to a lesser extent) or are also related to software

[6] https://bim-hrvatska.hr/registar-bim-tvrtki/

manuals. No courses or material that provide knowledge about integration of BIM and GIS in Croatia were found.

**Rest of Europe and beyond**

Regarding the BIM-GIS integration training resources from other countries (including materials hosted outside Europe) the following observations can be made. Most training resources on the subject are paid courses in the form of on-site courses, webinars and on-demand materials. Most of these training resources are produced by software vendors such as ESRI and Autodesk (mainly), professional training/VET providers and on-demand training platforms.

HEI training on the subject is included in very few MSc programs, postgraduate programs and summer schools in Europe. Also, it seems that there is a total lack of open training material available. This fact seems logical considering that the majority of available material is basically created by software vendors and that the lessons are delivered through consulting companies that have training as a part of their business.

Autodesk provides more than 20 free learning resources in the form of videos, slides and documents, where BIM and GIS are integrated. ESRI provides some video clips on BIM and GIS integration, as a part of their online training program. Unfortunately, these materials are strictly copyrighted and cannot be reused.

We found two dedicated MSc programs in Europe. The first one is the "Information Technologies for the Built Environment M. Sc.[7]" from TUM (School of Engineering and Design Technische Universität München). This is a unique study program since it provides knowledge and competencies specifically on the BIM-GIS integration topic. It provides a holistic, interdisciplinary understanding of information technologies and methods in the built environment.

There is a similar MSc program in the Netherlands at Technische Universiteit Delft, called Geomatic for the Built Environment. As probably the only institution of the ones we checked, this program includes several open courses[8], i.e., 3D modelling of the built environment, Digital terrain modelling, Photogrammetry and 3D computer vision, Machine Learning for the Built Environment, with lectures, assignments and additional readings. There is also a list of Master thesis works on the topic, which can be downloaded. Many of them provide data and codes via Github.

There are a large number of open access research articles/papers on BIM-GIS integration. The material can therefore be used and referenced. The training values of these resources may however be limited.

[7] https://www.ed.tum.de/ed/studium/studienangebot/information-technologies-for-the-built-environment-m-sc/

[8] https://3d.bk.tudelft.nl/education/#courses

Despite having the materials not open to the public, a few courses found online offer a useful and detailed description of the training content, structure and learning outcomes. The BIRGIT project can definitely take advantage of this public resource in the context of the creation of its own courses. Below is a list of interesting training resources which might be used in this sense:

- Summer School: GIS and BIM for a digital integrated design. Sapienza University Rome. https://www.uniroma1.it/sites/default/files/2.p_formativo_2022_.pdf
- GIS-BIM Integration for Architecture, Engineering & Construction Training – Overview to Online Training Course Video introduction: https://www.youtube.com/watch?v=so_GXft9d1k&ab_channel=BimEnable
- BIM and GIS make Cities Smarter : Infraworks-Civil 3d-ArcGIS . https://www.udemy.com/course/bim-and-gis-make-cities-smarter-infraworks-civil-3d-arcgis/
- GeoBIM Application and Technology Certification Programme. https://esrisingapore.com.sg/store/geobim-application-and-technology-certification-programme
- BIM and BIG DATA (Geographical Information Systems (GIS) https://bond.edu.au/subject/ssud70-308-bim-and-big-data-geographical-information-systems-gis?outline=SSUD70-308_2020_SEP_INT_01#curriculum
- BIM e DIGITAL Earth per Ingegneria e Architettura https://www.philoikos.it/wp-content/uploads/2021/08/Brochure_Master_BIMGIS_2%C2%B0EDIZIONE.pdf
- Master of Science Information Technologies for the Built Environment. https://www.ed.tum.de/en/ed/news-single-view-start/article/new-degree-program-master-of-science-information-technologies-for-the-built-environment/

### 3.3. Discussion and conclusions

The objective of this task is to identify existing courses and other types of learning resources (syllabus, on-line lectures, books, documents, recorded webinars, etc.) which could be used in the BIRGIT project. Learning resources of interest for the project should fulfil the following criteria:

1. They should be available on open licence (such as Creative Commons) and free of charge.
2. They should either be related to basic courses in BIM or GIS or to the integration of BIM-GIS technologies.

Two types of learning resources have been identified, namely resources provided by the partners of the BIRGIT project and resources provided by external parties. The list of resources provided by the partners is presented in Table 3.1 and the list of external resources is presented in Table 3.2.

There are a large number of basic courses in either BIM or GIS available, provided by the project partners as well as external parties. The number of learning resources where BIM-GIS technologies are integrated is however very limited, especially if you add the constraint of open licences.

The results of this task will be used when specifying the new curricula (T1.3), adapting existing courses to new training environments (PR2) and when developing new courses (PR3).

# 4. Survey of industry needs

## 4.1. Methodology

Task 1.2 (Survey of industry needs) aims at studying and describing, for each of the countries participating in the BIRGIT project, the training needs of the industry and end users in terms of required knowledge, skills and competencies for BIM-GIS integration.

In order to achieve this information, two methods were used:

- Interviews of experts in the BIM and/or GIS field
- Open online survey to the BIM-GIS community

Regarding the interviews, it was agreed among the participants in the task that a series of online interviews would be organised, at least one for each of the countries participating in the project (Italy, Croatia, Spain and Sweden). It was also agreed that each partner participating in the task would be responsible for finding the experts, organising the interview and carrying it out in the language of each country.

As a result, 9 interviews were conducted between May 2022 and September 2022**.** The emphasis of the interviews was on the training needs and necessary skills to make integration between BIM and GIS systems possible, focusing on the situation for each of the countries. That is why the project partners were given the opportunity to do the interviews in the local language. A list of suggested questions was made available by the task leader to all partners. The idea was to harmonise the content of all the interviews in order to permit an overall analysis of the responses. However, the list of questions was indicative and the interviewer was free to give more weight to certain aspects depending on the context and profile of the interviewee. The interviews were conducted as online meetings and consent was asked to the interviewee to record the call so that we can carefully analyse the responses.

The information collected in the expert's interviews obviously responds to a personal point of view on the topic. Therefore, with the idea of enriching this information, an open online survey was designed and launched to reach as many experts as possible and to acquire more concrete and detailed information in relation to training needs. The online survey was launched on 01 June 2022 and the results were analysed from 20 September 2022. During this period of time, a total of 53 responses were collected. The survey remains open and further responses will be monitored and analysed later.

It was agreed to design the online survey using EUSurvey[9]. EUSurvey is the European Commission's official survey management tool and is used for creating and publishing forms. The application, hosted at the European Commission's Department for digital services (DG DIGIT), is available free of charge to all EU citizens.

The results of both methods used (interviews and online survey) are summarised in the next sections. The main objective is to offer sounding information, both in terms of quantitative and

[9] https://ec.europa.eu/eusurvey/home/welcome

qualitative inputs, to help define the BIRGIT training curriculum. The task leader, GISIG, took advantage of the experience in the definition of training needs in similar projects. A working group was created with the partners involved in the task and the methods and approaches to reach the desired results were discussed during several dedicated online meetings. The task documentation, such as templates and the organisational schema needed to perform the foreseen work, were created and edited collaboratively using the technical means made available by the project coordinator.

In detail, the following documentation was created:

- A template for the questions of the online survey
- A template for the translation of the online survey to national languages
- A template for the interview questions (in English)
- An organisational schema to perform the interviews including information of the time needed and other technical/operational aspects to perform the interview in the most professional way possible.
- A template for the interview announcement and invitation mail to be used by all partners when promoting the survey.
- A document to collect relevant contacts/networks to which disseminate and promote the survey.
- A document to collect contact information for interview candidates.

Finally, it is important to highlight an effort in terms of identifying the professional profiles involved in BIM-GIS integration tasks. Obviously, the certification of the competences of the candidates for BIM and GIS professional profiles are regulated by different norms or standards for each country. For BIM professionals, the number and sometimes definition of these profiles vary from one country to another but globally the main BIM professionals can be summarised and defined with the following 3 profiles: BIM Manager, BIM Coordinator and BIM Specialist.

To become a BIM Manager, BIM Coordinator or BIM Specialist there is currently no specific training path. The professional is, however, required to follow autonomous or guided paths of continuous professional development. In fact, the ISO 19650 standard, the international standard for managing information using BIM, does not establish concrete profiles and related skills to fulfil the activities but recommends that individuals within organisations should be continuously upskilled to ensure that they have the necessary technical and non-technical skills and behaviours.

In the case of Italy, the required skills for the different recognised BIM professional profiles are defined in detail in the UNI 11337-7 Italian norm and the certification for these profiles are released by a certification institute. In Italy this institute is the TÜV Examination Institute following the skills required in the UNI 11337-7 norm.

Regarding GIS, the distinction between professionals is slightly clearer and simpler. Traditionally, GIS “Technical” profiles are the most well-known, being the “GIS Analyst” the more recurrent. Although not very common in the EU, it seems the role of “GIS Manager” is quite common in the UK and US and often cited when dealing with tasks involving data interoperability and BIM. Professional GIS certifications are less popular than in the case of BIM and they are typically focused on a specific skill set or GIS software application. Graduate GIS Certificates are instead quite common and offered by academic institutions as part of education programs such as GIS master’s degrees.

The following table summarises different BIM and GIS profiles and is divided depending on the type of tasks. On the one hand, what we call “Management” profiles deal with organisational and supervision tasks together with reporting and assessing the work. On the other hand, “Technical” refers to professionals with direct contact with data and software applications. Often, we find this profile under the generic definition of “Specialists". On the technical side, there are not many differences in terms of skills required between the different profiles. Actually, some of them refer to the same thing with a different name.

*Table 4.1. BIM and GIS professional profiles*

| | **BIM** | **GIS** |
|---|---|---|
| **Management** | BIM Manager<br>BIM Coordinator | GIS Manager<br>GIS Coordinator |
| **Technical** | BIM Specialist<br>BIM Information manager /CDE Manager<br>BIM Modeller<br>BIM Operator<br>BIM Analyst | GIS Specialist<br>GIS Programmer/Developer<br>GIS Analyst<br>GIS Technician |

Tasks that require the integration of BIM and GIS involve to a greater or lesser extent all the profiles in this table. Integration is therefore a transversal work process that implies an effort not only technical at the level of data and applications, but also in the organisational, communication and administrative side. Since all these actors play a role, all of them need to be properly trained to gain necessary knowledge.

Training needs are different for each profile, so, of course, this fact will be very much taken into account during the definition of the curricula and development of training materials.

## 4.2 The BIRGIT Interviews

The following section will describe in detail the results of the 9 interviews that were conducted in the context for task 1.2. The number of interviews for each country is distributed as follows:

- Sweden: 3
- Italy: 2
- Spain: 1
- Croatia: 3

The intention behind these interviews is to have first-hand information from experts in the sector selected for each of the countries participating in the project. The interviews are an extremely useful instrument to diagnose and establish the state of adoption of BIM-GIS integration practices in each county directly from the actors involved. The interviews carried out are balanced from the point of view of the professional profile of the interviewees, since they reflect the opinion of experts and professionals with proven experience coming from both the BIM and GIS sectors.

In the next section, for each country in the Consortium, the interviews held are described and analysed highlighting the most relevant points. A complete report for each interview is openly available to the public as a short article published in the project's Medium platform page available at the following URL: https://medium.com/@birgit_project. The interviewees were of course consulted about the possibility of publishing the interview publicly in article format and most of them accepted. We believe that the publication of these interviews has a relevant informative value and can also serve as an instrument to promote the project. This Medium page is also available from the project website.

### *4.2.1 Interviews in Sweden*

**Interviewee name:** Per Öryd

Per Olof Öryd is currently working as a Geodata coordinator at Lantmäteriet (The Swedish Mapping, Cadastral and Land Registration Authority). One of their missions is to make geodata available in society and to lead the digitization of the community building process. Per Olof is an experienced Business Development Manager and sales professional from GIS software industry and consulting. He gained broad skills in Digitalisation, Geodata, B2B, GIS, Urban planning, Enterprise Software, AI, IoT, Smart urban planning and Spatial Analysis.

**Date:** Wednesday the 15th of June 2022

**Duration:** 30 minutes

**Place:** Online

**Interview highlights:**

- BIM is widely used in construction business, but its users work isolatedly with their projects
- Lantmäteriet created a standardised platform where entrepreneurs can submit their BIM models and make them available as open data. The goal is also to integrate the buildings to the national geodata platform.
- There are gaps between CAD-BIM-GIS usage, even in the AEC industry, and it is really important to focus on their integration in education programmes, as need of 3D-profession will just increase in future
- It is important to have roots established in GIS before moving to BIM and optimally have experience as a system technician
- Enthusiasm and real interest in BIM-GIS integration are probably the most important for a BIM-GIS professional

**Full interview:** https://medium.com/@birgit_project/birgit-interviews-per-olof-%C3%B6ryd-sweden-b737fb7584d1

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**Interviewee name:** Sofi Almqvist

Sofi Almqvist is today the President and CEO of Geoforum Sweden, which is a national interest organisation that works to increase awareness of the importance of geodata in smart and sustainable social development. Sofi has a background in civil engineering as well as in land construction and infrastructure. Previously, she worked, e.g., with municipal community building, promoting the use of geodata and digitization to create efficient processes, or as a unit manager at Stockholms development office, among others.

**Date:** Wednesday the 22nd of June 2022

**Duration:** 30 minutes

**Place:** Online

**Interview highlights:**

- Geoforum and BIM Alliance have a close cooperation and a meeting place to exchange experience; its goal is to create a national centre of competence
- There is a great need of new competences in multiple areas

- Theoretical knowledge of GIS and data science is crucial to all geodata-related jobs, but there is a lack of trained staff
- Optimally, GIS knowledge should be combined with another specialised competence, such as urban planning, real-estate law or geology
- In general, there is a low awareness about GIS and BIM in the Swedish society; increasing the awareness would increase the geodata-industry demand

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**Interviewee name:** Peter Axelsson

Peter Axelsson has the position of BIM strategist at the Swedish Transport Administration, STA. His main responsibilities are within the strategic and long-term development of methods and processes for asset information in a life cycle perspective. Peter has been working at STA since 2014 with varied tasks that cover regulations and requirements documents, introduction of BIM, international and national standardisation or development of internal systems for asset management. He also handles R&D Projects, with his experience from the academic sector, where he worked after obtaining his PhD degree in Geoinformatics at the Royal Institute of Technology, KTH. Besides that, Peter worked in diverse companies, e.g. as data-coordinating specialist.

**Date:** Thursday the 16th of June 2022

**Duration:** 30 minutes

**Place:** online

**Interview highlights:**

- The Swedish Transport Administration uses both BIM data and GIS data in its operations. They usually buy services from designers and contractors and then act as both requirements setter and inspectors.
- The external services are provided by the traditional technical consultant companies, such as Tyrens, Sweco, Afry or WSP. They traditionally use American cloud services, but a European cloud service like GAIA-X might suit better in the long term.
- The new IFC standard version 4.3 for infrastructure is decided to be the main format for future exchange of facility data. Other formats used today are traditional CAD-formats like dwg and dgn, LandXML and similar. This data is then translated into the internal systems used within the Swedish Transport Administration for daily operations.
- Knowledge of modelling and of information structure are important skill requirements. The need for competent personnel in this area is considered to be great.
- Parts of the Transportation Agency´s data are included in the Swedish national open-data framework and can be used in education.

### *4.2.2 Interviews in Italy*

**Interviewee name:** Giovanni Perego

Mr Perego is a well-known BIM Senior Technical Specialist and blogger. He is an architect specialising in training, technical support, pre-sales consultancy and marketing on BIM, especially regarding Infrastructures. He is the author of the reference Italian blog for GIS, BIM and Infrastructures and lecturer at the BIM MSc of the Politecnico di Milano and of the University of Pisa.

**Date:** Wednesday 25 May 2022

**Duration:** 01:12

**Place:** Online

**Interview highlights:**

- Italy is still at the beginning of its experience regarding the adoption of BIM-GIS integration patterns.
- In Italy there is an increasing demand for skills in the field of BIM and GIS for infrastructures (especially in railways and underground services)
- BIM professionals who want to work in the field of infrastructure have a significant lack of knowledge and very few skills in GIS.
- In Italy the answer to the training needs of the market in terms of BIM and GIS integration comes mainly from the private sector (mostly software resellers) that offer certified and highly structured training programs.
- In Italian universities, at this time, the training offer in BIM is scarce and is concentrated in postgraduate and master's programs, mostly specialised in vertical BIM.
- It would be essential to create a BIM for infrastructure Master in Italy with a focus on GIS skills.

**Full interview:** https://medium.com/@birgit_project/birgit-interviews-giovanni-perego-italy-183e9bc95cf5

**Interviewee name:** Anna Moreno

Founder and President of the IBIMI (Italian BIM Institute) association[10]. BuildingSMART International Italian chapter. Ms. Moreno is a well-known expert, active in the development and promotion of the digital transformation of the construction industry through the creation and adoption of standards for the exchange of digital, open and international data.

**Date:** Tuesday 24 May 2022

**Duration**: 01:13

**Place:** Online

**Interview highlights:**

- Italy is still at the beginning of its experience regarding the adoption of BIM-GIS integration patterns.
- Italian context is mainly characterised by small local authorities and small companies/firms: It is an added value because in small contexts it is easier to apply change if a decision is made, including in introducing BIM.
- Main issues in the process of integration between BIM and GIS are:
- Number of subjects - it is unthinkable to reach the large number of local authorities and private companies/firms through regular training courses;
- Scarce networking skills - it is difficult for small companies to have a person who is an expert in BIM, energy efficiency and many other aspects. It would be important for them to specialise and collaborate to integrate their skills. The same applies to small municipalities.
- There is a need for a new advisory figure to support small municipalities and small enterprises, who is expert both in BIM and GIS and can therefore help the different actors as external consultants.
- Professionals in charge of managing the integration of BIM-GIS should:
    - Be able to visualise the model and understand if it is well made, not so much being able to design.
    - Hold a degree in architecture or engineering or diploma as land surveyor - in any case with previous professional experience in building design. Experience is more important than qualification for this specific purpose.

[10] https://www.ibimi.it/

- Have strong transversal and personal competences, such as management skills; negotiation because you will find yourself between conflicting positions; communication; and networking skills.

- With a view to BIM-GIS integration, and given the required ability to read models in different languages, it seems interesting to work on the figure of the Common Data Environment Manager.

**Full interview:** https://medium.com/@birgit_project/birgit-interviews-anna-moreno-italy-c68798b76178

### *4.2.3 Interviews in Spain*

**Interviewee name:** Yoana Lara

Yoana studied Industrial Technical Drawing in the IES Virgen del Camino and after that, she has run a wide variety of complementary training courses (Naviswork, Plant 3D, Revit 2018, Revit Architecture, AllPlan, Presto, Autodesk inventor, AutoCAD, etc.). The main software/tool she uses on a daily basis are Autocad, Topocal, Revit, Photoshop and Plant 3D. Currently, she is working in AIN as a BIM modeller and her main duty is the delineation and modelling of industrial projects.

**Date:** 19th September 2022

**Duration:** 30 minutes

**Place:** AIN Asociación de la Industria Navarra. Cordovilla, Navarra

**Interview highlights:**

- Yoana highlights that BIM includes a lot of information, many programmes, because it's a methodology.
- Regarding the situation in Spain, it is something that is emerging right now.
- Regarding the potential for use of the integration, she thinks that the greatest potential for use is in civil works, everything related to environmental impacts, such as the creation of a railway, a track, facilities in a field.
- It's impossible to find courses that train you in this field. Academic offer is very low or almost non-existent. In fact, for several years, she has tried to get training in courses and she has only managed to do a very short course many years ago.
- There is a big lack of people who have these skills/competences.
- She believes that is more important knowledge than experience. It's basic to have knowledge of databases and programs because one program in itself doesn't cover

all the aspects that the integration would need. Besides, it's fundamental to keep training and learning, and it is important to search what the government's websites offer because you have to take into account many environmental issues and you have to look for a lot of information.

**Full interview:** https://medium.com/@birgit_project/birgit-interviews-yoana-lara-spain-f4696d72ebc5

### *4.2.4 Interviews in Croatia*

**Interviewee name:** Ivan Cigrovski

Graduated from the Faculty of Geotechnical Engineering in Varaždin. From 2008 to 2009 worked as a construction site manager in companies Stipic Građevinarstvo and MGT. 2009 when he became co-founder of company Intelika, he started work in BIM, using design in Revit for high-rise construction. In 2014 co-founded company GO2BIM where work as a BIM Manager and Revit Consultant and modeller.

**Date:** September 5th, 2022

**Duration:** 47 minutes

**Place:** Online

**Interview highlights:**

- It is difficult for someone who is not educated in BIM design to understand exactly what BIM is and what exactly GIS is.
- BIM-GIS integration is a collaboration between systems that must be compatible and well connected, the second segment of integration is related to the compatibility of software packages.
- as a company they have no ambitions to deal with both, BIM and GIS, because that way they become uncompetitive on the market.
- their clients are looking for one type of product, and how it will end up in GIS is left to others because there are no candidates who come with knowledge of BIM and GIS
- new employers are "potential" not "experts" - they created educational materials, sent to candidates who could learn materials within two weeks
- so far, they have not received a candidate with the necessary knowledge, without company education
- candidates come with poor software knowledge but also with a low level of professional knowledge

- the skills needed for the GIS/BIM integration are IT literacy in every segment, knowledge of Revit and ArchiCAD and fieldwork experience

**Full interview:** https://medium.com/@birgit_project/birgit-interviews-ivan-cigrovski-croatia-a8086b45daf9

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**Interviewee name:** Dražen Galić

Graduated from the Faculty of Civil Engineering in Rijeka in 1986 and obtained his master's degree in Ljubljana in 1992, in the field of geomechanics. From 1986 to 1996, worked as an assistant and lecturer at GF Rijeka, in the field of geomechanics and hydraulic engineering. From 2008 to 2014, he taught a GIS course in municipal engineering as a part-time lecturer. In 1991 founded the company StudioARS, where he has been the director since 1996. He is part of the team implementing BIM technology in Croatian roads and of the team that created the manual Guidelines for the BIM approach in infrastructure for the HKIG (Croatian Chamber of Civil Engineers).

**Date:** 1st September 2022

**Duration:** 01:36

**Place:** Online

**Interview highlights:**

- He believes that the terms BIM and GIS should be analysed from different aspects, if they are properly defined, only then can we talk about mutual positive influences and some level of integration
- Integration in the sense of unifying data is possible, while unifying these two technologies is not possible - it is possible only by mutual use of these technologies in special phases and procedures
- GIS has a quality presence in faculty programs, BIM programs are in the creation phase, but Faculties cannot provide completely ready "up to date" experts, and this should not be expected
- Every organisation, company or institution must take care of adequate targeted education
- The integration of BIM-GIS does not represent the desired profile in terms of job profiling; therefore, the previous experiences are not universal because the concepts should be viewed separately

- Candidates with software knowledge do not have an advantage in employment, the advantage would then be given to a person who shows social and other learning capacities

**Full interview:** https://medium.com/@birgit_project/birgit-interviews-dra%C5%BEen-gali%C4%87-croatia-f30889395b9c

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**Interviewee name:** Leon Šagovac

Leon Šagovac has a master's degree in business management. He is a Managing Director at GDi Croatia, member of the GDi Group. He has more than 20 years of professional experience in information and communications technology, products, and services industry; from technical engineering roles, consultancy, sales, and marketing to executive management positions in operations and product development and also in GIS, IT, mobile telecom, location-based services, transport, financial services, complex management projects, application design and development, database design and implementation, guidance and training, support, etc.

**Date:** September 15, 2022

**Duration:** 41 minutes

**Place:** Online

**Interview highlights:**

- integration is no longer a technological issue
- BIM can load data from the GIS world, but compatibility of software packages works under certain conditions
- integration itself should not be seen as model or data integration, but as process integration
- approached to a workplace that would combine competences for the GIS/BIM integration needs to be multidisciplinary, combining knowledge from several domains
- knowledge of the software is necessary, but it is also necessary to know how they work together
- the skills needed for the GIS/BIM integration are modelling of the GIS database and the BIM model, how to connect GIS models with BIM models, knowledge of digitization of business processes and IT integration

- the soft skills needed for the GIS/BIM integration are understand the perception of space, creativity, critical thinking about the real needs of the industry

**Full interview:** https://medium.com/@birgit_project/birgit-interviews-leon-%C5%A1agovac-croatia-ce230d2d1881

## 4.3. The BIRGIT Online Survey

The BIRGIT survey "*Survey on the demand for BIM-GIS integration skills*" aims to identify demands on knowledge, skills and competences of the workforce needed for BIM-GIS integration. It focuses on training and education in the areas of AEC (Architecture, Engineering and Construction) and geospatial technologies. The survey was launched on the 01 June 2022 and is still open to receive input from respondents. Nevertheless, the results of the survey analysed in this report correspond to the 53 answers received until the 20 September 2022.

The survey is available at the following URL:
https://ec.europa.eu/eusurvey/runner/BIRGIT_survey

The dissemination and promotion of the online survey required an important effort from all project partners that were provided with the required information in order to properly disseminate the survey within their networks. In addition to the multiple communications and calls for participation in their respective networks of contacts, it is worth highlighting the promotion of the survey in an article in the project coordinator LinkedIn profile, several entries in the project's twitter account (https://twitter.com/birgitproject) and in various Facebook groups. Also, a dedicated page in the project website (https://birgitproject.eu/survey/) was created and used as a main reference in all communications related to the survey.

### *4.3.1 Survey structure*

The survey was designed with the main aim of identifying concrete demands on knowledge, skills and competences of the workforce needed for BIM-GIS integration. In addition to the interviews responses, the idea was to create a questionnaire mainly made of multiple-choice close-ended questions in order to collect responses within a limited frame of options. With close-ended questions we can obtain data that is clean and easy to analyse. The time required to complete this survey is around 10-15 minutes.

The complete list of survey questions, together with a link to the graphical results, is available in the Annex 1 of this report.

The survey is structured in 3 sections:

- Section 1: You and your organisation (Profile)
- Section 2: Industry demand of BIM-GIS integration skills
- Section 3: Perspectives on BIM-GIS integration

Section 1 is aimed at collecting information regarding the origin and professional profile of the respondents. This section is also asking for information on the type of company/organisation in which the respondents work.

Section 2 aims at getting insights and eval University of Rome ating the status of the adoption of BIM-GIS integration in the countries of the respondents as well as the status of the training / education offer dealing with BIM-GIS integration in these countries. This section also aims at assessing the job market requirements for BIM-GIS integration works. For this, the respondents are asked to specify and assess the required expertise level for a number of technical, methodological, procedural and organisational competencies and skills required for a BIM-GIS integration job.

Finally, section 3 is aimed at getting insights into the future of BIM-GIS integration. This section also has open-ended questions aimed at getting from the respondents their own views regarding specific measures and actions to strengthen BIM-GIS integration.

The questions in section 1 with multiple choice were mandatory. For the skills assessment questions in section 2 (based on the rating of the importance of a given skill), the reply was not mandatory.

At the end of the survey, participants were offered the possibility of optionally communicating their personal data in order to be informed of the results of the survey and of the project in general. The management of this information is done in compliance with the Directive 95/46/EC (General Data Protection Regulation). In this sense, 21 respondents agreed on leaving their personal information.

*4.3.2 Survey results*

The analysis of the survey results is taking into account the 53 questionnaires filled in on 20 September 2022. The survey is still open and questionnaires received after the closure date will be analysed subsequently and taken into account, but will not be part of this report. The survey response is not ideal, but reasonably enough for the further analysis and further implementation of the project.

The EU Survey tool permits to filter the results based on selected criteria. This feature is extremely useful when analysing the results of the surveys in relation to aspects such as the origin of the respondents or their professional profile.

Find below an analysis of the main findings from survey responses grouped for each of the survey sections. The complete survey results and figures are available in Annex 1 of this report.

**Section 1: You and your organisation**

Regarding the type of organisation in which our respondents work we can say that almost 50% of them are linked to small and medium enterprises (SME). We should highlight that, while practically all BIM professional profiles work on SME's, an important number of GIS

professional profiles come from the Education&Research and the Public Administration domains. This fits well with the fact that traditionally BIM is mainly largely used in the private sector while GIS is of common use in the Public Administration entities and government agencies.

Regarding the number of answers by country, we can say that the distribution is quite balanced, although it is worth noting the high interest from respondents in Croatia.

- Croatia: 14 respondents
- Italy: 12 respondents
- Spain: 6 respondents
- Sweden: 9 respondents
- European organisations: 3 respondents
- Other countries: 9 respondents (Cyprus, Greece, Malta, Belgium, Bosna Hercegovina, Estonia and Albania)

Also, the professional profile of our respondents is well balanced. We can say that practically half of the participants come from the GIS domain and the other half from the BIM one. But the two worlds don't mix much: Only two respondents from the BIM side also defined themselves as GIS data/service users, and only 4 respondents from the BIM side defined themselves professionally using also a GIS profile, meaning they have GIS knowledge to some degree.

Regarding the business sector in which our respondents work, we found heterogeneity in the results so a more in-deep analysis was conducted based on filtering the results by different criteria. Overall, the most popular sector (50%) was Architecture, Engineering and Construction (AEC), followed by respondents linked to the Training and education sector (30%). As expected, respondents that defined themselves with BIM professional profiles are mainly involved in the AEC sector. For instance, in our survey we received 26% responses from Croatia (the country with more participants) and that of these the majority (71%) were people with BIM professional profiles and working mainly in the AEC sector. It is also noteworthy that an important part of the GIS professional profiles work mainly in the Training and education sector (almost 40%) and in the AEC industry (22%) and not much on the traditional sectors linked to GIS as environment and urban planning.

We also asked if the companies in which our respondents work organise training activities and the answer was that 80% of the companies/organisations do carry out some training activity. This fact corroborates the importance that upskilling activities and internal continuous training have today in the companies. Overall, 50% of these organisations conduct both distance learning or in-house training as main training activities. In house training and webinars are by far the most popular training actions in AEC companies and among BIM-related job profiles.

31 out of 53 respondents define their companies /organisations as “training providers” showing that an important part of the respondents has a direct relationship with training tasks in BIM or GIS. Most popular educational programs/levels addressed by these training providers are Master or equivalent followed by Vocational training (VET). Of course, university programs are mainly delivered by universities and research institutions while vocational training is delivered mainly by SME’s and VET Providers.

As a final note, since only 38% of the respondents agreed on leaving their personal information, we cannot clearly establish a gender division between our participants. Nevertheless, from the 21 answers with personal information attached we can see that 33.33% are female.

**Section 2: Industry demand of BIM-GIS integration skills**

The first question in section 2 was one of the most important questions of the survey and it was aimed at evaluating the status/maturity of adoption of BIM-GIS integration in the countries of the respondents. Overall, the final result shows us, as expected, the absence of a mature / well-developed status in any country. Also as expected, more than half of the responses point to a state of emerging/early adoption of the integration.

Responses from Sweden and Spain show a clear tendency to evaluate the status of adoption as “emerging/early adoption”. In Croatia, while the majority of respondents think that the status of the adoption is in emerging/early adoption a third of the respondents from this country think that the status is “In growth”, so in a more advanced step. It is important to highlight that in the case of Italy, the same number of respondents thinks that the status is “emerging” and “in growth”, demonstrating that in this country the integration is maybe in a slightly more mature stage than in others. The responses from the interviews also indicate that Italy is probably the country of the consortium where integration practices are in a more advanced state of development.

Another key question in this section was aimed at identifying the more popular fields of application of BIM-GIS integration workflows or the fields where the integration has more potential to be used. It is therefore interesting to analyse the overall results, in particular, the responses for each country. Users were able to choose as many options as they wanted and the final result gave the following ranking:

1. Land use and Urban planning
2. Architecture
3. Roads and highways

It must be said that other more specialised options like underground networks, facility management, railways and bridges were far from the first places but received also significant attention. Regarding the professional profile of the respondents, there is no significant difference between their choices. Finally, the most selected result by country were the following:

- Croatia: Architecture
- Italy: Utilities underground networks
- Spain: Land use and Urban planning
- Sweden: Roads and highways

Respondents from other countries consider as main applications Land use and Urban planning and Roads and highways. It is interesting to note how the field of underground facilities management is perhaps the field in which integration receives more attention at the moment in Italy.

Section 2 also focuses the attention on the needed education level and background for the BIM-GIS integration job applicants. In this sense the results are quite clear: Respondents overall consider BSc and MSc equally as the desired education levels for candidates for these kinds of jobs. Although a certificate in professional/vocational training is also well considered, advanced academic education seems to be a clear requirement for carrying on BIM-GIS integration tasks.

Regarding the disciplines best well rated as background of the job applicants, we can say that the clear preferences when hiring are from the domain of engineering, architecture and geoinformatics. Respondents with BIM-related professional profiles consider that the ideal background is Architecture and Engineering. Respondents from the GIS sector think that background training in Geoinformatics is essential but also studies in disciplines like Geodesy, Geography or Cartography are relevant when dealing with BIM-GIS integration.

The survey has been useful to get a clear response regarding the identification of the current main providers of training/education dealing with BIM-GIS integration. In the first place, the main actors are Software vendors. In fact, as verified in task 1.1, the availability of training resources (mainly video tutorials and hands-on training) coming from companies like Autodesk and ESRI dealing with BIM-GIS is very large. Respondents with BIM-related professional profiles consider that the main training and education comes mainly from software vendors and also from consultancy companies. Instead, GIS-related respondents consider that main training / education providers dealing with BIM-GIS integration are Universities, even if they recognize the importance of Software vendors. We think that the vision from the BIM respondents is closer to the reality and that nowadays most training on BIM-GIS integration is definitely happening outside academic institutions and HEIs.

Software vendors (mainly Autodesk and ESRI, the most important players of the market) are currently offering a rich portfolio of BIM-GIS integration online training resources, obviously focused on the single or joint use of their own products and applications. According to our respondents, leaving aside the offer of software vendors, the training offered by universities or professional training centres is clearly insufficient to cover the industry needs on this emerging topic. We agree on this mismatch between offer and demand. This lack of training seems to be a clear obstacle in the growth and mainstreaming of BIM-GIS integration. This notable gap is also recognized and confirmed in the interviews.

When asking our survey participants about the level of preparation of candidates for jobs requiring BIM-GIS integration, the overall response is that the skills of these candidates are partially covering the job requirements meaning that they will definitely need further training and need to learn additional skills. The same is happening for existing employees: Current professionals from the Geospatial and AEC industry need to upskill or reskill if they want to carry on BIM-GIS integration tasks.

The most important part of the BIRGIT survey deals with the identification and assessment of concrete competencies and skills required to cope with BIM-GIS integration. For this, our respondents were asked to rate as "*basic*", "*intermediate*" or "*expert*" the expertise level for an important number of concrete competences and skills. To make the survey less heavy for our respondents, responses were optional. The following analysis will mainly consider the overall final result but, when relevant, some differences on the weight given to each skill depending on the professional field of the respondents (BIM or GIS), is also provided. In almost all areas, the responses, whether coming from BIM or GIS experts, express the tendency to recognize the need for intermediate skills and, in most cases, advanced ones. Therefore, we can say that BIM-GIS integration deals with a large number of skills where an advanced level of knowledge is essential.

From the analysis of the general competencies required, we can say that the starting point for BIM-GIS integration work is, without a doubt, solid fundamental knowledge in both disciplines, at least and especially the basic principles. The same is happening regarding the use of BIM and GIS software: Whether they are BIM or GIS professionals, they both think that it is essential that the level of use of tools from one domain or another should be (at least) at an intermediate level to successfully address integration tasks. A lot of importance is given to a required advanced expertise on the Design of integrated BIM-GIS databases. In fact, in BIM-GIS integrated workflows, geoinformation and infrastructure design data sources are brought together, so a lot is usually happening on data integration and preparation tasks (for instance IFC-CityGML integration).

In order to have as much detailed information as possible on required skills the respondents were asked to give their opinion on the expertise level required for different skill sets. The first skill set was referring to personal/soft skills, and the assessment of this kind of skills revealed interesting findings. First and most important is the extreme importance given to collaboration and teamwork skills: Integration work necessarily involves collaboration between various professionals with experience in different fields. Also, in this sense, another very important aspect highlighted by all respondents is the need for advanced expertise in project coordination and management. Finally, 66% think that the ability to see the whole picture, (holistic thinking) is crucial. On the other hand, no or low importance is given to other soft skills such as customer relationships, business related competencies, leadership, languages or creativity.

The next two skill sets to be assessed referred to concurrent use of BIM and Geospatial data. Projects where BIM and GIS integration have great added value attached imply the need of mass data, both static and dynamic, current and historical, geometrical and semantic,

microscopic and macroscopic. Again, respondents answered the need for very solid skills on basic principles i.e. fundamental knowledge for the management of both BIM and GIS data.

Regarding specific BIM data skills, much importance is given to 3D modelling tasks and use of model-oriented software. Knowledge in data specifications and other standards (such as IFC) is also valued. Regarding specific GIS data skills, we can highlight skills on 3D GIS, georeferencing, map projections and resampling data tasks. From these results we can conclude that advanced skills on BIM and GIS data handling are needed, since the evaluation level for these skills are always between intermediate and expert level. For BIM professional profiles the responses in terms of BIM specific skills indicate a predominance of requiring high expertise when dealing with BIM modelling and work with BIM data formats, but there is not much agreement on what level of experience is required in geospatial data operations.

Regarding data capture, overall importance given to these particular sets of skills (both from BIM or GIS professionals) is intermediate to low. In fact, knowledge of different data capture technologies is considered important but never at an advanced level.

An essential part, if not the most important, of the integration work between BIM and GIS has to do with direct work with specific tools capable of working with BIM, GIS or both types of data. This implies the use of connectors or importing features. This is done often by enabling BIM systems to connect to 3D GIS data but also (although to a lesser extent) the other way around, enabling GIS systems to support BIM data formats.

Overall, from our survey, knowledge of GIS Software is considered important at an intermediate level. ESRI's ArcGIS Pro is considered the most relevant software of all those on the GIS software list. Responses regarding GIS software from BIM professionals indicate a significant lack of knowledge of these tools, since half of the respondents have no opinion on this.

Regarding knowledge of BIM software and tools, the overall importance given to skills on the use of different tools is also intermediate. Autodesk Revit is the software best known overall, followed by Autodesk Civil 3D and Autodesk InfraWorks. Among BIM professionals, advanced knowledge in Autodesk Revit is considered to be by far the most valuable.

Other software products not related to ESRI or Autodesk receive little or no attention. Finally, it is important to highlight that knowledge of the IFC specification received in the survey, is considered of high value, especially among BIM professionals.

Overall, Programming and Development skills received a relatively low value attention. From the answers, a disparity of opinions is evident from those who give importance to this type of skill to those who give very little relevance to them. We could highlight the importance of skills related to requirement analysis and identify user needs and the use of scripts, but in any case, the need for this kind of knowledge remains on an intermediate level.

On the contrary, much attention and importance is perceived in adopting GIS and BIM standards. This specific skill, at expert level, is one of the most important from the survey and confirms the importance of advanced knowledge in the use and implementation of standards and their essential role in interoperability between systems.

Finally, organisational and institutional aspects that have a role in BIM-GIS integration workflows, such as legal, business and policy related aspects, received little attention and therefore they were evaluated requiring mainly a basic to intermediate level of knowledge.

**Section 3: Perspectives on BIM-GIS integration**

The final section of the survey was devoted to discovering trends and important aspects related to education and training to be considered for the future reinforcement of the BIM-GIS integration.

Our respondents were first asked about the importance of investing in continuous training for employees, and 40% of them considered this assumption as very important, regardless of the origin or professional profile of the respondents. Regarding other education-related aspects, our respondents also gave much importance to work on real-life business cases (case-based learning). Other aspects such as Internships or thesis work in companies are considered important but to a lesser degree. The responses thus demonstrate clearly the importance of processes of upskilling employees to fill workforce skills gaps.

The last set of questions of the survey were open-ended questions meaning the respondent was free to answer in a text box their opinion. Being optional responses, not a lot of responses were collected, nevertheless we analyse here a few interesting insights. When asked about other training/education actions recommended to strengthen BIM-GIS integration, some responders insisted on the need of providing more training in the companies to add new skills to the employees. The kind of skills to be reinforced were mostly related to use of software, knowledge on standards and data interoperability operations. The interest in strengthening standardisation should be highlighted as a key aspect for BIM-GIS integration. Finally, even if education outside the company's walls received poor attention in the comments received, the importance of introducing the topic of BIM-GIS as mandatory was mentioned in civil engineering and architecture applications.

Interesting thoughts were also collected when asking about factors limiting the adoption of BIM-GIS integration. One of our respondents replied “too many skills and knowledge for an individual”. This fact is based on the widespread assumption that the person responsible for the integration of the two systems must be an expert in both fields and that it is very difficult to find a professional profile with these skills. Other interesting limiting factors collected were:

- Not enough time for current employees to up-skill themselves
- Lack of awareness of needs, possibilities and opportunities of BIM-GIS Integration
- Expensive software to be bought and expensive training for employees
- Little desire to learn new technologies and workflows in companies (for instance still using CAD and not BIM)

When asked about the future of BIM-GIS integration, our respondents replied with a mix of optimism but also with realism, aware that there is still a long way to go. According to our respondents, in the future, and thanks to the need to adapt policies that include the obligatory

use of BIM systems, the use of these systems would be widespread and this will therefore reinforce BIM-GIS integration making the job market and the demand for professionals dedicated entirely to integration grow. This fact was clearly stated also by some of our interviewees.

Finally, another aspect highlighted by our respondents is that the availability of more and better examples and best practices of BIM-GIS integration from countries where these practices have been operating for years, such as the US, Taiwan and the UK, will have a multiplier impact in countries such as Croatia or Spain, still at the beginning of the adoption of integration workflows.

## 4.4. BIM-GIS integration status in Europe

The objective of this section is to offer, for each of the countries participating in the project, a brief summary of the current situation in relation to the integration of BIM-GIS systems. For this, the results of the online survey, the interviews carried out and desk research investigation have been taken into consideration.

### *4.4.1 Sweden*

It is still not compulsory to use BIM in Sweden, but there is a requirement from all the bigger government agencies to deliver drawings etc. with BIM when working on large projects. There is also proposal to the government to include it in the law:https://www.riksdagen.se/sv/dokument-lagar/dokument/motion/inforande-av-krav-pa-bim_H802872. In addition, there is a new legal requirement since January 2022, that every new construction should provide LCA (life-cycle analysis). Carbon footprint of the materials and building-process is the main focus of these LCAs. In the same time, the footprint can be decreased up to 30-50% with effective planning, which makes BIM-use crucial. Without BIM, it would be hard to reach the sustainability legal requirements, even if BIM itself is not required.

One of the biggest BIM users in Sweden is the Swedish Transport Administration, Trafikverket. We interviewed a representative of this agency, Peter Axelsson, on their practice (see 4.2.1.). One conclusion was that the agency works in close cooperation with big private consultancy companies. These companies indeed represent the main actors in the Swedish BIM-GIS integration and in the development of this field here. In particular, we can name e.g. Tyréns with their GeoBIM Portal (https://www.geobim.se/) or Sweco (https://www.sweco.se/vart-erbjudande/digitala-losningar/databearbetning-och-automatisering/gis-och-geodata/), who uses it in, e.g., analyses of noise, solar radiation or storm water as well as in complex BIM models. In contrast, the academic sector has not taken up the integration yet.

The City of Goteborg provides probably the most complete description of a BIM-coordinator and BIM-manager roles in their CAD/BIM requirement brochure (https://goteborg.se/wps/wcm/connect/970d12dc-a1ed-4b0c-9771-de61152ccafa/RA-1820-v.9.0_CAD_BIM-kravspecifikation.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=970d12dc-a1ed-4b0c-9771-de61152ccafa). We have not found any equivalent for the GIS-coordinator.

### *4.4.2 Italy*

As confirmed by the results of the survey and the opinion given by the two interviewees, regarding the adoption of BIM-GIS integration, Italy is still at the beginning of its journey. There is an increasing demand for skills in the field of BIM and GIS for infrastructure management and in this sense, it is important to highlight the domain of underground services, an application field in which we have not observed great interest in other countries. It is also worth mentioning the need for extensive monitoring of a big number of infrastructures (specially bridges) and therefore also the environmental context of these infrastructures.

The Italian context, although it does not clearly differ from other countries, has its peculiarities. One of them is the big number of small companies/firms involved in the AEC sector, and the other is the good predisposition of these companies in the adoption of BIM. It is therefore a well-developed private sector in GIS and BIM technologies that can benefit from the GIS/BIM integration approach. The negative part is that this fragmentation of the market makes it very difficult to provide training courses to all.

For this, the promotion of a professional figure to support small municipalities and small enterprises, who is expert both in BIM and GIS is key. According to our interviewees, this professional profile (mainly a kind consultant) must have demonstrated experience and strong communication and project management skills.

There is a growing training offer from private education providers and software resellers in relation to BIM-GIS integration and it should be mentioned that this training is closely linked to commercial products from Autodesk and ESRI. On the other hand, training programs in universities dedicated to BIM-GIS Integration are almost non-existent (with some exemptions, e.g., TU Muenchen and summer school from the Sapienza University of Rome). Training offered in BIM is still scarce and concentrated in MSc programs, mostly specialised in vertical BIM. It would therefore be important to promote new postgraduate programs based on BIM for infrastructures (horizontal BIM) and with a strong focus on GIS skills.

The role of public authorities is also very important. The increasing availability of open GIS data by municipal administrations undoubtedly offers many possibilities for the implementation of BIM-GIS integration techniques. However, it is important that awareness of the existence of these data grows and that administrations encourage construction companies to use them.

Finally, it is important to mention the positive role that the legal/policy context regarding BIM in Italy will have on promoting the use of BIM and consequently greater possibility of integrated use with GIS. The iItalian «BIM law» (2021) from the Ministry of Infrastructure and Transport makes BIM mandatory in new construction works and interventions on existing buildings.

### *4.4.3 Spain*

Regarding the development of BIM structures, there is still a long way to go. 8 of the 100 largest construction companies in the world are from Spain. Spain has the second largest high-speed railway network. There are 52 airports, almost 1,000,000 professionals of which 200,000 are architects, technical architects or civil engineers.

It is a fragmented but very experienced sector working in a large part of the world and with a great deal of experience in the development of infrastructures. However, it is still a sector in need of improvement because it needs to increase its productivity and competitiveness. Introducing collaborative methods and increasing the rate of digitalisation. This means that BIM has been seen as an opportunity for the sector.

Large construction and engineering companies have been using BIM since 2010 but mostly in international projects. There are projects in other emerging countries, such as the Middle

East, where the use of BIM was in demand and these large companies had to start using the methodology in their own companies.

Since 2015 there has been a BIM commission of the Ministry of Development where it was announced that the mandatory use of BIM in public works was going to be introduced progressively. For building works from 2018 and for road works from 2019. For other uses this mandate will be introduced progressively. This mandate was created with the purpose of:

- Establishing a strategy to achieve a maturity level regarding BIM
- Promoting the use of BIM in professional and educational fields
- Establishing an implementation calendar

At a national level, BIM is used for the design of bridges, rails, buildings and so on. (https://cbim.mitma.es/proyectos/sustitucion-de-tirantes-del-puente-del-centenario-situado-entre-el-pk-10000-y-el-pk-12000 ; https://cbim.mitma.es/proyectos/obras-de-acondicionamiento-del-edificio-de-uso-administrativo-sito-en-la-plaza-del-marques ; https://cbim.mitma.es/proyectos)

Currently, the use of BIM is not mandatory in Spain (excepting Catalonia), nevertheless public organisms are increasingly asking to use BIM in their projects and constructions. Among these public organisations we have found: ADIF (rail infrastructure administrator), AENA (Spanish public company that manages the airports), Renfe (the leading passenger and goods rail transport company in Spain) and Correos (state company responsible for the provision of the postal service in Spain).

Public procurement helps to maintain innovation in the use of new technologies, otherwise companies become comfortable and do not invest in innovation because clients do not ask them to do so. The step taken at the national level by the General State Administration to create an inter-ministerial commission focused on this aspect of public procurement is very important. Taking into account that they are evolving more and more and we have more standards of all kinds, both formats and normative rules, all of this is evolving.

Public demand for BIM has increased in recent years and the investment made has been very large. By type of infrastructure, mainly road and rail projects and works have been encouraged, and to a lesser extent water and maritime projects.

There is a need to make IFC the tool for sharing information between project partners. In recent years the growth of software solutions around BIM has been exponential, which makes interoperability more complex.

When it comes to integration of BIM and GIS there is a tendency to work with both. However, there is still a lot to do, as there is a huge lack of training courses in this area. Organisations which integrate BIM and GIS do it by integrating GIS in BIM programs such as civil 3D, infraworks, Autodesk…)

As mentioned, the integration is still in an early stage. Nevertheless, the integration is mainly used in photovoltaic and wind installations and in road projects. Additional application areas

are for route marking, for checking if it is a flood zone, for checking if there is any protected animal or flora species and so on.

In Navarre, BIM and GIS are mostly used in planning, design, construction and functionality of infrastructures.

*4.4.4 Croatia*

Based on the results of the surveys and three interviews that we have attached, the integration of BIM and GIS in Croatia has hardly even started yet. According to the interlocutors, one of the reasons for the lack of understanding of integration lies in the fact that the academic community recognizes GIS as a necessary skill and trains students/users for it, while BIM education is not conceived as an independent course. It is integrated within other courses or is based on the level of education for a particular software. Education for individual software is mostly carried out within individual companies, depending on their needs. Accordingly, the concept and possibilities of BIM are not sufficiently explained to users, so the connection of BIM and GIS doesn't even occur.

It seems that it is necessary to educate candidates so that someone educated in BIM design can understand what GIS is, and vice versa. The knowledge of an employee who would unify and understand the integration of these two skills should be multidisciplinary, combining knowledge from multiple domains that include IT literacy in each segment, knowledge of GIS and BIM concepts, software knowledge, and field work experience.

In the domain of market needs for BIM products, although there is a register of BIM companies in Croatia and apparently a lot of companies work with BIM, regarding the survey and interviews conversations with companies, conclusions are that BIM mostly remains in the domain of architecture and a minor part in road management. Unlike BIM, GIS is integrated in a much wider range of uses.

Our interlocutors believe that smaller companies don't have access to GIS tenders. Related to that, there is a big difference in the needs of smaller and larger companies for possible integration. Smaller companies, although aware of the need to integrate BIM and GIS, don't see their interest in developing in both directions due to the limited needs of the market, because investors are not ready to pay for integrated BIM and GIS projects despite all the advantages they bring. The large company we interviewed (e.g. GDi Croatia) fully understands and supports integration. Smaller companies think that they should stay in one domain, while for the integration itself they should hire external associates.

GIS has been in the market for a long time, and everyone understands the benefits of using GIS. In BIM, according to our interlocutors, there is still a lot of work to be done in cooperation with state institutions to make the market accessible to everyone. The interlocutors think that it is important to organise logistical support for the purpose of digitising public administration and connecting the administration and companies dealing with BIM and GIS. In addition, they believe that integration itself should not be seen as integration of models or data, but as integration of processes. The integration procedures must be prescribed by the state

institution with the appropriate rulebook and/or standard. Until it becomes a commitment, they believe that integration will not be possible.

*4.4.5 Rest of Europe and beyond*

The integration of BIM and GIS in construction management is definitely a new and fast developing trend in recent years in Europe and the rest of the world. Nevertheless, there is no literature that gives a clear vision of the state of adoption of these techniques in the European or global context, at least not analysed in depth. Available articles usually focus on one issue, analysing the applicability of integration for a particular area (for instance for bridges).

An early investigation of current state of implementation of BIM-GIS integration in Europe was carried out by the GeoBIM project[11] managed by EuroSDR, the research association of European National Mapping and Cadastral Agencies (NMCAs). This two-year project, ended in 2020, aimed at developing a coherent/uniform view on BIM-GIS integration (or "GeoBIM", that is the term they use). The project focused on the provision of best practices for integration of Geo-data in BIM processes and software and established the state of play of the integration in Europe by means of a survey involving the 11 participant countries in the project.

As expected, the GeoBIM survey results showed very varying levels of BIM-GIS integration maturity across the participating countries. Regarding awareness, the survey gave a picture where pretty much all countries see added value of linking BIM and GIS despite technical and non-technical challenges but, in terms of activities, the implementation varies very much from one country to another. From the results of the survey, amongst the NMCAs the Norwegian Mapping Authority reports the highest number of GeoBIM-related activities. It is also to highlight relevant activity in the Netherlands, Sweden and Switzerland. On the other side, at the time of the survey (2020) Poland and Ireland have limited awareness of the subject and a very low number of ongoing activities.

It is important to highlight from the GeoBIM survey the very limited work at the time performed at national level by the public administrations. All the work in integration was done at project/company level and we think this fact is still occurring today.

Regarding the current role of European institutions in BIM-GIS integration, we can say that the supply of open spatial data in the European Union is growing due to several regulations set by the European Commission (such as INSPIRE and Open Data) and that this availability is permitting a bigger use of Geodata integration in construction processes. Also, permission policies for building and construction requiring the use of BIM and GIS data are currently being implemented in several European countries, boosting the use of integration. In fact, national legislations are an important driver in the adoption of BIM: Countries including Italy, the Netherlands, Denmark, the UK, France, Finland, Norway, Sweden, Catalonia and Ireland have existing or emerging BIM mandates, with other countries presenting a slightly more fragmented and less developed picture on the legal side.

[11] https://3d.bk.tudelft.nl/projects/eurosdr-geobim/

Regarding international standards involved in the BIM-GIS integration, it is essential to talk about already mentioned IFC and CityGML. The IFC (Industry Foundation Classes) exchange format was developed by the International Alliance for Interoperability (now known as buildingSMART) and provides a formalised representation of typical building components. CityGML is an open data model for the storage and exchange of 3D city models, based on Geography Markup Language (GML3) and is an Open Geospatial Consortium standard. According to the GeoBIM project survey, CityGML and IFC are the most used international standards in Europe, but while in some countries like Finland their use is widespread, in other countries such as Poland they have hardly been introduced yet. Another interesting project, the GeoBIM benchmark 2019[12], funded by ISPRS and EuroSDR, evaluated the state of implementation of software tools, addressing these reference standards in Europe. The results provided by the project highlighted several problems with existing GIS and BIM tools supposed to support IFC and CityGML, especially regarding the quality of data conversions.

BIM-GIS integration is not only about software. The utilisation of BIM-GIS integration in the AEC industry requires new and innovative management methods and coordination mechanisms, new mathematical modelling methods and the adoption of ontologies to overcome semantic barriers. But software is still the main issue. The number of programs that allow combining BIM and GIS data is limited. Nowadays, BIM-GIS integration heavily relies on the adoption of several commercial solutions. The integration between BIM and GIS is a theme closely followed by ESRI and Autodesk for years. There is actually a strategic alliance between these two big companies in this sense that focus on providing a shared software environment. In fact, both ESRI and Autodesk are moving from pure data interoperability and simple reading of different formats through extensions to permit working with different data formats without any kind of conversion.

For instance, regarding ESRI, it is possible now to drag IFC, Revit or Civil 3D data into an ArcGIS Pro map or connect to BIM360 or Autodesk Construction Cloud though the new ArcGIS GeoBIM application. Autodesk products are currently the most commonly used across Europe by Architects, infrastructure planners, designers and managers. Autodesk is a clear market leader in Europe: According to the 2021 report of USP Marketing Consultancy's European Architectural Barometer, 45% of architects use Autodesk REVIT as BIM software, and Autodesk actually has a market share of 66% in the CAD category. The runner-up is Graphisoft's ARCHICAD, which is used by about one-third of architects as BIM software. Inside Autodesk Civil 3D and Autodesk InfraWorks you can now access ArcGIS online directly via the connector available permitting using, managing and editing GIS data directly from the BIM system. Also, Like ESRI'S GeoBIM, Autodesk BIM Collaborate Pro allows AEC teams to seamlessly collaborate and manage using data from multiple systems in a geospatial context.

## 4.5. Conclusions

BIRGIT's task 1.2 (survey of industry needs) aims at describing, with a focus on the countries participating in the project, the needs of the industry and end users in terms of required knowledge, skills and competences for BIM-GIS integration. In order to collect this information,

[12] https://3d.bk.tudelft.nl/projects/geobim-benchmark/

two main subtasks were designed and performed: From one side interviews to experts in the BIM and/or GIS field and from the other the creation and publication of an online survey targeted to the European GIS/BIM community.

As one of the main results of our investigation, we can conclude that there is not just one ideal occupational profile dealing with BIM-GIS integration since this task requires the participation of different actors: From the ones managing the raw data, to the ones managing the organisation and communication between teams and the ones performing the most technical works.

We conclude that to perform BIM-GIS integration, ideally, at least two different generic profiles are needed: one with a managerial profile, with fundamental knowledge in both areas (BIM and GIS) and the other with a technical profile with intermediate to advanced knowledge in BIM and GIS applications. Further analysis leads us to think that the weight of these job profiles is mainly in the BIM domain. This is because, traditionally, GIS is used to enrich BIM, so integration is happening more often in the BIM working environment than in the GIS side. In other words, most of the time BIM-GIS integration means a bigger use of geodata and consequently GIS systems in the AEC industry. Therefore, we can conclude that, generically, the ideal profile of the person in charge of implementation of BIM-GIS integration tasks is that of a person who currently works in the construction industry, with solid experience in the use of BIM technology and who carries out a process of upskilling in GIS data management (specially in 3D GIS) and in the use of GIS software and tools.

One interesting finding from our survey is the fact that BIM professionals seem to have a greater knowledge of the GIS domain than vice versa. But this assessment must be taken with care since in reality more BIM profiles than GIS have participated in the survey. Generally speaking, the survey indicates an important level of mutual ignorance between BIM and GIS professionals and this is even more evident regarding software tools.

Another important result of the survey is the relevance that ESRI and Autodesk products receive in the survey, being by far the most rated actors regarding software providers. The survey also points out the importance of adopting interoperability standards and the role of the member states administrations in providing support, procedures and policies to boost integration procedures. In fact, lack of BIM-GIS integration is seen very often linked to the lack of policies and obligations on the use of BIM. A lot of importance from BIM users is given to standardisation.

From the survey, data capture and data management in general seems to be a secondary field indicating how BIM-GIS integration deals more on data usage itself than on data collection. Programming and Development are definitely not seen as important skills. The trend shows the importance of skills related to fundamental technical aspects and the use of tools, but not tasks related to software development. Also, not much importance is given to the knowledge on economic, policies or legal aspects.

Both the survey and the interviews highlighted the importance of upskilling and continuous training for employees as the most important aspect to strengthen GIS-BIM integration in the near future. Regarding which type of educational strategy to adopt there is a great disparity of

answers, so there is little clarity in what type of formulas to adopt for training, but the trend is to strengthen training programs in companies as the main strategy.

BIM courses are often taught as technology training without any theory or collaborative learning. In contrast, it is clear from our investigation that the industry values both technical and collaborative skills, as the base for better integration and growth of future employees. Also, it seems very important that the training takes into account the use of concrete examples and good practices. In fact, the importance of case-based learning will be without a doubt considered also in the next phases of our project.

Finally, it is important to highlight that, as stated from both the Swedish side (Mr. Öryd) and from the Italian side (Mr. Perego), the availability of centralised data platforms with open geospatial data from public administration is key. Without these data sources freely available for the construction companies, it will be impossible to advance in BIM-GIS integration.

# 5. Specification of VET courses

## 5.1. Methodology

Task 1.3 (Specification of VET courses) aims at identifying and describing the main structure of a common qualification in BIM-GIS integration accordingly to the training needs identified in the previous tasks (Task 1.1 and Task 1.2).

The result of this task will be the definition of a common EQF 5 level qualification that responds to the training needs in BIM-GIS integration identified in each partner country, so that it is valid at a European level.

The aim of this section is to propose the (possible) final structure and the competence units of the common qualification “Expert in BIM-GIS integration” or “Manager in BIM-GIS integration”.

The identification and definition of the learning units and the learning outcomes is based on the EQF and ECVET guidelines. This product corresponds to the agreed EQF level, considering the complexity, range and level of learning expected to be achieved.

The ECVET Curriculum contains a general description of the learning units and the learning outcomes. The hours of blended learning, including contact hours, hands-on practice, self-study, and assessment, and allocated respective ECVET points. In order to describe the common structure of the qualification, the following sources were used:

- Partners countries’ situation of BIM-GIS integration and analysis of existing courses (Task 1.1)
- Analysis of experts interviews in each partner country and training needs identification in survey (Task 1.2)
- EQF 5 level qualification standard

As a result, a number of competence units has been identified through the analysis and conclusions of Task 1.1 and Task 1.2. These competence units have been grouped into different training modules that compose the common qualification.

Through the comparison of the results of the research of the existing courses and the current status of BIM-GIS integration in each partner countries (T1.1) and the identification of the industry needs in each partner country and at European level, in this part of the project a set of competence units has been identified. Each of the Learning Outcomes has been defined in terms of professional context (competences) required in Industry (T1.2). Therefore, in the description of the main structure of courses, the following competences has been considered:

- Personal/soft skills
- Geospatial Data skills
- Data Capture and Management skills

- GIS Software competences
- BIM software tools competences
- Programming and Development skills

The competence units have been described complying with ESCO classification and matching with occupational profiles identified in the results of the survey (Task 1.2).

Through an appropriate combination of the competence units identified, a set of training modules (or courses) has been identified.

In detail, the following documentation was created:

- A guideline for the description of learning outcomes, contents and learning methodologies.
- A template for the development of the proposed training modules: description of specific LOs, contents, learning methodologies.

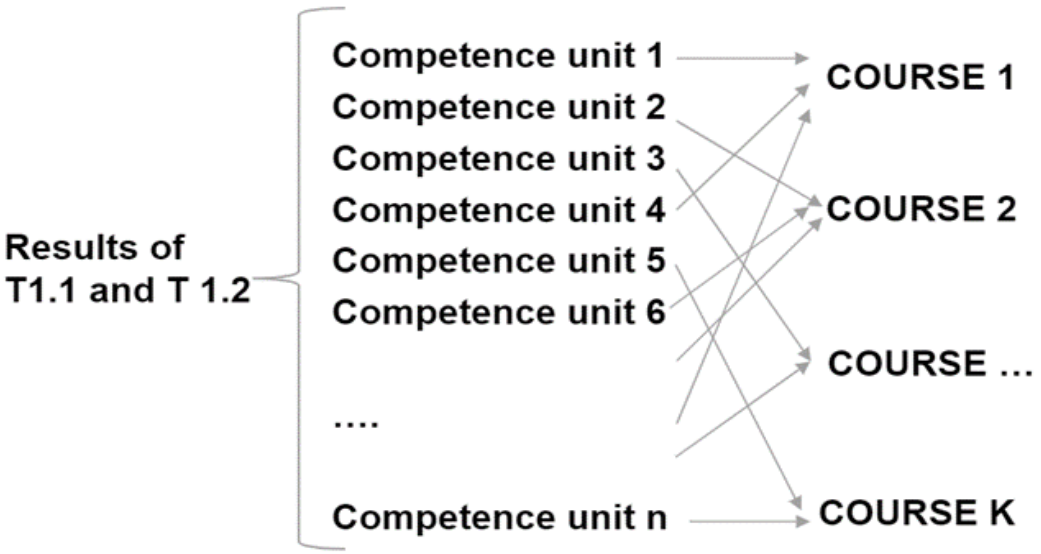


*Figure 5.1. Combination of the competence units identified and identification of a set of training courses*

The common qualification consists of these training modules (courses) divided into different competences units. The main structure of the qualification will follow national requirements of EQF 5 level. For example, in Spain an EQF 5 level qualification must have between 2 and 7 core units or competence units, each of which corresponds to one training module of 40 to 220 hours, and each training module must be divided into 2 to 3 units of 30 to 90 hours each. This has been followed in the definition of the common qualification of BIM-GIS integration.

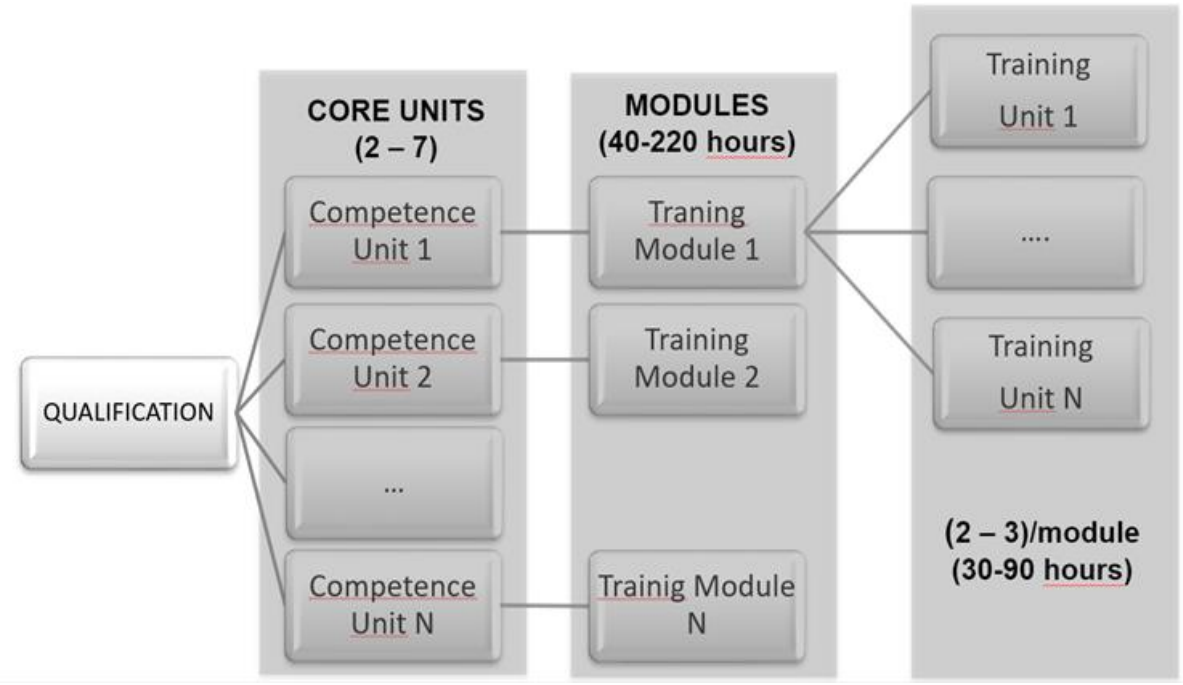


*Figure 5.2. The definition of the common qualification of BIM-GIS integration*

In the description of the main structure of the common qualification, a common structure and terminology has been considered in order to ensure consistency and homogeneity. The common terminology used to describe the qualification is the following:

**EQF**

The European Qualification Framework is a translation tool that helps understand and compare qualifications awarded in different countries and by different education and training systems, structured in eight levels

**EQF Level**

The European Qualification Framework (EQF) is based on eight reference levels defined in terms of learning outcomes. Before developing the Learning Outcomes, Partners should agree on a specific EQF level for the Curriculum. The level defined for the BIRGIT qualification is 5 EQF.

BIRGIT Curriculum is aimed at EQF Level 5

*Table 5.1. BIRGIT Curriculum EQF Level 5*

| ***Qualification level*** | ***Knowledge*** | ***Skills*** | ***Responsibility and Autonomy*** |
|---|---|---|---|
| 5 | Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge | a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems | exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others |

**ECVET points/ ECVET principles**

ECVET points/credits allocation is based on using a convention according to which 60 points/credits are allocated to the learning outcomes expected to be achieved in a year of formal full-time learning. ECVET allocates points/credits to qualifications and not to education and training programmes. Each EU country has specific conditions on the implementation of ECVET methodology. Within this curriculum 25 hours of training correspond to 1 ECVET credit. If 25 hours of training corresponds to 1 ECVET credit, then 150 hours training approach corresponds to 6 ECVET credits.

**Hours of Learning**

Number of hours needed to apply this Curriculum, distributed in contact, hands-on practice hours, self-study hours and assessment hours.

**Learning Outcomes**

Learning outcomes are statements that describe significant and essential learning to be achieved and can reliably demonstrate at the end of the training. In the EQF learnings outcome are described in terms of Knowledge, Skills, Responsibility and Autonomy

**Knowledge**

In the context of EQF, knowledge is described as theoretical and/or factual.

**Skills**

In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive, and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools, and instruments).

**Responsibility and Autonomy**

In the context of the EQF responsibility and autonomy is described as the ability to apply knowledge and skills autonomously and with responsibility.

## 5.2. Results

AIN, the leader of this task, proposed the qualification structure according to the training needs analysis in interviews to experts and in the survey in each partner country.

To do so, the first result obtained in this task is the set of competences (knowledge, skills and responsibility and autonomy) defined through the analysis of existing courses and status, interviews and survey.

According to the interviews, the **main competences that experts consider** for BIM-GIS integration are the following (these competences have been prioritised and selected according to each partner's country requirements and needs):

- GIS and data science basic knowledge
- Urban planning, real-estate law and geology knowledge
- Modelling and information structure competences
- BIM and GIS infrastructures competences
- BIM for infrastructure with a focus on GIS skills
- Be able to visualise the model and understand if it is well made
- Manage common data environment
- Read models in different language
- Work with compatible and well-connected models and datasets
- IT literacy
- Knowledge of Revit and ArchiCAD
- Fieldwork experience
- Integration competences:
    - Modelling of the GIS database and BIM modelling
    - How to connect GIS models with BIM models

- Knowledge on digitalization of business process
- Exchange of facility data – IFC standard
- IT skills for integration

- Soft skills
  - Understand the perception of space
  - Creativity
  - Critical thinking about the real need in industry
  - Networking and communication skills
  - Negotiation skills
  - Management skills

In the tables 5.2 and 5.3 below the industry needs identified in each partner country are summarised.

*Table 5.2. The industry needs identified in each partner country*

| **INDUSTRY NEEDS** | **CROATIA** | **ITALY** | **SWEDEN** | **SPAIN** |
|---|---|---|---|---|
| **Sector** | AEC/ Software development distribution | AEC | AEC/ Urban planning | AEC |
| **Integration status/maturity** | In growth - early adoption | In growth - early adoption | In growth - early adoption | Early adoption |
| **Future potential of use** | Architecture/ Land use and urban planning/ Smart cities/ Bridges | Architecture/ Land use and urban planning/ Roads and highways | Roads and highways/ Smart cities/ Land use and urban planning/ Railways | Land use and urban planning/ Architecture/ Railways |
| **Match between VET programs and industry's needs** | Not matched | Partially matched | Partially matched | Not matched |

Also, to ensure that the qualification matches the **training needs in each partner country**, a collection of the training needs identified through the survey have been analysed per country in terms of competences and level of competence required.

*Table 5.3. The training needs identified in each partner country in terms of competences and level of competence required (expert level; intermediate-expert level; intermediate level; basic-intermediate level; basic level)*

| Set of skills | CROATIA | ITALY | SWEDEN | SPAIN |
|---|---|---|---|---|
| **BIM data skills** | BIM fundamentals expert level<br><br>3D Building models expert level<br><br>Proficiency using model authoring software such as Revit, SolidWorks intermediate-expert<br><br>Analysis: running simulations and creating archival databases intermediate-expert | BIM fundamentals expert level<br><br>3D Building models intermediate-expert<br><br>Proficiency using model authoring software such as Revit, SolidWorks intermediate-expert<br><br>Analysis: running simulations and creating archival databases intermediate | BIM fundamentals expert level<br><br>3D Building models expert level<br><br>Proficiency using model authoring software such as Revit, SolidWorks, intermediate-expert<br><br>IFC specification and other standards (COBie, AgcXML) intermediate-expert | BIM fundamentals expert level<br><br>3D Building models intermediate-expert<br><br>Proficiency using model authoring software such as Revit, SolidWorks, intermediate<br><br>Analysis: running simulations and creating archival databases intermediate |
| **Geospatial data skills** | GIS fundamentals expert level<br><br>Extraction, transformation and loading GIS data intermediate-expert<br><br>Data analysis and interpretation of EO/GI data (aerial images, satellite data, etc.) intermediate-expert<br><br>Georeferencing, map projections and resampling data intermediate-expert | GIS fundamentals basic level<br><br>Extraction, transformation and loading GIS data expert level<br><br>Data analysis and interpretation of EO/GI data (aerial images, satellite data, etc.) intermediate<br><br>Georeferencing, map projections and resampling data intermediate-expert | GIS fundamentals expert level<br><br>Extraction, transformation and loading GIS data intermediate-expert<br><br>Data analysis and interpretation of EO/GI data (aerial images, satellite data, etc.) intermediate-expert<br><br>Georeferencing, map projections and resampling data intermediate-expert | GIS fundamentals expert level<br><br>Extraction, transformation and loading GIS data intermediate<br><br>Data analysis and interpretation of EO/GI data (aerial images, satellite data, etc.) intermediate<br><br>Georeferencing, map projections and resampling data basic level |

| | | | | |
|---|---|---|---|---|
| **Data capture and management skills** | Planning and collection of field data (sample size selection, field data technologies) intermediate<br><br>Knowledge of different data capture technologies (multispectral sensors, LiDAR, Radar, etc.) intermediate<br><br>Design, creation and maintenance of GIS databases intermediate-expert | Internet of Things basic<br><br>Knowledge of different data capture technologies (multispectral sensors, LiDAR, Radar, etc.) basic-intermediate<br><br>Design, creation and maintenance of GIS databases intermediate-expert | Planning and collection of field data (sample size selection, field data technologies) intermediate<br><br>Knowledge of different data capture technologies (multispectral sensors, LiDAR, Radar, etc.) intermediate<br><br>Design, creation and maintenance of GIS databases intermediate-expert<br><br>Querying databases in different languages (e.g. SQL) intermediate-expert | Internet of Things basic-intermediate<br><br>Knowledge of different data capture technologies (multispectral sensors, LiDAR, Radar, etc.) basic-intermediate<br><br>Design, creation and maintenance of GIS databases intermediate |
| **GIS software/tools** | QGIS intermediate-expert<br><br>ESRI ArcGIS Pro intermediate-expert<br><br>PostGIS intermediate<br><br>Grass GIS intermediate | QGIS intermediate<br><br>ESRI ArcGIS Pro intermediate<br><br>PostGIS intermediate | QGIS intermediate<br><br>ESRI ArcGIS Pro intermediate-expert<br><br>PostGIS basic-intermediate<br><br>Grass GIS basic | QGIS intermediate-expert<br><br>ArcGIS geoBIM intermediate-expert<br><br>PostGIS intermediate<br><br>Grass GIS intermediate |
| **BIM software/tool** | Autodesk BIM 360 intermediate<br><br>SolidWorks basic-intermediate<br><br>ArchiCAD (intermediate)<br><br>Vectorworks intermediate | Autodesk BIM 360 intermediate<br><br>IFC specification Open-BIM expert | Autodesk BIM 360 intermediate<br><br>IFC specification open-BIM intermediate-expert<br><br>ArchiCAD basic-intermediate<br><br>Vectorworks – Bentley systems basic-intermediate | Autodesk BIM 360 intermediate<br><br>SolidWorks intermediate<br><br>ArchiCAD intermediate<br><br>Vectorworks – Bentley systems intermediate |

| | | | | |
|---|---|---|---|---|
| **Programming and development tools** | Integration of sensor data and IoT in applications intermediate<br><br>Design and development of applications (python, Java, ctt...) intermediate | Integration of sensor data and IoT in applications basic-intermediate<br><br>Design and development of applications (python, Java, ctt...) intermediate | Integration of sensor data and IoT in applications intermediate<br><br>Design and development of applications (python, Java, ctt...) intermediate | Integration of sensor data and IoT in applications intermediate-expert<br><br>Design and development of applications (python, Java, ctt...) intermediate-expert |
| **Soft skills/ Organisational-institutional aspects** | Time and stress management<br><br>Communication skills and emotional intelligence<br><br>Understanding and adopting GIS and BIM standards expert | Time and stress management<br><br>Communication skills and emotional intelligence<br><br>Understanding and adopting GIS and BIM standards expert | Time and stress management<br><br>Communication skills and emotional intelligence<br><br>Understanding and adopting GIS and BIM standards expert | Time and stress management<br><br>Communication skills and emotional intelligence<br><br>Understanding and adopting GIS and BIM standards expert |

Considering soft skills and organisational aspects, the partners agree on working on the development of this skills in a transversal way during the modules of the qualification, so that students could develop those skills through the different learning methodologies applied to achieve the learning outcomes and teach the content: learning by doing, working in groups to do a specific exercise, peer-evaluation, etc. Therefore, there is no training module associated with the development of soft and organisational skills in the qualification. Also, some managing aspects will be considered in the learning outcomes and contents of training modules.

Regarding Programming and development tools, all partners agree on not being considered in the curriculum since the aim of the qualification is not a profile able to develop new software to integrate BIM-GIS data, but to work with integrated BIM-GIS data understanding and adopting GIS and BIM standards.

Regarding BIM and GIS software and tools, the curriculum cannot focus on development of competences to work in the different software that uses data independently, so here the curriculum considers the most used standards which allow to work with data coming from different tools, such as: IFC, CityGML, InfraGML, among others.

As a result of all the collected information explained above, one of the issues to face-up in the curriculum development is the compatibility of tools and software and use of standards to integrate data coming from different sources. Also, basic knowledge of BIM-GIS integration and its application in real cases and scenarios. Lastly, there is also a worry about managing aspects and other soft skills that are tackled in a transversal way in the modules of the qualification.

According to survey results, the **relevant knowledge and competences to be considered** in a common curriculum are the following:

*Table 5.4. The relevant knowledge and competences for curriculum development*

| **Competence (level)** | **Content** |
|---|---|
| Holistic knowledge of both GIS and BIM (basic) | Basic principles |
| Using BIM and GIS software and tools (intermediate) | -BIM: Revit (advanced), Civil 3D, Infraworks<br>-GIS: ESRI's and ARCGIS PRO |
| Design of integrated BIM-GIS databases (Advance) | -BIM-GIS integrated workflow<br>-Infrastructure design data sources (IFC – CityGML integration) |
| Soft skills (as a transversal part of the curriculum) | -Collaboration and teamwork skills<br>-Project coordination and management<br>-Holistic thinking (see the whole picture) |
| BIM and geospatial data skills | -Maps data (static and dynamic)<br>-Fundamental knowledge of management of BIM and GIS data. |
| Advanced skills on BIM-GIS data handling (intermediate-expert level) | - <u>BIM data skills</u><br>o 3D modelling<br>o Model authoring software<br>o Data specifications and other standards (IFCT)<br>- <u>GIS data skills</u><br>o 3D GIS<br>o Georeferencing<br>o Map projections<br>o Resampling data<br>o Data transformation (standards/formats) |

| | |
|---|---|
| | |
| Using integrated data (expert level) | - Tools that support both types of data: BIM and GIS<br>- Connectors<br>- Enabling BIM systems to connect to 3D GIS data.<br>- Enabling GIS systems to support BIM data formats |
| Programming and development skills (intermediate) | Requirement analysis and identify other needs |
| Adoption of GIS and BIM interoperability standards (expert level) | Advanced knowledge in the use and implementation of standards |
| Organisational and institutional aspects (basic-intermediate level) | Organisational and institutional aspects:<br>- Legal<br>- Business<br>- Policy |
| knowledge in BIM and GIS applications (intermediate to advance) | Use cases |

Moreover, the results of the survey identify learning methodology to be considered in the **methodological approach** of the learning units of the qualification as:

- Work on real life business cases
- Internships (in companies – longer degrees)
- Thesis works (in companies – longer degrees)
- Case-based learning

As an important result, best practices of BIM-GIS integration in partner countries and other countries must be considered in a specific module in the qualification according to the importance of case-based learning. Respondents to both, interviews and survey, highlight the importance of working on real life business cases.

In order to reach consensus about the competences to be developed and the learning units to include in this curriculum all partners provided their suggestions through different online brainstorming sessions.

Through various brainstorming online sessions among the partners, the original layout proposed by AIN has been modified considering the experience of each partner country and the research made by everyone in the previous tasks. This has led to several implementations at the competence units' level that have been introduced, both in terms of consolidation and content enhancement. The current version appears more effective and better oriented to the practical application to BIM-GIS integration training addressed to technicians and also to managers, looking in specific at the SMEs, coherently with the 5° EQF level assumed as reference.

The first issue that has been discussed during brainstorming sessions was if the qualification should be focused on technical or managing aspects. According to the 5° EQF level the curriculum will consider technical aspects; however, as a manager' profile is also highly demanded in some industries and countries, the consortium agreed on including some managing competences in the curriculum.

The following discussions were focused on the different standards to transfer to work in BIM-GIS integrated scenarios. The most usable standards are City GML, IFC standard and Infra GML. All of them show similar problems when trying the integration of one standard into another as all of them are too generic to apply in practice. The aim of the qualification is not to elaborate and develop software, so it will be focused on identifying what software supports the different tools and formats available in BIM and GIS. The problem of updating data is that 3D modelling from the GIS perspective is very different from the BIM perspective.

All the suggestions in the brainstorming sessions and the conclusions in Task 1.1 and Task 1.2 were analysed, and **topic clusters** were identified as follows:

- Integration problems of data
- Different applications
- Different standards: IFC, CityGML, InfraGML, GeoJSON, etc.
- Managing or technical aspects

Based on the results obtained with the desk and field research, the development approach assumes the qualification organised into two main levels:

- a core set of competence units, expression of the global, common dimension of BIM-GIS integration; and
- a complementary set of domain-related competence units, more responsive to the different contexts, useful also in order to innovate the more "traditional" local

qualifications, based on cases of use and application examples of BIM-GIS integration.

The proposed profile can find the suitable contextualization by a variable number of competence units crossing the BIM and GIS dimensions, related to the different domain in which both methodologies may be implemented in order to have a correct use of integrated data. **Two clusters of competencies** have been identified:

i) INTRODUCTION TO BIM-GIS INTEGRATION

Basic knowledge about integration, how the integration works and use of software that support integration. Introduction to some standards available to work with integrated data like CityGML, IFC and InfraGML. Show different types of modelling and different modules to integrate BIM and GIS. Basic procedure of integration and examples. (Generic perspective of integration).

ii) SPECIFIC APPLICATIONS OF BIM-GIS INTEGRATION

Holistic view of applications and different uses to show and demonstrate how to use integrated data since depending on the software used. This core of units involves best practices, benefits and impacts in order to go through specific applications that work with integrated data in specific contexts and show different parts/models of integration. The application examples will be both from partner countries and other countries. Data integration examples with managing and technical perspectives, show open city models, etc. (Specific perspective of integration).

**Qualification structure**

The content of qualification is organised in 7 Training Modules (TM) that are pedagogically sequenced. This is the coherent training block associated with each one of the competence units of the two main levels (CORE) that conform the qualification. Each competence unit corresponds to one training module as EQF qualification standards settle.

Based on the previous work, 6 major topics have been identified to be addressed by the curriculum. Based on these topics the Learning Units will be developed and the Knowledge, Skill and Responsibility/Autonomy will be defined by the project partners in PR3.

The Learning Units based on the development process defined above are described in the table 5.5.

*Table 5.5. The Learning Units*

| Unit | Title | CORE UNIT |
|---|---|---|
| Unit 1 | Holistic approach to BIM and GIS integration | Introduction to BIM-GIS integration |
| Unit 2 | Integrated BIM-GIS databases and models | |
| Unit 3 | Data specifications and standards | |
| Unit 4 | Visualisation of integrated data | |
| Unit 5 | Managing and organisational aspects in BIM-GIS integration | |
| Unit 6 | Possibilities and opportunities of BIM-GIS integration | Specific applications of BIM-GIS integration |
| Unit 7 | Application Domains (use cases) | |

Soft skills will be developed through practical learning methodologies in each unit like best practices of BIM-GIS integration; work on real life business cases; case-based learning; teamwork., etc.

Each TM has between 40 and 220 hours and describes the training necessary to acquire a specific competence unit, that constitutes the minimum unit of creditable professional training. Each Training Module is characterised by its name, code, professional qualification level, the CU which is associated, duration, capabilities and evaluation criteria and content.

*Table 5.6. The Learning Outcomes of each unit*

| Unit | Title | Learning outcome |
|---|---|---|
| Unit 1 | Holistic approach to BIM and GIS integration | Understand the key factors of BIM-GIS integrations, their benefits and impacts |
| Unit 2 | Integrated BIM-GIS databases and models | Connect BIM and GIS data and models |
| Unit 3 | Data specifications and standards | Manage GIS and BIM interoperability standards and exchange facility data |
| Unit 4 | Visualisation of integrated data | Design and visualise Integrated BIM-GIS datasets to use them in different models |
| Unit 5 | Managing and organisational aspects in BIM-GIS integration | Manage BIM-GIS considering organisational and institutional aspects |
| Unit 6 | Possibilities and opportunities of BIM-GIS integration | Understand the needs, possibilities and opportunities of BIM-GIS integration |
| Unit 7 | Application Domains (use cases) | Understand the application of BIM-GIS integration and the benefits and opportunities that integration brings to different domains. |

*Table 5.7. Suggested Content of Learning Units to be developed*

| **Unit** | **Content** | | |
|---|---|---|---|
| Unit 1 | BIM and GIS software and tools | Advanced skills on BIM-GIS data handling | |
| Unit 2 | BIM-GIS integrated workflows | Enabling BIM systems to connect to 3DGIS data | Enabling GIS systems to support BIM data formats |
| Unit 3 | Data specifications and other standards | Adoption of GIS and BIM interoperability standards | Exchange of facility data |
| Unit 4 | Data capture technologies and visualisation | Integrated BIM-GIS datasets: design, distribution and visualisation | |
| Unit 5 | Fundamental knowledge of management BIM-GIS data | Organisational and institutional aspects | Managing aspects |
| Unit 6 | Needs of BIM-GIS integration | Possibilities of BIM-GIS integration | Opportunities of BIM-GIS integration |
| Unit 7 | Benefits and impacts of application | Application Domain 1 | Application Domain 2 |

The results of Task 1.3 are a draft list of modules and a generic learning outcome to each module according to the results of Task 1.1 and Task 1.2 and the conclusions of the online brainstorming sessions among the consortium. The description of the specific learning outcomes to be learnt in each module and the content, learning methodologies and tools will be well defined in PR3.

The analytical structure developed in Task 1.3 has to be seen as the common reference of the BIRGIT project, not assuming the specific domains relevant in terms of real applications. These domains will be identified in PR3, on the basis of their operational contexts, and

implemented in the training curricula, following national standards and use cases of each partner country and other countries outside the consortium.

To describe and develop the learning content of the second CORE unit each partner will have to identify the status of integration in their country and the different standards used. To do so in PR3, partners will search for best practices and use cases, city models in different countries to be explained to students.

# 6. Discussion and Conclusions

The fusion of BIM and GIS provides the power to build robust context models where geoinformation and infrastructure design data are brought together, helping to better understand how assets interact within the context of a real place and geography. By providing a real-world context of an asset's existing environment within which designers and engineers can explore and evaluate design and construction it is said that "GIS informs BIM". Then, rich, more accurate models can be utilised to improve the overall operations and maintenance of assets within a larger area.

The results of PR1 can be divided in accordance with 3 key tasks:

- T1.1 – Review of existing courses and learning materials, resulted in the list of training courses and learning materials identified as being of potential interest to the project partners. Each item is described using characteristics like type of resource (course, lecture etc), ownership, date of creation, URL, credits, language, EQF level, target group, prerequisites, main topic, learning outcomes, syllabus, software used, licences etc. Overall, two types of learning resources have been identified, namely resources provided by the partners of the BIRGIT project and resources provided by external parties. Mainly there are a large number of basic courses in either BIM or GIS available. On the contrary, the number of learning resources where BIM-GIS technologies are integrated is very limited.

- T1.2 – Survey of industry needs, included an online survey to the BIM-GIS community and interviews with experts in the BIM and/or GIS field. One of the main results of our investigation shows that there is not just one ideal occupational profile dealing with BIM-GIS integration, since this task requires the participation of different actors: from the ones managing the raw data, to the ones managing the organisation and communication between teams and the ones performing the most technical works. To perform BIM-GIS integration, ideally, at least two different generic profiles are needed: one with a managerial profile, with fundamental knowledge in both areas (BIM and GIS) and the other with a technical profile with intermediate to advanced knowledge in BIM and GIS applications. Further analysis leads us to the conclusion that the weight of these job profiles is mainly in the BIM domain. Traditionally, GIS is used to enrich BIM, so integration is happening more often in the BIM working environment than in the GIS side. In other words, most of the time BIM-GIS integration means a bigger use of geodata and consequently GIS systems in the AEC industry. So, the ideal profile of a person in charge of implementation of BIM-GIS integration tasks is that of a person who currently works in the construction industry, with solid experience in the use of BIM technology and who carries out a process of upskilling in GIS data management (specially 3D GIS) and in the use of GIS software and tools.

- T1.3 – Specification of VET courses, based on the training needs identified in the previous Task 1.1 and Task 1.2, resulted in a draft list of modules and a generic learning outcome to each module. Two main clusters of competencies have been identified: Introduction to BIM-GIS integration and specific applications of BIM-GIS

integration. The analytical structure developed in this task has to be seen as the common reference of the BIRGIT project, not assuming the specific domains relevant in terms of real applications. These domains will be identified in PR3, on the base of their operational contexts, and implemented in the training curricula, following the national standards and use cases of each partner country and other countries outside the consortium.

The overall results of PR1 Industry requirements on BIM-GIS training programs and courses, are very valuable and provide a very good basis for the continuation of the project namely for PR2 Localization of existing courses and PR3 Development of new courses.

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# Annex 1: Survey on the demand for BIM-GIS integration skills

The complete statistics resulting from the BIRGIT online survey results collected during the period June 1, 2022 to September 20, 2022 are available in the following online document:

https://birgitproject.eu/wp-content/uploads/2022/11/BIRGIT_survey_results.pdf

During this period, 53 surveys were filled in.

The survey structure and questions is available below:

**Section 1: YOU AND YOUR ORGANISATION**

1.1 What type of organisation are you working for?

1.2 In which country is your organisation located?

1.3 What professional profile would describe your current position best?

1.4 Please indicate the sector or sectors in which your business/ organisation/ institution mainly operates.

1.5 Does your organisation organise training actions? If yes, what which type of actions?

1.6 If you are a training provider, what educational level or levels do you address?

**Section 2: INDUSTRY DEMAND OF BIM-GIS INTEGRATION SKILLS**

2.1 How would you evaluate the status/maturity of adoption of BIM-GIS integration in your country?

2.2 In which fields are BIM-GIS integration technologies mainly used or has future potential to be used in your country?

2.3 Assume you wish to hire a person for working with BIM-GIS integration. Which education levels are desired for such candidates?

2.4 Indicate the disciplines in which an ideal BIM-GIS integration job applicant should be trained in.

2.5 Which are from your perspective the main training / education providers dealing with BIM-GIS integration?

2.6 How would you assess the level of match between current higher-educational institutions (HEI) and/or VET programs and the needs of the industry in terms of BIM-GIS Integration?

2.7 Following your experience, do NEW APPLICANTS FOR VACANCIES in jobs requiring BIM-GIS integration fulfil the required skills?

2.8 From your perspective, to what extent do CURRENT EMPLOYEES in the Geospatial and AEC industry have the competences and skills that are required for BIM-GIS integration?

2.9 Please specify the required expertise level for the following competencies in relation to BIM-GIS integration.

2.10 Skills Assessment

*For each of the following skills set, the most relevant skills required for a BIM-GIS integration job are rated.*

*2.10.1 Personal/Soft skills*

*2.10.2 BIM data skills*

*2.10.3 Geospatial Data skills*

*2.10.4 Data Capture and Management skills*

*2.10.5 Knowledge of GIS Software and tools*

*2.10.6 Knowledge of BIM software and tools*

*2.10.7 Programming and Development skills*

*2.10.8 Organisational and Institutional aspects*

**Section 3: PERSPECTIVES ON BIM-GIS INTEGRATION**

3.1 Which types of education-related aspects do you consider to be the most important to strengthen GIS-BIM integration?

3.2 Would you recommend any other training/education specific action to strengthen BIM-GIS integration?

3.3 From your prospective, which factors can limit the adoption of BIM-GIS integration workflows?

3.4 How will the future of GIS-BIM integration look like, in your opinion?