PR3 – Design of new learning materials

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Short Description:

The goal of this activity is to develop new educational materials, according to specific needs of the training providers, with the idea of reusing these adapted materials in their training offers. The localisation processes focus on adapting free and open licensed educational materials and deal mainly with translation of text lectures by using the Digital Europe e-Translation service. In total 3 courses were translated to English and eight courses were localised and translated to local languages.

Keywords:

BIRGIT Project, BIM and GIS integration, vocational training, new courses, localization

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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)	

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1 Introduction

The objective of this report is to give a description and understanding for the processes of development of the new learning materials.

1.1 The BIRGIT project

Both in the public and private sectors, the construction and geospatial 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 construction and geospatial information management, we can increase the efficiency of the construction processes, improve transparency and reliability, and better manage assets such as buildings, roads, and other essential public facilities.
There is a lack of skilled personnel and 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 on the built environment and urban management, usually include courses in BIM or GIS, but not their intersection. As a consequence, professionals of 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 project's main objective 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 are being developed. This material 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 programs within the partnership and the possibility for other training providers to use these courses as well.

1.2 PR3 Development of new learning materials

BIRGIT's main tasks have been divided into four parts, called Project results (PR's). They are the following:

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

The project results envisioned to be delivered by the project are organised in a logical sequence, starting with scanning through existing literature and the requirements of the industry on knowledge and skills level of recently educated employees and an inventory of existing learning materials, mainly in the countries of the project partners but also through the European continent. The selection process of these existing resources and learning materials were the first step in the project (PR1).
The second step was to choose learning materials which existed in any European language but English and translate them into English, which is the main language during the duration of the project and also the preparations of other, new learning materials (PR2).

The third step was the development of new learning materials (PR3) which was undertaken in three groups. The topics in the three groups were selected according to the findings of, in the first hand, PR1 which provided a good overview about in what subjects further learning materials where needed.

PR3 is the most extensive part of our efforts. Learning material which could be useful for the VET providers in our consortium were identified and the intended contents were sketched out. Very soon we came to the following distribution:
Basic knowledge like what is BIM and what is GIS was collected under one single heading. Most of this work has been performed by the Spanish partner, based on the fact that they had previous experience in BIM, but virtually no experience in GIS.
Another aspect of BIM are the very recent developments and trends of 3D GIS, City Models and Digital Twins.
These trends have gone so far in the last year that there are new developments of Digital Twins for almost everything, even humans and other living beings.
In the following section we will therefore give a short description of the contents of the three learning material packages and of the methodology used to achieve this development.

1.3 Structure of the document

In this document we describe the generation of new learning material based on our a priori knowledge and the findings from PR1 on the existence or learning materials from other sources.

In section 2 we describe the three learning material modules developed.

In section 3 we describe the modified Scrum method that was used for the development of the material.
Section 4 describes the actual process of designing the learning materials, in section 4.4 we document our findings (made by members of the team) regarding the quality of the learning materials and in section 5 we describe the need for and the used procedure of localization of the material.
In section 6 we present a short discussion and Conclusions of the development of the learning materials during PR3.
Testing of the materials in an actual learning situation will be carried out and reported in the PR4 Report.

2. Short description of the three learning material packages

From the start of the project we had planned to divide the course packages into three parts or "modules".

Introduction to BIM

These learning materials offer a comprehensive introduction to Building Information Modelling (BIM) and its various applications. It begins with the fundamentals of BIM, exploring the benefits and challenges of its use in the construction industry. The concept of Level of Development (LOD) is introduced, alongside an explanation of how BIM evolves from 3D models to multi-dimensional (3D–10D) representations, integrating data related to time, cost, sustainability, and other factors. The learning materials emphasise how BIM is not only a 3D tool, but a holistic process that enhances efficiency and collaboration throughout a building's lifecycle.

The learning materials also focus on managing BIM data, explaining key concepts like data management, workflow optimization, and coordination between various disciplines in a project. Topics such as the Industry Foundation Classes (IFC), a standard for data exchange, are discussed. Additionally, the course explores BIM's practical applications, including its role in infrastructure projects, facility management, and the preservation of historical buildings.

3D GIS, City Models and Digital Twins

This set of learning materials consists of three parts. The first part deals with concepts and data standards related to 3D city models, such as different geometric vector models, voxel representation, semantics of 3D city models and data standards (CityGML). The second part deals with the acquisition and management of 3D geospatial data, for instance from tacheometry, photogrammetry and terrestrial and aerial laser scanning. Commonly used software tools are also reviewed. This part also includes three different assignments with data. The third part deals with digital urban twins, with a specific focus on the usage of sensors and sensor networks. This part also contains an assignment using air quality sensor networks. Digital twins have become very popular, as they are usually created and used as testbeds for changes intended to be done to the real object, e.g., a city.

BIM - GIS Integration

The learning materials introduce students to BIM-GIS integration, explaining the benefits of combining these models and clarifying the difference between interoperability and full integration. They explore the similarities and differences between BIM and GIS, highlighting the challenges these differences pose to integration. They compare various integration approaches, discussing their pros and cons, while explaining the workflow and steps involved in integrating different parts of the models. They also touch on the importance of data quality and potential issues that may arise during the process.

Finally, the materials examine data conversion between BIM and GIS. They explain which data can be obtained from each model and describe the conversion process in both directions, focusing first on BIM-to-GIS and then GIS-to-BIM, addressing the challenges in each. They conclude with a brief overview of software tools used for conversion and also discuss practical applications of BIM-GIS integration throughout a project's lifecycle, offering real-world use cases.

3. Modified Scrum Methodology

A number of methods exist for agile and collaborative development, such as Dynamic System Development Method (DSDM), Scrum, Rational Unified Process (RUP) and many others. Scrum is a commonly used method for collaborative work, mainly applied in software development projects. According to the Scrum Guide (Schwaber and Sutherland, 2017) the method has also successfully been used in other types of projects. Nowadays it is often considered an industry standard for collaborative work, at least within the software development domain, although its limitation is sometimes expressed, and different improvements are suggested (Lowe, 2024).

Scrum is an iterative and incremental framework for managing product development. The method relies on assigned roles (product owner, developer, Scrum master etc), workflows (short development cycles called sprints, sprint planning meetings, daily Scrums, sprint reviews etc) and artefacts (product backlog, sprint backlogs, product increment etc). The Scrum methodology was earlier considered to work less well for teams which are geographically dispersed or working part-time and for teams whose members have very specialised skills and cannot pick up work of other team members. The wide usage of Scrum methodologies during the Covid-19 epidemic did however induce some changes, which improved their usability. The expected remaining limitations were one of the main reasons for adapting the Scrum methodology to the specific requirements of developing learning material in geographically dispersed development groups, as outlined by Östman and Östman (2018). As a result, the modified Scrum methodology is based on three main concepts, the assigned roles, the workflows, and the artefacts.

The participants in the development process were having different roles,the roles of product owners, Scrum masters and developers. One objective of the BIRGIT project is to develop learning material in English, which then is to be localised based on local needs and used by training providers in their regular training offers. This development was organised into three Learning

Material (LM) packages ('Introduction to BIM', '3D GIS, City Models and Digital Twins' and 'BIM-GIS integration'). For each LM package, product owners were assigned. Their role was to participate in sprint meetings and to assure that the learning material is usable when the training courses are to be implemented. Since each LM package was to be implemented at several training providers, several product owners were assigned for each LM package. For each LM package, a Scrum master was also assigned. Their role was to solve problems, plan the activities, backlog management, reallocate resources if needed, and facilitate communication.

The workflows being used during the LM development processes consist of sprints, Scrum meetings, sprint meetings and quality reviews. The development cycle starts with a sprint meeting, where the objectives of the developments are presented by the product owners as well as the length of the sprint. The sprint is the period in which the actual development takes place. The usual length of a sprint was around 2 months in this project, which is somewhat longer than compared to common software development projects. The development within a sprint is monitored by the Scrum master, who also leads the bi-weekly sprint meetings. During these sprint meetings, various issues are discussed. In software development projects, daily Scrum meetings are usually applied. However, in this type of development, Scrum meetings every second week were found to be more appropriate. But due to this and the long physical distance between the developers, much of the Scrum meeting discussions were related to coordination, resulting in lengthy Scrum meetings. At the end of a sprint, a new sprint meeting was conducted, and the product owners gave response to the work carried out and issued new directives for the upcoming sprint. When the learning material did reach a mature status, it was submitted for quality review. In this process, assigned quality reviewers were examining the products in terms of correctness and coherence with internal rules for graphical design.
The development work was supported by various forms (artefacts), such as Syllabus, product backlog and sprint backlog. The syllabus was intended to act as a product specification, having information such as structure (list of lectures and assignments), learning outcomes, intended audience, pre-required skills, language and format etc. See figure 1 as an example of Syllabus.

3D GIS, City Models and Digital Twins

PRODUCT OWNER(S)	COURSE OVERVIEW
Erik Escalier (Ocellus Information Systems AB) Sanja Samanovic (University North)	3D geospatial data are increasingly becoming available, for instance through open data portals. To combine these data sets, a solid understanding of geometric and semantic modelling is required, as well as appropriate tools and processes for the usage and analysis of data. Maintaining a 3D urban database also put additional requirements on processes as compared to the 2D case. The needs for proper management of 3D geospatial data are becoming more recognized together with the implementation of new technologies, such as digital twins.
EMAIL(S)	PROMINENCE
erik.escalier@ocellus.se sasamanovic@unin.hr	Earlier versions of this course
VERSION NUMBER	OWNERSHIP
0.4	Author(s) and licenses
URL	

Figure 1. Extract of a product specification (syllabus)

PRODUCT BACKLOG, COURSE 3D GIS, City Models and Digital Twins

PRODUCT BACKLOG 2023-11-14

Component	Sprint Goal	Status	Review 2023-10-08	Review 2023-11-05
City Models				
L1: Concepts of 3D modelling of the built environment	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
L2: Semantic city models	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
L3: 3D GIS data standards	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
L4: Creation, use and examples of existing city models	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
A1: 3D theory - self-testing quizzes and short reflections about semantic 3D models, usage,	Ready for localisation?	Pending		

Figure 2. Extract of a product backlog

During each sprint meeting, the status of the development was reviewed, and comments provided by the product owner. To document these comments, a product backlog was used, see figure 2. This backlog was implemented as an excel file and described the status and the current sprint goal for each LM component.

AGILE SPRINT BACKLOG, 3D GIS, City Models and Digital Twins, Sprint 4

LEARNING RESOURCES	ASSIGNED TO	STATUS	SPRINT GOAL	2023-12-13	2024-01-16	2024-01-30	2024-02-13	
1. City Models				Status	Status	Status	Status	St
L1.1: Concepts of 3D modelling of the built environment	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Hopefully 16/2	
L1.2: Semantic city models	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Hopefully 16/2	
L1.3: 3D GIS data standards	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Later	
L1.4: Creation, use and examples of existing city models	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Later	
A1.1: 3D theory - self-testing quizzes and short reflections about semantic 3D models, usage, own experience	Hans	Not started	Ready for localisation	Help needed	Quest by Hans	Tbr Roderic and Vlado	Later	
A1.2: Save and convert 3D data	Ariana	Not started	Deleted	-	-			

Figure 3. Extract of a sprint backlog

The third artefact used in the development was the sprint backlog, which describes the status and problems to be addressed in more detail, see figure 3.

All artefacts were stored on a shared space in the project file repository.

4 Development of the Learning Materials

The following sections will describe, for each of the 3 developed modules, the development process, structure and contents.

4.1 Introduction to BIM

4.1.1 Course development process

The development of learning materials followed an adapted version of the Scrum methodology, an agile framework used for managing product development that emphasised iterative progress, collaboration, and flexibility. By dividing the project into Sprints and holding regular Scrum meetings, the team effectively managed obstacles, shared ideas, and produced a comprehensive course divided into three blocks. Moreover, this approach allowed all participants to create working teams across countries and beyond each organisation's boundary. It served as an ultimately efficient tool to overcome different working styles and to produce standardised outcomes, and enabled the BIRGIT project to deliver innovative learning materials on BIM and GIS.
The process involved five Sprint reviews with an average of 4 Scrum meetings per cycle, starting from the 3rd of May 2023 and until the finalisation of all learning materials in March 2024. This summary outlines the process undertaken to create the course materials.

Sprint 1: Roles definition and Course Outline

During the first Sprint, the team has defined and distributed roles to facilitate the sprint process and then defined the overall structure of the course, objectives and target audience. Through collaborative discussions in Scrum meetings, the team identified key topics to cover and outlined learning outcomes for each block. They also established a timeline for development and delivery. To assist all participants in the tracking of the process, three tools have been created: Syllabus, Sprint Backlog and Product Backlog. All participants were asked to contribute, while the scrum leader coordinated and maintained (updated) them.

The scrum meetings were held online on 3 May, 17 May, 31 May, and 14 June, and the Sprint Review Meeting was held on 26 June 2023

Sprint 2: Content Creation

Sprint 2 was dedicated to the development of course content. Due to changes in team membership and differences in holiday periods in consortium countries, materials have been developed without a regular scrum meeting schedule, which has slowed down the review process and the improvement of learning materials.

The Sprint meeting was held on 26 September 2023, and it focused on the need for a re-organisation of the common virtual workspace on Teams, the choice of a common methodology in the definition of learning outcomes, and definition of a format: power-point slides + scripts (lecture notes). Moreover, there has also been a planned systematisation of the review process.

Sprint 3: Content Creation

The third Sprint started with a redefinition of roles in the team given the recombination of team members, with a subsequent reorganisation of workloads, adapted to the latest course structure and to the other course materials developed for PR3. Also, the review process has been restructured to allow all contributors to follow the procedure.
Once roles and work flow processes had been re-established, the cycle focused on the design of course materials. Reviewers worked Learning Outcomes closely with product developers to ensure a higher quality of the learning materials. Scrum meetings provided opportunities to address challenges and brainstorm offered possible solutions regarding course contents, assignments and quality of materials.
Scrum meetings were held on 10 October, 24 October, 7 November, and the Sprint Review on 21 November 2023.

Sprint 4: Fine tuning and review

During Sprint 4, the team Feedback loops were crucial in refining the course content and ensuring the standardisation of course materials through a regular update of the review folder and management tools. The materials were structured in 3 learning "Blocks", each containing three lectures:

- Block 1 – BIM Definition
- Block 2 – Working with BIM data
- Block 3 – BIM Applications

The Workload was also redistributed accordingly, and to each lecture two reviewers have been assigned who checked the coherence of material and content overlap across different lectures, and the adherence to the agreed structure and templates of other course materials created.
The scrum meetings were held online on 13 and 19 December 2023, on 16 and 30 January 2024 and on 13 February 2024. The Sprint Review Meeting was held on 27 February 2024.

Final Review and Delivery

After the finalisation of course materials, the date of final Review was set to 12 of March, the date of delivery of all materials version 1.0 in portable document format (pdf) and ready for publication. The scrum leader coordinated a comprehensive review of all content, resolved any remaining issues, and packaged the materials for distribution. Internal meetings and email exchanges facilitated last-minute adjustments and ensured that the course met the established criteria for completion.

4.1.2 Introduction to BIM - Course Description

Introduction to BIM is the first of three modules in the course material developed by project BIRGIT. By first we mean it should normally be taken first by a student, as it provides initial knowledge about what is BIM and what can you do with it. Thus, the course material contains lectures dealing with the properties of BIM, the definition of "Industry Foundation Classes", short IFC, the ISO Standard for storing BIM's in a computer and for information exchange with customers, architects and others involved in the development of buildings.
BIM is also used to document historic buildings for the case of reconstruction and restauration and for documentation of infrastructure and facility maintenance.

The Module "Introduction to BIM" has been developed to the needs discovered in PR2. To develop comprehensive and introductory learning materials on BIM: definition, uses and applications. The learning materials can be used as a structured course, as modular learning paths, or as individual lectures.

Course structure
The Learning material "Introduction to BIM" is structured in three thematic learning BLOCKS, created and offered as a sequential learning path, but ultimately self-standing.

BLOCK 1 – BIM definition
BLOCK 2- Working with BIM Data
BLOCK 3 – BIM Applications

Intended Audiences

The primary intended audiences are VET providers and VET practitioners, who may be interested in using the learning materials for their courses.

VET students can be considered a secondary target audience, since they can also use the learning materials for self-learning.

Prerequisites

Due to the introductory aim of the course “Introduction to BIM”, no specific prerequisites are asked from the audience. Learning materials are offered in chronological order to guarantee that each lectures’ prerequisites are met, but it is not mandatory to follow the suggested order. In fact, since the learning materials are offered as support for VET providers, each learning material can be accessed separately.

Language requirements

All learning materials have been developed in English language and in pdf format. For each lecture a PowerPoint presentation and Lecture Notes in text format have been developed. Each learning provider has selected some or all learning materials and provided a translation into the national language.

4.1.3 Learning Materials

In this section a quick showcase of all course lectures, with a brief summary and learning outcomes is presented. All materials are available for download in pdf format on the BIRGIT website https://birgitproject.eu/learning-materials/.

BLOCK: BIM Definition

Lecture: Fundamentals of BIM
The lecture introduces Building Information Modelling (BIM) as a digital process revolutionising construction, emphasising its role in enhancing efficiency, sustainability, and project success. It covers fundamental concepts, historical development, AECOO industry applications, data management, dimensionality, LOD standards, and ISO 19650. Emphasising collaboration and practical applications, the training equips students with essential skills for real-world BIM projects, ensuring they understand its transformative impact on the construction industry.

Learning Outcomes

- Define the main concepts of Building Information Modelling.

- Identify the benefits of BIM for different stakeholders.
- Recognize the different stages of the BIM lifecycle.
- Describe the importance of BIM standards and best practices

Lecture: Benefits and challenges using BIM
This lecture explains the differences between CAD and properly performed BIM, with focus on BIM as a process, not only 3D models of assets. Further, the lecture provides an introduction into the life-cycle of an asset, from the early idea and design through construction to operation, and the role of BIM in these steps. The focus lies on benefits of BIM usage, but also names challenges of BIM implementation and possibilities how to deal with these issues.

Learning Outcomes

- Explain differences between CAD and BIM
- Understand role of BIM in diverse phases of building life-cycle
- Name benefits of challenges of BIM use
- Discuss factors slowing down BIM implementation

Lecture: Level of Development and 3D – 10D BIM
Lecture introduces the concept of "Level of Development" in the BIM process and explains how it changes during the object's life-cycle. Then, it opens up what diverse kind of information can be provided by BIM within the 3D-10D dimension of the process and how it can enhance issue solutions in the AEC industry

Learning Outcomes

- Explain the role of different Levels of Detail in BIM
- Name diverse kinds of information which can be provided by BIM
- Relate the Level of Development and the 3D-10D concept to asset life-cycle

<u>BLOCK: Working with BIM Data</u>

Lecture: Data management in BIM
The Data Management in a BIM module contains the necessary knowledge and skills to effectively manage BIM projects and handle data during their life cycle. Participants will develop skills for comparing and utilising cutting-edge technologies, tools, and software to ensure interoperability and collaboration among stakeholders and data exchange among applications.

Learning Outcomes

- Formulate key principles for effective BIM project management.
- Compare the latest technologies, software, and tools to ensure seamless interoperability between different software applications.
- List and describe techniques to optimise data workflows through collaboration.
- Select a method for analysis of BIM data, to generate reports, and to create visualisations to support decision-making in BIM projects.

Lecture: BIM process workflow

The lecture explains what the BIM process looks like - from the initial stage, when a new project's conceptual idea is introduced, through planning and construction and further through many years of operation and maintenance. The main focus is to explain the role of the different documents that specify the requirements in the individual steps of the project life cycle. Another important topic of this lecture is the selection of appropriate data, which are needed in the different life-cycle steps.

Learning Outcomes:

- Revise for role and content of an Exchange Information Requirement document in a BIM process
- Explain the importance of a BIM Execution Plan
- Understand the value and usage of Class Systems and a Model View Definition
-

Lecture: BIM Coordination

This lecture opens an important topic of the BIM process, i.e., its coordination. It starts explaining how individual disciplines design their specific models, which are then merged to an interdisciplinary model. The student shall learn to understanding why, how and by whom this is done. Further, the lecture explains how the data and models are shared for successful access and communication within a project's many stakeholders. The lecture's last topic deals with issues that can slow down the process of BIM implementation and introduces the BIM maturity level, which depends on how many of the issues have been solved.

Learning Outcomes

- Explain the role of discipline-specific BIM models
- Understand why the specific models are merged to final model
- Assess the main advantages of the Common Data Environment

- Describe the crucial steps in BIM implementation and how they relate to BIM maturity level

Lecture: IFC as a data exchange format

The aim of this lecture is to briefly describe the structure and content of an IFC file. The background of the standard is described as well as its importance for the development of the BIM sector. The overall content of the BIM schema is then described, as well as the basic structure of the STEP format, which is the de-facto standard used for serialising the IFC model. An example of how to interpret an IFC file is also provided.

Learning Outcomes

- Explain the role of IFC in the building and construction industry.
- Explain basic concepts used in IFC, such as
  . Objects and entities, inheritance and properties
  . Basic IFC entities such as IfcWall
- Describe the basic structure of an IFC file in STEP format.
- Analyse the content of an IFC file and relate its STEP entities to the IFC standard

Assignment
The aim of this assignment is to clarify the structure and content of an IFC file. The learner will open the textual version of an IFC file and element by element relate each property to the corresponding part of the IFC standard specification.
Learning Outcomes

- Examine the records in an IFC STEP file.
- Explain the properties specified by the IFC records.

<u>BLOCK: BIM Applications</u>

Lecture: BIM for infrastructure and facility management
This lecture introduces the use of BIM in infrastructure and facility management. It explains the fundamental principles of applying BIM in civil engineering projects, the combined use of GIS data, examples of applications, and available technical solutions. The second part focuses on BIM implementation in facility management, covering applications such as space management, asset management, maintenance planning, energy efficiency, safety, and more.

Learning Outcomes

- Understand the fundamental principles and benefits of BIM in the context of infrastructure and facility management.
- Describe the application of BIM in various infrastructure and civil engineering projects.
- Understand the benefits of using GIS data in BIM infrastructure projects.
- Identify and assess different technical solutions to be used in BIM infrastructure projects.
- Identify and assess the effectiveness of BIM implementation in different facility management tasks and practices

Lecture: BIM for Existing Historical Buildings
This lecture introduces the use of BIM to manage historical buildings and structures. It presents the key benefits of using HBIM for historic buildings and the steps to perform the entire process - from the preliminary data acquisition to the modelling and its maintenance. Finally, it presents some examples of possible applications and 3 real cases.

Learning Outcomes

Understand the specialised application of BIM and its key benefits in the context of the historical building and structures
List the steps of the HBIM process
Describe concrete possible applications of HBIM

4.1.4 Conclusions

The course "Introduction to BIM" has been developed to respond to the needs discovered in PR2; to develop comprehensive and introductory learning materials on BIM: definition, uses and applications. The learning materials can be used as a structured course, as modular learning paths, or as individual lectures.

4.2 3D GIS, City Models, and Digital Urban Twins

4.2.1 Course Development characteristics

The development of learning materials on "3D GIS, City Models, and Digital Urban Twins", followed the modified Scrum methodology as described above.
The process involved four sprints with an average of 4 Scrum meetings per cycle. In addition to these sprints, quality review processes were activated for the nearly completed final products. In total, the development process covered around 10 calendar months.
The main artefact being used in the development cycles are the syllabus (product specification), product backlog, sprint backlog and quality review form.

The Scrum methodology is an agile approach to development, where there is an option of incorporating changes in the requirements as the development proceeds. This feature was seen as very important in the development of the BIRGIT learning material.
Some modifications were also made to the artefacts being used. For instance, information about used and planned development work was found to be unnecessary and consequently removed from the initial artefacts.
After the finalisation of learning materials, a final review was initiated, where the Scrum master should review all content and assure the project guidelines, such as the usage of British English, were appropriately applied. As a final step, the material was packaged for distribution.

4.2.2 Course description

The learning materials being produced are structured in three different blocks, where each block has one main author.

BLOCK: City models

The learning material on City Models consists of three lectures, where each lecture consists of a powerpoint file and a more elaborated text document. These lectures deal with topics such as the main concepts and different types of 3D geographical modelling, 3D raster/voxel models, reality-mesh models, semantic city models and 3D data standards, mainly CityGML.

The City Model block is currently a theoretical block, and it has not yet any practical assignments developed.

BLOCK: 3D data processing

The learning material on 3D data processing consists of three practical assignments and four lectures. Each lecture is delivered as slides in a powerpoint file and more detailed instructions in a text document. The practical assignments consist of a text document where the assignment task is specified together with a proposed solution of the task. This document is supported by a powerpoint file, suitable for instance for introducing the assignment to students.

The topics being covered are mainly related to processing and integration of different types of land surveying data, from various types of sensors, various levels of details, various ways of data processing (CAD or GIS), various geometry types etc.

Assignment: Sensor alarms

Assignment summary

This assignment is about reading sensor data from an air quality sensor network, The sensor network can be accessed using the OGC Sensor Observation Standard (SOS). If the air pollution exceeds a certain threshold, an alarm is to be issued.

Learning outcomes

At the end of this assignment, the learner is expected to be able to:

- Access sensor measurements in a sensor network.
- Develop a small Python script for handling sensor measurements.

BLOCK: Digital urban twins

The learning material on digital urban twins consists of the lectures and one practical assignment. Each lecture is delivered as slides in a powerpoint file and a more detailed instructions in a text document. The practical assignment consists of a text document where the assignment task is specified together with a proposed solution of the task.
The first lecture deals with definitions and main concepts being used in digital urban twins. The remaining part of the learning material is targeting the management of sensor network and especially sensor networks for urban air quality. Consequently, the remaining two lectures deal with sensor data standards and an introduction to air quality. The practical assignment is then devoted to
issuing sensor alarms based on real-time readings of air quality sensors.

In the remaining part of the section on 3D GIS, City Models and Digital Twins we list the developed learning materials by lecture name, a short summary and the intended learning outcomes.

Lecture: Concepts of 3D modelling of the built environment

Lecture summary:

This lecture provides the introduction to 3D geographical modelling and is possible to take without previous knowledge of 3D GIS. It starts with several different concepts of 3D visualisation and explains how they differ according to area of usage. The student learns briefly about voxels models and more deeply about creation of reality-mesh models, with real-world examples.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Understand main concepts and different types of 3D geographic modelling
- Understand the principles of 3D raster / voxel modelling
- Describe creation and advantages of reality-mesh models

Lecture: Semantic 3D city models

Lecture summary

This lecture focuses fully on semantic models as the state-of-the art-approach of the city modelling and basis for applications like smart cities and digital twins. It goes through advantages of models with semantic information and explains how such models are created. In the last part, the lecture shows several examples of existing semantic models as well as of their use in societal planning***.***

Learning outcomes

At the end of this lecture, the learner is expected to be able to

- Explain the semantic part of the city models and differences compared to graphical 3D models
- Summarise the main steps of semantic model creation
- Name examples of existing models as well as of their possible applications

Lecture: 3D GIS data standards

Lecture Summary

The last lecture of this block describes the 3D city models on data level. It introduces the student into the CityGML conceptual model and describes its modules and how they can be used in diverse aspects of city modelling. It goes more deeply into certain representation, e.g. geometric, topologic or time, because knowledge of these is important for understanding the process of BIM-GIS integration. Further, the lecture provides information on different CityGML encodings as well as other 3D formats.

Learning Outcomes

At the end of this lecture the learner is expected to be able to:

- Name several ways how 3D data can be stored, with focus on CityGML encodings.
- Summarise the main parts of the CityGML conceptual model and how it is used.
- Understand the aspects of CityGML that are important for conversion to and from BIM.

Block: 3D Data Processing

Lecture: 3D Data acquisition technologie

Lecture summary

The lecture explains 3D geospatial data acquisition surveying technologies: tacheometry, photogrammetry and 3D Laser scanning. It covers terrestrial and aerial laser scanning.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Explain 3D geospatial data acquisition technologies
- Describe the ways of using data acquired with different sensors (UAVs, ALS, TLS, Tacheometry)

Lecture: 3D Data Acquisition Technologies

Lecture summary

The lecture explains 3D geospatial data acquisition surveying technologies: tacheometry, photogrammetry and 3D Laser scanning. It covers terrestrial and aerial laser scanning.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Explain 3D geospatial data acquisition technologies
- Describe the ways of using data acquired with different sensors (UAVs, ALS, TLS, Tacheometry)

Lecture: 3D Data Sources

Lecture summary

The lecture explains 3D data sources that can be used in BIM and GIS. It covers metadata description, authoritative and non-authoritative data sources and licenses.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Identify and describe available 3D data sources that can be used for GIS and

Lecture: 3D Tools Applications

Lecture summary

The lecture explains different tools and applications for 3D data processing. It covers commercial and free and open source.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Describe and choose different tools and applications for 3D data processing

Assignment: Creation of 3D Buildings from Surveying Data

Assignment summary

The assignment explains creation of 3D building model from surveying data. For the assignment AutoCAD Map 3D software is needed.

Learning outcomes

At the end of this assignment, the learner is expected to be able to:

- Describe and explain creation of 3D buildings from surveying data
- Apply commercial CAD software to produce a 3D building with a medium level of detail (LOD 2) based on surveying data

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Assignment: Extract 3D Buildings from Point Clouds

Assignment summary

The assignment explains possibilities of using 3D data sources in QGIS application to extract building data. The sample data used in the assignment are aerial laser scanning data (LIDAR).

Learning outcomes

At the end of this assignment, the learner is expected to be able to:

- Identify and describe available 3D data sources that can be used for GIS and BIM
- Experiment with external geodata in QGIS

Assignment: Merging Data having different LOD's

Assignment summary

The assignment explains possibilities of combining 3D data with different geometries and level of details (LOD).

Learning outcomes

At the end of this assignment, the learner is expected to be able to:

- Combine 3D geospatial data having different geometry types
- Interpret different Level of Details (LODs)

Block: Digital Twins

Lecture: Introduction to Digital Urban Twins

Lecture summary

The aim of this lecture is to define the concept of digital urban twins and give some examples of its usage. More specifically, the lecture describes different types of data that may be included in digital urban twins, like historical data, 3D data, real-time data, and crowdsourced data. Some key data processing activities, like engineering and design, optimization, simulation and predictions and monitoring are also described as well as instigation of actions by issuing operation control messages or alerts.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Define the concept of digital twins.
- Describe characteristic features of digital urban twins.

Lecture: Sensor Data Standards

Lecture summary

The aim of this lecture is to define the concepts of sensors and sensor network and to give some examples of their usages. The remaining focus of this lecture is then to describe how to access the outputs of the sensors and sensor networks, using OGC standards like Sensor Observation Services and OGC sensor API.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Explain core concepts, such as sensors, sensor networks.
- List different types of sensors and their usages.
- Describe the basic principles of accessing sensor networks.

Lecture: Air Quality Programs

Lecture summary

The topic of this lecture is air quality and how this type of issues is addressed by EU and related policies. Air quality measures are described as well as monitoring strategies at EU level. EU network for providing near real-time measurements of air quality is also described. The lecture is an introduction to the assignment on sensor alarms of air quality monitoring.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Explain motives for the European Clean Air Policies
- Describe basic components of the EU Ambient Air Quality Directive
- Describe actions which might reduce air pollution in cities

Assignment: Sensor Alarms

Assignment summary

This assignment is about reading sensor data from an air quality sensor network, The
sensor network can be accessed using the OGC Sensor Observation Standard (SOS). If
the air pollution exceeds a certain threshold, an alarm is to be issued.

Learning outcomes

At the end of this assignment, the learner is expected to be able to:

- Access sensor measurements in a sensor network.
- Develop a small Python script for handling sensor measurements.

4.3 BIM - GIS integration

4.3.1 Course development process

Over six months, the BIRGIT team has worked on the development of a comprehensive learning package aimed at facilitating the integration of Building Information Modelling (BIM) and Geographic Information Systems (GIS). At the beginning of developing the learning materials, we have divided this work package, referred to as PR3, into three distinct submodules regarding the theme, with the third module specifically dedicated to BIM - GIS integration. Our approach to this endeavour has been marked by continuous planning, iterative development, and regular collaboration.
Throughout the development of learning materials, we adopted agile principles, specifically the Scrum framework, to manage our project and ensure good collaboration. Scrum methodology helped us work in small, iterative steps toward our goals. We held regular meetings every one to two weeks depending of a stage of progress, to review progress, address challenges, and adjust the syllabus and materials. These meetings kept the team aligned and fostered collaboration. We also used backlog management to prioritize tasks and share progress. The Scrum process involved the Scrum master, the development team, and the project owner. The scrum method was applied during the development of learning materials, through the Scrum master, who was selected from the team members, the development team and the project owner.
The project began with identifying key topics for the BIM-GIS integration submodule. Through discussions and brainstorming, we developed a syllabus that balanced theory and practical applications. This foundation guided the next phases of development. As we created learning

materials, we refined the syllabus based on project owners' within a project team feedback. Early drafts faced internal critical review, leading to multiple iterations and significant change. Also, a major challenge was designing practical exercises due to the lack of advanced open-source tools. Initial efforts focused on free solutions, but limitations led to reconsidering commercial options. While this aspect remains uncertain, we continue exploring ways to for a hands-on learning out of the project's scope.

4.3.2 Course description

These learning materials introduce students to BIM-GIS integration, covering its benefits, key differences, and challenges. They explore various integration approaches, workflows, and the importance of data quality. hese learning materials provide an introduction to BIM-GIS integration, outlining its benefits and distinguishing between interoperability and full integration. They examine the similarities and differences between BIM and GIS, emphasizing the challenges these differences create. Various integration methods are compared, along with their advantages and limitations. The importance of data quality and potential issues that may arise during integration are also discussed. Additionally, the materials focus on data conversion between BIM and GIS, explaining what information can be extracted from each system and how it is converted in both directions—first from BIM to GIS, then from GIS to BIM—while addressing the specific challenges of each process. The content concludes with real-world applications of BIM-GIS integration throughout a project's lifecycle.

Course Structure

The Learning material "BIM-GIS Integration" is structured in three thematic learning BLOCKS, created and offered as a sequential learning path, but ultimately self-standing.

- BLOCK 1 – Introduction and workflow
- BLOCK 2 – BIM-GIS in project's life cycle
- BLOCK 3 – Integration Use Cases

Prerequisite

Students are expected to have a basic understanding of both BIM and GIS idnividually, including practical experience with these technologies and familiarity with their key features and data formats. If they do not have this background, they should first review the first two modules on the BIRGIT website: „Introduction to BIM“ and „3D GIS, City Models, and Digital Urban Twins“ to better understand the challenges and characteristics of BIM-GIS integration, the integration of these two technologies.

Learning Materials

In this section a quick description of all course lectures, with a brief summary and learning outcomes is presented. All materials ae available for download in pdfformat on the BIRGIT website https://birgitproject.eu/learning-materials/

BLOCK: Introduction and workflow

Lecture: Introduction to BIM-GIS Integration

This lecture introduces the student into the topic of BIM-GIS integration by explaining why it is beneficial to combine these models and also what the difference between interoperability and full integration is. In its second part, the lecture takes up the main similarities and differences between the models and why the differences cause challenges to the integration.

Learning outcomes

- Explain why to integrate BIM and GIS based on their main concepts
- Understand differences between interoperability and full integration
- Know the differences between BIM and GIS that challenge the integration

Lecture: BIM-GIS Integration Workflow

The lecture starts by comparison of different integration approaches, their advantages and disadvantages. Then, it describes how the integration proceeds, takes up the steps in the workflow and explains what parts of the models are to be integrated. The lecture discusses even data quality and possible issues to care of in the process.

Learning Outcomes

- Name different integration approaches
- Know the steps in the integration workflow
- Understand importance of data quality and possible issues of the conversion

Lecture: BIM-GIS Data Conversion

The last lecture of this block goes more deeply into the data conversion. First, it provides information which data can be obtained from which model, before continuing with the description of the conversion in both directions. First, BIM-to-GIS path is described, including the challenging parts. It is followed by similar explanation of GIS-to-BIM procedure. In the end, the lecture provides a short overview of the software dealing with the conversion.

Learning Outcomes

- Summarize what information can be provided from BIM and GIS model
- Describe the main steps and challenges of conversion BIM-to-GIS

- Describe the main steps and challenges of conversion GIS-to-BIM

BLOCK: BIM-GIS in project's life cycle

Lecture: BIM-GIS integration – overview

This lecture provides an overview of the integration between BIM and GIS, focusing on key concepts, scales, and distinct characteristics of both technologies. It is designed for participants with basic knowledge of BIM and GIS. Key learning outcomes include understanding the fundamental principles of BIM-GIS integration, recognizing different scales in both fields, and identifying their unique properties. The lecture highlights how BIM enhances data consistency throughout a project's lifecycle, while GIS provides spatial context for better decision-making. The integration of both technologies supports more efficient infrastructure planning, management, and sustainability.
Learning Outcomes

- Explain the basic concept and main properties of BIM GIS integration.
- Understand different scale of BIM and GIS.
- Know particular properties of BIM and GIS.

Lecture: BIM-GIS integration in projects' life cycle

The document discusses the integration of BIM and GIS in the construction planning phase, highlighting their complementary roles. BIM provides detailed building models, while GIS offers spatial data for site selection, environmental analysis, and infrastructure planning. Their integration enhances efficiency, sustainability, and decision-making throughout a project's lifecycle, from pre-construction analysis to facility management. Challenges persist due to software limitations and lack of collaboration, but overcoming them enables better visualization, compliance, and resource management. Integration is showcasing how combined BIM-GIS models improve urban planning, logistics, and maintenance, ensuring long-term cost-effective infrastructure management.

Learning Outcomes

- Explain different project's stages in which BIM GIS integration can be applied
- Understand the benefits of integration for different stakeholders
- Know which benefits integration can provide in each stage of project's life cycle

BLOCK: Integration Use Cases

Lecture: BIM-GIS integration – use cases

This lecture explores the integration of BIM and GIS through practical applications. It covers key benefits, challenges, and legislative aspects, aimed at participants with basic BIM and GIS knowledge. Case studies include flood analysis for site selection, urban planning, energy performance assessment, construction site optimization, and traffic simulations. The lecture highlights how BIM-GIS integration enhances decision-making, improves efficiency, and supports sustainable infrastructure development by combining detailed building models with spatial analysis.

Learning Outcomes

- Explain state of the art of the legislative on BIM GIS integration.
- Understand benefits gained from the use cases of the integration.
- Know the advantages and shortcomings of BIM GIS integration

The internal order of these lectures should be maintained in any teaching situation, as the knowledge presented in the different lectures is in a hierarchical order.

4.4 Quality Review

The development of the three course packages was carried out by three different groups of people, some were members of more than one group, others participated in one group only. An important person in each group was the Scrum Master, which varied between the groups. However, the presence and participation of Anders Östman in the scrum process was an important factor, as he had been in touch with the Scrum method earlier (Östman and Östman, 2018).
In order to maintain quality in the learning materials, each single lecture and assignment was reviewed by a person to evaluate the quality of the lecture. The reviewer would then write down her/his opinion about the quality and possibly suggest some changes. After the review the lecture was worked through taking into account the reviewers comments. After completed modifications the lecture was reviewed anew. If satisfied, the lecture was marked as accepted and not changed any further.

5 Localisation of new course materials

5.1 Methodology

Most of the materials were developed in English in order to enable all members of the team to work on the new modules. English as a foreign language is relatively well understood by a large part of the population in Sweden, but understanding and mastering of the English language in, e.g., Spain, Italy and Croatia can vary. Thus, for the new learning materials a translation had to be produced. During PR2 we localized some of the material that was discovered during PR1 using the European Commissioon Translation System (European Commission, 2023).

This system had produced good results during the localisation efforts in PR2 and was therefore chosen again. One important reason to use eTanslation was the fact that only very little manual post-processing had to be done.
The localized version in Swedish, Italian, Spanish and Croatian can be downloaded from the BIRGIT homepage.

5.2 Results

The localisation of the course materials was successful using the Translation tool of the EU. All modules were translated into the four languages spoken by the team members.
We believe that the learning materials have good quality guaranteed through the review process. The tests which will be carried out in PR4 will hopefully give us the answer to the question if the learning materials are of good quality.

6. Discussion and Conclusions

This report describes in detail the development of a suite of learning materials devoted to the subject of BIM-GIS Integration. The modified Scrum methodology, adapted from previous projects and experiences, worked well, although a few additional modifications were still required.
The learning materials are grouped into three modules. The structure and the contents of the materials imply that a potential learner is expected to have much more experience in the handling of GIS then handling BIM Data. Thus, the first learning module is devoted to the study of the basic elements of mainly BIM and the IFC-format which in its different variations in the standard offers a continuous growth of the technique when incorporating new developments This module consists of 9 lectures and one assignment, having an estimated workload corresponding to 3 ECTS/ECVET. The second learning module deals with 3D GIS, City Models and Digital Urban Twins. This module consists of 9 lectures and 4 assignments, corresponding to an estimated workload of 4 ECTS/ECVET. The third learning module deals with BIM-GIS integration where several specific applications are presented and discussed, highlighting when, why and how BIM and GIS may be integrated and what can be the positive experiences from such integrations. The third learning module consists of 6 lectures, corresponding to an estimated workload of 1 ECTS/ECVET.
The practical use of the learning modules will in time give knowledge about the applicability of this part of the learning offer.

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8. Annex

The following tables illustrate all developed learning materials. We use the following convention to keep the separate developments separated. We have defined above the three blocks we divided the PR3 into three subject areas – A: Introduction to BIM, B: 3D Data, City Models and Digital Twins and C: BIM – GIS Integration.

The tables A1 – A3 List all lectures in Module A by lecture name, Reviewer, Materials created and language translated into

BLOCK A1 – BIM Definition			
Lecture(s)	**Author(s)**	**Materials created:**	**Translated into:**
Lecture 1.1 **Fundamentals of BIM**	Carlos Clemente (AIN); Esther Bautista Gil (AIN)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 1.2 **Benefits and challenges using BIM**	Ariana Kubart (Ocellus)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 1.3 **Level of Development and 3D – 10D BIM**	Ariana Kubart (Ocellus)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian

Table A1: Lectures in learning module A1: Introduction to BIM - Introduction to BIM

BLOCK A2 – Working with BIM Data			
Lecture(s)	**Author(s)**	**Materials created:**	**Translated into:**
Lecture 2.1 **Data Management in BIM**	Sanja Samanovic (UNIN); Danko Markovinovic (UNIN)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 2.2 **BIM process workflow**	Ariana Kubart (Ocellus)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 2.3 **BIM Coordination**	Ariana Kubart (Ocellus)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 2.4 **IFC as a data exchange format**	Anders Ostman (Novogit)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Assignment **IFC**	Anders Ostman (Novogit)	Assignment Solutions	Spanish; Swedish; Croatian

Table A2. Lectures in learning module A2: Introduction to BIM - Working with BIM data

BLOCK A3 – BIM Applications			
Lecture(s)	**Author(s)**	**Materials created:**	**Translated into:**
Lecture 3.1 **BIM for infrastructures and facility management**	Roderic Molina (GISIG)	PowerPoint Presentation Lecture Notes	Italian; Spanish; Swedish; Croatian.
Lecture 3.2 **BIM for Historical Existing Buildings**	Silvia Gorni (GISIG)	PowerPoint Presentation Lecture Notes	Italian; Spanish; Swedish; Croatian.
Lecture 3.3 **BIM softwares and tools**	tbd		

Table A3. Lectures in learning module A3: Introduction to BIM – BIM Applications

Block B1: City Models			
Lecture(s)	Author(s)	Materials created:	Translated into:
Lecture 1.1 **Concepts of 3D modeling of the built environment**	Ariana Kubart, Ocellus	Powerpoint Presentation Lecture notes	English, Spanish, Italian
Lecture 1.2 **Semantic 3D City Models**	Ariana Kubart, Ocellus	Powerpoint Presentation Lecture Notes	English, Spanish, Italian
Lecture 1.3 **3D GIS Data Standards**	Ariana Kubarts, Ocessus	Powerpoint Presentation Lecture Notes	English, Spanish, Italian

Table A4. Lectures in Learning module B1: 3D Data, City Models and Digital Twins. City Models

Block B2. 3D Data Processing			
Lecture(s)	Author(s)	Materials created:	Translated into:
Lecture 2.1 **3D Data Acquisition Technologies**	Vlado Cetl, UNIN Sanja Samanoviĉ, UNIN Danko Markovinoviĉ, UNIN	Powerpoint presentation Lecture Notes	English, Spanish, Italian
Lecture 2.2 **3D Data Sources**	Vlado Cetl, UNIN Sanja Samanoviĉ, UNIN Danko Markovinoviĉ, UNIN	Powerpoint presentation Lecture Notes	English, Spanish, Italian

Lecture 2.3 **3D Data Tools Applications**	Vlado Cetl, UNIN Sanja Samanoviĉ, UNIN Danko Markovinoviĉ, UNIN	Powerpoint presentation Lecture Notes	English, Spanish, Italian
Assignment 2.1 **Creation of 3D Buildings from Surveying Data**	Vlado Cetl, UNIN	Assignment instruction (docx and pptx)	English, Spanish, Italian
Assignment 2.2 **Extract 3D Buildings from Point Clouds**	Vlado Cetl, UNIN	Assignment instruction (docx and pptx)	English, Spanish, Italian
Assignment 2.3 **Merging Data having Different LOD's**	Vlado Cetl, UNIN	Assignment instruction (docx and pptx)	English, Spanish, Italian

Table A5. Lectures in Learning module B2: 3D Data, City Models and Digital Twins. 3D Data Proc.

Block B3: Digital Twins			
Lecture(s)	Author(s)	Materials created:	Translated into:
Lecture 3.1 **Introduction to Digital Urban Twins**	Anders Östman, Novogit	Lecture Notes (docx and pptx)	English, Spanish, Italian
Lecture 3.2 **Sensor Data Standards**	Anders Östman, Novogit	Lecture Notes (docx and pptx)	English, Spanish, Italian
Lecture 3.3 **Air Quality Programs**	Anders Östman, Novogit	Lecture Notes (docx and pptx)	English, Spanish, Italian

Assignment 3.1 **Sensor Alarms**	Anders Östman, Novogit	Assignment instruction (docx and pptx)	English, Spanish, Italian

Table A6. Lectures in Learning module B3: 3D Data, City Models and Digital Twins. Digital Twins

Block C1: Introduction and Workflow			
Lecture(s)	Author(s)	Materials created:	Translated into:
Lecture 3.1 **Introduction to BIM-GIS Integration**	Ariana Kubart, Ocellus	Lecture Notes (docx and pptx)	English, Spanish, Italian
Lecture 3.2 **BIM-GIS Integration Workflow**	Ariana Kubart, Ocellus	Lecture Notes (docx and pptx)	English, Spanish, Italian
Lecture 3.3 **BIM-GIS Data Conversion**	Ariana Kubart, Ocellus	Lecture Notes (docx and pptx)	English, Spanish, Italian

Table A7. Lectures in Learning module C1: BIM – GIS Integration Introduction and Workflow

Block C2: Introduction and Workflow			
Lecture(s)	Author(s)	Materials created:	Translated into:
Lecture 2.1 **BIM-GIS Integration - Overview**	Olga Bjelotomic Oršuliĉ, UNIN	Lecture Notes (docx and pptx)	English, Spanish, Italian
Lecture 2.2 **BIM-GIS Integration in project’s Life cycle**	Olga Bjelotomic Oršuliĉ, UNIN	Lecture Notes (docx and pptx)	English, Spanish, Italian

Table A8. Lectures in Learning module C2: BIM – GIS Integration, Introduction and Workflow

Block C3: BIM-GIS Integration -use cases			
Lecture(s)	Author(s)	Materials created:	Translated into:
Lecture 3.1 **BIM-GIS Integration -use cases**	Olga Bjelotomic Oršuliĉ , UNIN	Lecture Notes (docx and pptx)	English, Spanish, Italian

Table A9, Lectures in Learning module C3: BIM – GIS Integration, BIM – GIS Integration – use cases