INTELLECTUAL OUTPUT 1

TASK O1-A4

CircularBIM Course Curriculum based on ecological challenges and BIM technologies

Erasmus+

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Consortium members: Universidad de Sevilla (USE), Asociación Empresarial de Investigación Centro Tecnológico del Mármol, Piedra y Materiales (CTM), CYPE SOFT SL (CYPE), Universitatea Transilvania din Brasov (UNITBv), Asociatia Romania Green Building Council (RoGBC), Centro Tecnologico da Ceramica e do Vidro (CTCV) and Universidade do Minho (UMinho)

1. Subject data

Name	CONSTRUCTION METHODOLOGIES AND PROCEDURES BASED ON CIRCULAR ECONOMY CONCEPTS BY USING BIM
Module	Environmental Engineering and Sustainable Development
Qualification in which it is taught	*
Other qualifications that could be offered *	Architecture/Urbanism Degree Engineering of Construction Degree Civil Engineering Degree Public Works Engineering Degree Master's programmes related to Civil Engineering
Centre	*
Character	OPTIONAL
Term	Four months
Course	*
Language	Official Language*
ECTS	3
ECTS learning hours	25
Overall workload (hours)	75
Theory class schedule	*
Classroom	*
Practice class schedule	*
Place	*

(*) All the fields marked with an asterisk are subject to completion with the specific information for each educational centre.

2. Teacher's data

Teacher responsible	*
Department	*
Area of knowledge	*
Teacher's office location	*
Phone	*
E-mail	*
URL / WEB	*
Tutorial timetables	*
Tutorial location	*
Teaching and research profile	*

(*) All the fields marked with an asterisk are subject to completion with the specific information for each educational centre.

3. Description of the subject

3.1. Short description of the contents

- Construction and sustainable development.
- Environmental regulation and sustainability in construction.
- Sustainable materials, processes and solutions used in constructions sector.
- Construction and demolition waste (CDW).
- Evaluation, selection and optimal use of different materials and construction methods for building elements using BIM technology.
- Circular Economy concepts and Life Cycle Assessments (LCA) of a material or procedure used in construction execution.
- BIM technologies used in sustainable construction.
- The Circular Economy in the European context.
- Implementing the sustainable construction strategies. The European / national Territorial Strategy.
- The use of CircularBIM Tool.

3.2. General description of the subject

Sustainability is the ability to endure without depleting the future availability of natural resources or unduly damage of the wider environment. This concept has been incorporated in the idea of sustainable development in the recent years.

Some concepts such as Circular Economy have been integrated into sustainability strategies and policies. A Circular Economy is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

The construction sector is one of the key sectors of the economy, being among those mobilize the most natural resources and generate the most waste. But, there is a long way to go to restructuring this sector toward circular economy.

Reaching some of the objectives of the Circular Economy Strategies at European level involves facing various challenges in the construction sector, from legal and administrative barriers to raising awareness in society.

It must be emphasised that the role of designers, architects and engineers when it comes to incorporating sustainable, recycled materials, into the eco-design of building and infrastructure. Likewise, project managers play an important role, especially when it comes to approving changes that allow reusing materials generated at the site itself, thereby avoiding transportation to treatment plants for subsequent incorporation and thus reducing fuel consumption and the associated greenhouse gas emissions.

In this subject, sustainable processes with circular economy principles in the construction

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industry are known and studied, understood as those that consume less raw materials, energy and produce less waste, thus producing a lower environmental impact and preserving economic resources.

In order to reach the goals of this new economic methodology, this subject will study the normative frame of reference, for the quantification of the environmental impact generated by construction processes and procedures.

1. Circular Economy (CE) in the construction sector is key to increase the quality and quantity of recycling and reuse of construction and demolition materials. So, in this context, waste management plays a crucial role in the circular economy. The way waste is managed can lead to high recycling rates and the return of valuable materials to the economy, or on the contrary to an inefficient system in which most recyclable waste ends up in landfills or is incinerated, with potentially damaging effects on the environment and significant economic losses. Understanding that the waste generated during a production process, or due to the exhaustion of the useful life of a product is a potential resource, is one of the fundamental keys to initiating the transition process.

2. BIM methodology. It is a collaborative working methodology for the creation and management of construction projects in which, through the creation of a digital information model, data relating to geometry (3D), time (4D), costs (5D), environment (6D) and maintenance (7D) can be accessed.

The use of CircularBIM Tool is an attractive part of the analysis of environmental benefits by adapting the construction sector to the transition towards the circular economy. The use of it will provide some necessary information to solve an analysis problem, calculating and reducing the generated waste of the construction processes and procedures.

3.3. Objectives of the subject

1. Adequate knowledge of the difficulties and problems of the transition to the circular economy in the construction sector, as well as the function of design to provide the construction products and materials a second life by reusing, reassembling, reconfiguring and recycling them.

2. Ability to design the requirements of building users to meet them, respecting the limits imposed by budgetary factors and construction regulations, and in relation to bioclimatic and sustainability aspects.

3. Knowledge of the mechanisms that favour the recovery, reuse and recycling of construction materials.

4. Knowledge and ability to design an architecture by using high-grade products with high-recycled content or easy to separate into components that minimises the wastes generated in the construction of the building.

5. Train the student to acquire a critical and scientific way of thinking, to be able to apply the offered technologies to their constructive solution, to respond to the demands of citizens regarding sustainability and to protect the environment during all the life cycle of the building.

6. Teach the basic operation of the CircularBIM Tool, as a professional instrument to evaluate the environmental impacts of products, processes and services and how to decrease them.

7. Acquire the necessary basic knowledge of Circular Economy and analyse the databases

and impact assessment methodologies available to perform the calculation of this impact.

8. Make practical cases that support learning.

9. Present the foundations and the environmental regulations that pertain to constructive development.

10. Teach the operation of the OER platform, as an open educational resource for self-learning in performance methodologies for sustainable development in construction with circular economy principles.

3.4. Contribution of the subject to professional practice

This subject aims to raise awareness among future professionals about the need to adequately foresee the negative consequences that human actions may have on the environment during the development of a specific project, ranging from the stage of previous studies to the rehabilitation phase or dismantling. In it, students will be provided with the necessary knowledge to develop and apply tools for analysis, decision making, prevention, correction, mitigation, etc., of the negative effects that a specific construction project may cause.

Currently, with the legislative changes that have taken place in recent years, some preventive tools have been included in other environmental permits or authorizations, although they play an essential role in minimizing environmental problems.

On the other hand, it must be highlighting the set of measures that allow us to correctly manage the different environmental aspects of a specific activity, which will allow us to comply with current environmental legislation, as well as achieve levels of environmental excellence.

Finally, the acquisition of knowledge in the new technologies of design and management of construction projects, through the use of BIM methodologies, as essential tools for the development of construction projects will facilitate the adaptation to the new requirements of the labour market.

3.5. Recommendations to course the subject

(*) Completion subject to the criteria of the educational centre.

3.6. Special measures provided

(*) Specific regulations of the educational centre with respect to the establishment of special adaptation in the methodology and the development of teaching for students who suffer from some type of disability or limitation.

4. Competencies and learning outcomes

4.1. Basic competencies

BC1. Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context.

BC2. That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

BC3. That students know how to communicate their conclusions and the knowledge and ultimate reasons that sustain them to specialised and non-specialised audiences in a clear and unambiguous way.

BC4. That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

BC5. That students can gather and interpret relevant data to make judgments that include a reflection on relevant issues of a social, scientific or ethical nature.

4.2. General competences

GC1. Be able to demonstrate a detailed and well-founded understanding of the theoretical and practical aspects and the methodology of work in the field of Environmental Engineering and Sustainable Processes.

GC2. Be able to predict and control the evolution of complex situations through the development of new and innovative work methodologies adapted to the field of Architecture, Environmental Engineering and Sustainable Processes.

GC3. Be able to take responsibility for their own professional development and their specialization in one or more fields in the field of Architecture, Environmental Engineering and Sustainable Processes.

GC4. Be able to foster, in professional contexts, the technological, social or cultural advancement within a society based on knowledge.

GC5. Be able to take responsibility for their own professional development and their specialisation in one or more fields of study.

4.3. Specific competences

SC1. Know the principles of sustainable development applied to engineering and construction, and the rules that affect the environment.

SC2. Know the procedures related to energy efficiency.

SC3. Knowledge of the impact of the construction sector in the achievement of sustainable development and, especially, deepening knowledge of the regulations on the environmental impact of the building.

SC4. Intensification in techniques for assessing the environmental impact of building and demolition processes, the sustainability of buildings, and their relationship with the energy efficiency of buildings.

SC5. Know the different tools of environmental management, as well as its correct

application to reduce environmental problems.

SC6. Plan the implementation of an environmental management system, as well as coordinating and maintaining through advances BIM technologies.

4.4. Transversal competencies

TC1. Aptitude for the written and oral communication, as well as for the analysis, organisation, planning and synthesis that provides sufficiency or suitability in the critical reasoning.

TC2. Ability to manage computer tools that allow data management, problem solving and help decision making.

TC3. Aptitude for teamwork, interdisciplinary, that combines interpersonal skills while maintaining respect for diversity, such as coexistence with other cultures.

TC4. Ability to acquire criteria of continuous training, adaptability to social transformations, motivation for quality from creativity.

TC5. Ability to reconcile environmental requirements with the conditions of development.

TC6. Ability to apply ethical criteria and sustainability in decision making.

4.5. Learning outcomes

1. Know the different tools of environmental management, differentiating those of a mandatory nature from those of a voluntary nature.

2. Identify and assess the different environmental aspects in a constructive process.

3. Know the different concepts of the field of sustainability.

4. Know the sustainable construction, circular economy and the life cycle analysis.

5. Understand Building Information Modelling (BIM) as a tool.

6. Be able to develop a bioclimatic project, considering the design, new technologies, its functionality and circular economy principles.

7. Develop the capacity for environmental evaluation of construction projects, and the capacity for self-criticism.

8. Student can cooperate in a project team, correctly carrying out the tasks assigned to him.

9. Know the different European environmental specific regulations in the construction and BIM field.

5. Contents

5.1. Contents of the subject

Environmental legislation and Circular Economy in construction sector.

Preventive tools of environmental impact study. Generation of alternatives.

Methodologies for environmental impact assessment.

Construction and sustainable development.

Analysis of the project and alternatives. Identification and assessment of impacts.

5.2. Theory programme (sessions and issues)

THEMATIC AREA I: CONSTRUCTION SECTOR AND CIRCULAR ECONOMY REGULATIONS

UNIT 1. Introduction

1.1 Concepts. Sustainability. Environment.

1.2 Regulatory context of sustainable development and environmental quality.

1.3 Status of the level of implementation of sustainable construction.

1.4 System references for environmental declarations of buildings.

UNIT 2. Circular Economy for construction sector

2.1 Definition and scope.

2.2 Principles of Circular Economy for Building Design.

2.3 Circular Economy principles by target groups.

THEMATIC AREA II: SUSTAINABILITY OF MATERIAL RESOURCES

UNIT 3. Sustainability of building materials

3.1 General characteristics.

3.2 Models and tools for assessing the level of environmental impact of construction materials and products.

3.3 Sustainable material resources.

UNIT 4. Environmental indicators

4.1 Comparison of materials, practical methodology.

4.2 LCA in constructions sector.

4.3 Normative frame of reference for LCA.

4.4 LCA examples.

4.5 LCA conclusions.

THEMATIC AREA III: SUSTAINABLE CONSTRUCTION PROCESSES AND SOLUTIONS

UNIT 5. Comparative study of construction processes and procedures

5.1 Structures and foundations.

5.2 Covers and enclosures.

5.3 Installations.

5.4 Coatings.

5.5 Comparison of solutions.

THEMATIC AREA IV. CONSTRUCTION AND DEMOLITION WASTE (CDW)

UNIT 6. Construction and demolition waste

6.1 General aspects of CDW.

6.2 Regulatory context of CDW.

6.3 Demolition and hazardous waste.

6.4 CDW budgeting.

THEMATIC AREA VII. BIM TECHNOLOGIES

UNIT 7. BIM technologies

7.1 BIM definitions.

7.2 Technical regulations related to BIM technologies.

7.3 The use of BIM in the Sustainable Building Design.

7.4 BIM and environmental challenges and its application in the construction sector.

7.5 CircularBIM Tool.

5.3. Practices programme

Realisation of 4 practical cases of 4 different construction typologies.

6. Teaching methodology

6.1. Teaching methodology			
Activity	**Teaching techniques**	**Student's work**	**Hours**
Theoretical classes	Expositive classes of the theoretical contents, using the method of lesson dialogue. Resolution of doubts raised by students.	On-site:	**12**
		Non-on-site:	0
Solution of problems and practical cases	Resolution of practical cases. Problems are proposed to students for their resolution in the classroom at a certain time. They are solved through the use of blackboard and / or projector. Proposition of exercises for resolution at home.	On-site:	**3**
		Non-on-site:	2
Practices in computer classroom	Search for information, management of databases and use of tools for calculating and estimating emissions.	On-site:	0
		Non-on-site:	4
Cooperative work activities	Resolution of practical cases. Working groups will be set up in the classroom to carry out practices, monitoring the participation of the group's members.	On-site:	**3**
		Non-on-site:	2
Tutorials	Resolution of doubts about theory, problems, practices and seminars.	On-site:	0
		Non-on-site:	3
Seminars and visits to companies and facilities	In the seminars, specific topics of the theoretical syllabus will be expanded. Depending on availability, a visit will be made, or the assistance of an environmental management professional will be scheduled.	On-site:	**3**
		Non-on-site:	0
Work / Individual study	Study of the subject.	On-site:	0
		Non-on-site:	25
Works / Informs	Realisation of works and reports of practices to be delivered by the student.	On-site:	0
		Non-on-site:	10
Formative evaluation activities	Follow-up and development of works, practices and reports.	On-site:	0
		Non-on-site:	4
Official exams	Preparation, correction and review of written tests.	On-site:	**2**
		Non-on-site:	0
Exhibition of Works	Evaluation and correction of the expositions corresponding to the different works to be carried out by the student.	On-site:	**2**
		Non-on-site:	0
			75

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7. Assessment methodology

7.1. Activities and assessment criteria		
Activities	**Systems and assessment criteria**	**Percentage Weight (%)**
Written tests.	Theoretical-practical knowledge acquired by the student will be evaluated.	60
Assessment of practices cases with ICT support.	Knowledge acquired in practices with ICT support will be evaluated.	0-5
Individual and teamwork assessment works.	Development and presentations of individual and group works will be evaluated.	30
Other assessment activities.	Attendance and participation to classes of the subject will be evaluated.	5-10
Works		
Individual and teamwork works.	All aspects related to the task to be carried out will be evaluated, from the search of information to the final presentation.	40
Resolution of practical cases.	Both the proposed solution and the analysis of alternatives and the justification of the solutions that have been carried out will be evaluated.	20
Assessment of practices cases with ICT support.	Knowledge acquired in practices with ICT support will be evaluated.	0-5
Individual and teamwork assessment works.	Development and presentations of individual and group works will be evaluated	30
Other assessment activities.	Attendance and participation to classes of the subject will be evaluated.	5-10

7.2. Control and monitoring mechanism

The control and monitoring of student learning will be done through the following actions:

- Participation in the issues and practical cases raised in class.
- Assistance to theoretical and practical classes.
- Tutorials.
- Carrying out self-evaluation questionnaires.
- Assessment of the individual written test, or of the research works, individual and in group.

8. Bibliography and resources

8.1. Bibliography

National Institute of Building Sciences, Introduction to the National Building Information;

EU Commission JRC Technical Report, Building Information Modelling (BIM) standardization, 2017;

EUBim-Handbook for the Introduction of Building Information Modelling by the European Public Sector, 2016;

International BIM implementation guide, RICS guidance note, global. 1st edition;

https://www.construible.es/biblioteca/informe-circular-economy-principles-building-designcomision-europea

EU Construction and Demolition Waste Management. Guidelines for the waste audits before demolition and renovation works of buildings, 2018.

8.2. Regulations

EN ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 1: Concepts and principles (ISO 19650-1:2018)

EN ISO 19650-2:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of the assets (ISO 19650-2:2018)

EN ISO 12006-3:2016 Building construction - Organization of information about construction works - Part 3: Framework for object-oriented information (ISO 12006-3:2007)

EN ISO 29481-1:2017 Building information models - Information delivery manual - Part 1: Methodology and format (ISO 29481-1:2016)

EN ISO 29481-2:2016 Building information models - Information delivery manual - Part 2: Interaction framework (ISO 29481-2:2012)

EN ISO 16739:2016 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries (ISO 16739:2013)

SR EN 15804 + A1: 2014. Sustainable development of construction works. Product environmental statements. Basic rules for the category of construction products.

SR EN 15942: 2012. Sustainability of construction works. Environmental product declarations. Communication format business-to-business.

Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March

2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC.

8.3. Online resources and other resources

www.allbim.net
www.bimserver.org
www.circularbim.eu
www.codigotecnico.org
www.csostenible.net
www.eco-circular.com
www.magrama.gob.es
www.oerco2.eu

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