O2/A3

COMMON EUROPEAN CURRICULA

Methodologies of utilisation of BIM/GIS for calculation of LCA during urban development planning

UrbanBIM

Erasmus+

Universitatea Transilvania din Brașov
ROMANIA GREEN BUILDING COUNCIL
Centro Tecnológico del mármol, piedra y materiales
Universidad de Sevilla
Warsaw University of Technology
datacomp

Table of contents

1. Subject data

Name	METHODOLOGIES OF UTILISATION OF BIM/GIS FOR CALCULATION OF LCA DURING URBAN DEVELOPMENT PLANNING
Module	Environmental Engineering and Sustainable Development
Qualification in which it is taught	*
Other qualifications that could be offered *	Architecture Degree Civil Engineering Degree Engineering of Construction Degree Public Works Engineering Degree Urban planning Degree Master's programmes related to (Add more if applicable)
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. Teachers 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

- Urban planning and sustainable development
- Sustainable materials, processes and solutions used in constructions sector
- Construction and demolition waste (CDW)
- Evaluation, selection and optimal use of different materials for construction elements using BIM technology
- Life cycle assessments (LCA) of a material used in construction execution
- BIM/GIS technologies used in urban planning
- the urban development in the European context
- Urbanism and complex evolution of the localities; urban law and urban development legislation
- Implementing the spatial sustainable development strategies. The European / national Territorial Strategy
- The use of UrbanBIM Tool

3.2. General description of the subject

The term sustainable means that it can stand on its own, without depleting natural resources. A world driven by natural resources, requires good management of them, to achieve what is known as sustainable development or satisfaction of the needs of present generations without compromising the possibilities of the future. Sustainable development encompasses three factors, society, economy and environment. To achieve the objective of sustainable development, societies need to develop a series of tools that are undoubtedly the product of research, development and adaptation of the human being to the environment.

The Urban Development is defined within the conversion of the land shape and propriety, or the way of using the land through planning tools and involves generally speaking the development of new buildings or changing the existing ones, including broad spectre engineering planning.

In this regards the urban planning projects as tools, are the way of describing a planning policy of the development, and include also, in addition of a graphical presentation, the writing documents and regulations.

The spatial planning - the methods which are used in the Public Sector for ensuring a rational organisation of the territories, the environment protection and achieving the economic and social goals.

The main activities of territorial planning and urbanism are based on the distribution of the strategies, politics and programs of sustainable development over the entire national territory and follow-up on the specific regulations.

In the curricula, the sustainable strategies of urbanism and territorial planning are studied and understand as operational tools for spatial management of territory, in concordance with the understanding the processes in the construction industry that consume less raw materials, energy and produce less waste, thus producing a lower environmental impact and preserving economic resources.

To do this, the following methodologies will be studied within the normative frame of reference, for the quantification of the environmental impact generated by construction.

Knowledge of the basics in the life cycle assessment system of building materials
Life Cycle Analysis (LCA) is a process that allows us to evaluate the environmental burdens associated with a product, process or activity, identifying and quantifying both the use of matter and energy as waste and emissions to the environment, to determine the impact of that use of resources and to evaluate and implement environmental improvement strategies.
CO2 emissions, carbon and ecological footprint, are direct indicators of the impacts that buildings generate on the environment.
The use of BIM in the design of urban elements.
Acquiring notions about resource management.
Choosing the optimum solutions from the point of view of sustainability in design.
Assessing the impact of a product or process on the environment.
Work-sharing in design team and multidisciplinary coordination with BIM tools.

3.3. Objectives of the subject

1. 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.

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

3. Knowledge and ability to design an architecture that minimizes the waste generated in the construction of the building/roads/urban spaces.

4. 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 the construction process.

5. Acquire the necessary basic knowledge of LCA, and analyse the databases and impact assessment methodologies available to perform a LCA.

6. Make practical cases that support learning.

3.4. Contribution of the subject to professional practice

Using BIM as a tool in the design process.

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 adaptations in the methodology and the development of teachings for students who suffer some type of disability or limitation.

4. Competencies and learning outcomes

4.1. Basic competences
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 specialized and non-specialized 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 have the ability to 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. That the students have demonstrated 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. That students are able to predict and control the evolution of complex situations through the development of new and innovative work methodologies adapted to the field of Urban Planning, 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 Urban Planning, 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 specialization 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 constructions sector in the achievement of sustainable development and, especially, deepening knowledge of the regulations on the environmental impact of the urban built environment and of the administrative territories.

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 urban and territorial management, as well the correct implementation for reducing the problems in urban coordination using Smart and BIM tools.

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

4.4. Transversal competences

TC1. Aptitude for the written and oral communication, as well as for the analysis, organization, 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 and the life cycle analysis.

5. Understand Building Information Modelling as a tool.

6. Student is able to cooperate in a project team, correctly carrying out the tasks assigned to him.

7. Know the different European environmental specific regulations in the constructions BIM field.

5. Contents

5.1. Contents of the subject

Environmental legislation and sustainability in construction. 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 ENVIRONMENT REGULATIONS

UNIT 1. Introduction.

1.1 Concepts. Sustainability. Environment.

1.2 Fundamentals of environmental engineering.

1.3 Sustainability in construction: regulations.

1.4 Status of the level of implementation of sustainable construction.

THEMATIC AREA II: SUSTAINABILITY OF MATERIAL RESOURCES

UNIT 2. General characteristics.

2.1 Introduction to the study of the sustainability of the materials.

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

UNIT 3. Sustainability of construction materials in urbanistic development.

3.1 Stone materials.

3.2 Metallic materials.

3.3 Wood.

3.4 Plastic materials.

3.5 Other materials.

UNIT 4. Environmental indicators.

4.1 Comparison of materials, practical methodology.

4.2 Life cycle analysis (LCA) in constructions sector.

4.3 Normative frame of reference for LCA.

4.4 LCA examples.

THEMATIC AREA III. CONSTRUCTION AND DEMOLITION WASTE (CDW)

UNIT 5. CWD.

5.1 General aspects of CDW.

5.4 Waste management study (WMS)

THEMATIC AREA IV. BIM/GIS TECHNOLOGIES USED IN URBAN DEVELOPMENT PLANNING

UNIT 6. BIM/GIS technologies.

6.1 BIM/GIS definitions.

6.2 Technical and environmental regulations related to BIM/GIS technologies in the constructions sector.

6.3 The use of BIM/GIS in the design of urban elements.

UNIT 7. Calculation Tool (UrbanBIM).

7.1 Use of UrbanBIM Tool.

7.2 Application of the practical case to the tool UrbanBIM.

7.3 Analysis and study of results.

7.4 Constructive alternatives to adapt urban planning to reduce environmental impact.

<u>THEMATIC AREA V: URBAN PLANNING</u>

UNIT 8. Urban Planning and Sustainable Development. Practical examples.

8.1 Environment Planning and Natural Resources Management.

8.2 Sustainability and the Built Environment (N-zero communities).

8.3 Buildings and Public Services. Quality of Life Assessment and Sustainable Housing solutions.

5.3. Development of theoretical content

<u>THEMATIC AREA I: CONSTRUCTION SECTOR AND ENVIRONMENT REGULATIONS</u>

UNIT 1. Introduction.

<u>Lesson 1.1. Introduction</u>

Environmental decay is the result of economic activities created and developed by man in his quest for prosperity and comfort. In essence, the concern for environmental protection is a form of negotiation in which we need to know what Man can make of nature in order that HE survives and what he should not do against nature so that IT survives.

Recent climate changes have dramatic effects on human life in several parts of the world. Temperature fluctuations kill hundreds of thousands of people and affect the health of millions.

If in the following 10 years greenhouse gas emissions are not confined, climate change will get out of control and will cause a major unbalance for the nature.

Rising temperatures will lead to an increase of extreme phenomena such as extreme heat, drought and violent storms.

In Europe, summers could become unbearably hot, especially in countries like Greece, Spain and Italy, while Great Britain and Northern Europe will experience dry summers and winters with abundant precipitation, accompanied by strong blizzards.

Although climate change impacts have made their presence felt in Romania, the state of health of the population, especially in urban areas being at minimum quotas, the possible causes of major environmental disasters are still not made aware.

The focus and balance of the environmental efforts depend on the local conditions, including resources, policies and individual actions and the community's unique characteristics. The concept of sustainable community has been applied to various aspects, such as urban spreading, redevelopment of built-up areas, economic development and growth, ecosystem management, agriculture, biodiversity, green buildings, water management and pollution prevention.

1.1 Concepts. Sustainability. Environment.

Lesson 1.1.2. Sustainable development. Context and concepts

The term sustainable means that it can stand on its own, without depleting natural resources. A world driven by natural resources, requires good management of them, to achieve what is known as sustainable development or satisfaction of the needs of present generations without compromising the possibilities of the future. Sustainable development encompasses three factors, society, economy and environment. To achieve the objective of sustainable development, societies need to develop a series of tools that are undoubtedly the product of research, development and adaptation of the human being to the environment.

In this subject, sustainable processes in the construction 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.

Lesson 1.1.3. Environment and build environment

The repercussions of the economic development and the modern technological progresses has been affected in the meantime the environment and the population wellness, even in the middle of the functional-working town areas, which are representing several architectural programs with different urban design.

The developed European countries are building a model for the environment control, having as purpose a society well integrated in the environment.

The urban-planning specialists, also the architects considered the model as a complex vector of integration. They showed the interior relations of each components as:

- bio-geochemical for the natural environment.
- physics-spatial relations and functional relations for the artificial environment.
- social relations, materials and spiritual relations for the socio-economics environment [1].

In the meantime, has been described the functionality methods, first for the natural environment the functionality method is ecological balanced, and for the other two environments, artificial and socio-economics, the functionality method comes along with the development.

1.2 Fundamentals of environmental engineering

Lesson 1.2.1. Development of the environmental engineering

A century ago all buildings have been built similar to passive and low energy concepts. They were designed to suit the local climates, local traditions, culture, environment and built using local materials. In the last hundred years the world has changed immensely, as witnessed by the much-altered faces of the cities we have grown up in.

The city nowadays, has a different profile. The growth of the development created specifics local geosystems, unfortunately very polluted, and being in incapacity to improve the life quality of the citizens. The various shapes and volumes of the buildings, the different types of materials, characterized in general by low specific heat, big caloric conductibility and permeability, moreover using and covering the streets and side-walks with waterproof surfaces, and also together with the underground infrastructure, lead to a misfortunately heat, due to the fact that the heat does not have the natural benefits of the evaporation, and is excessive increasing the air heat [2].

Lesson 1.2.2. Management of building constructions resources and technologies

- What can be produced and sourced locally, on a country or on a continental regional scale of building materials for houses, buildings and other constructions?
- Which materials in use today can be replaced with more environmentally friendly products, or even better and still sustainable products?
- What can be done in terms of reducing the environmental footprint of raw material extraction, processing, forming/shaping/producing/manufacturing and transportation?

1.3 Sustainability in construction: regulations.

Lesson 1.3. Sustainability in construction: regulations

Sustainable development of construction works.

Product environmental statements. Basic rules for the category of construction products.

Environmental product declarations. Communication format business-to-business.

1.4 Status of the level of implementation of sustainable construction.

Lesson 1.4. Status of the level of implementation of sustainable construction

Reducing the environmental impact by managing the natural resources and materials in order to create products and services, is a key for the development of the new generations by allowing them to balance the traditional methods with innovative, cutting edge technologies. Through life-cycle thinking and analysis one can better manage the natural- and manmade resources, the materials and the efficient use of energy, that goes into construction and life time operation of buildings and constructions [4].

Unit 1: CONSTRUCTION SECTOR AND ENVIRONMENT REGULATIONS			
Topic	**Short title**	**Lesson**	**Short title**
1.	Introduction	1.1	Introduction Environmental balance
1.1	Concepts. Sustainability. Environment.	1.1.2	Sustainable development. Context and concepts
		1.1.3.	Environment and build environment
1.2.	Fundamentals of environmental engineering	1.2.1	Development of the environmental engineering

		1.2.2.	Management of building constructions resources and technologies
1.3.	Sustainability in construction: regulations	1.3.	Sustainable development of construction works
1.4.	Status of the level of implementation of sustainable construction	1.4.1.	Sustainability of construction works

References Unit 1:

1. Ochinciuc, C.V.: Conceptul Dezvoltarii Durabile in Arhitectura. Proiectarea Integrata. (The Sustainable Development Concept in Architecture. The Integrated Projecting) Bucuresti, Editura Universitara “Ion Mincu”-Bucuresti, (2002), p. 15-38.
2. G. C. Chițonu, Sustainable Urban Context. In: Bulletin of the Transilvania University of Brașov , CIBv 2017 • Vol. 10 (59) Special Issue No. 1 – 2017
3. Task O2/A1.3. ROMANIAN REGULATIONS REGARDING BIM TECHNOLOGIES IN CONSTRUCTION SECTOR
4. Ch. Cazacu, G. C. Chițonu, Reducing the Negative Enviromental Impact of Building Constructions, In: Bulletin of the Transilvania University of Brașov , CIBv 2018 • Vol. 11 (60) Special Issue No. 1 – 2018

THEMATIC AREA II: SUSTAINABILITY OF MATERIAL RESOURCES

UNIT 2. General characteristics.

Construction materials have a considerable economic and environmental impact on projects since they represent, for example, in the construction of social housing in Andalusia, more than 50% of all costs or 80% of the ecological footprint for different types of construction (Solís-Guzmán, González-Vallejo, Martínez-Rocamora, & Marrero, 2015). Urban developments are large consumers of non-renewable resources and/or with great difficulties for their potential reuse or recycling, and others are hazardous materials that need an assessment of their risks during their life cycle.

This unit studies materials from the perspective of sustainability through indicators such as the generation of waste and its recyclability, or during its extraction and production, through incorporated energy or CO2 emissions (Marrero, Rivero-Camacho, & Alba-Rodríguez, 2020). To this end, the different eco-labels and the Environmental Product Declarations are studied, along with the study of the data included on the impacts of the life cycle analysis (LCA) by the suppliers (Solís-Guzmán, Rivero-Camacho, Tristancho, Martínez-Rocamora, & Marrero, 2020). The contents of the lessons are summarised below.

2.1 Introduction to the study of the sustainability of the materials.

Lesson 2.1. Introduction to the study of the sustainability of the materials

The environmental indicators usually used in the evaluation of building materials are explained, such as the carbon, ecological or water footprint and a brief introduction to the analysis of the life cycle and its respective indicators such as destruction of the ozone layer, eutrophication, greenhouse gases, etc.

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

Lesson 2.2. Models and tools for assessing the level of environmental impact of construction materials and products

Ecological labels are described, and the processes and criteria for selecting eco-efficient materials, examples and recommendations are included.

UNIT 3. Sustainability of construction materials in urbanistic development.

3. Sustainability of material resources

In Topic 3, construction materials and products are analysed by families that depend on their main raw material. The same scheme is followed in all the lessons where the environmental impact is defined along the life cycle: consumption of raw materials and water, energy consumption, generation of emissions and waste or potential recycling/reuse.

The families of building materials according to their nature are grouped in the following lessons:

Lesson 3.1. Stone Materials

Within the family of stones, in addition to aggregates and stones, soil is analysed as a construction material and concrete, mortar and cement.

Lesson 3.2. Metallic Materials

The most commonly used metals in construction are studied, including steel, aluminium, copper, lead, zinc, etc.

Lesson 3.3. Wood

The wood and its treatments are studied for its preservation, from less shocking ones like boron salts, to other more harmful ones like arsenic.

Lesson 3.4. Plastic Materials

Its use in pipes and insulating materials is being studied.

Lesson 3.5. Other Materials

Innovative materials such as linoleum, bamboo, etc.

Summary table of the thematic content of units 2 and 3:

General characteristics and Sustainability of building materials in urban planning			
Topic	Short title	Lesson	Short title
2	General characteristics	2.1	Introduction
		2.2	Models and tools
3	Sustainability of material resources	3.1	Stone Materials
		3.2	Metallic Materials
		3.3	Wood
		3.4	Plastic Materials
		3.5	Other materials

References units 2 and 3:

Marrero, M., Rivero-Camacho, C., & Alba-Rodríguez, M. D. (2020). What are we discarding during the life cycle of a building? Case studies of social housing in Andalusia, Spain. Waste Management, 102, 391–403. https://doi.org/10.1016/j.wasman.2019.11.002

Solís-Guzmán, J., González-Vallejo, P., Martínez-Rocamora, A., & Marrero, M. (2015). The Carbon Footprint of Dwelling Construction in Spain. In The Carbon Footprint Handbook (pp. 261–283). CRC Press - Taylor & Francis Group.

Solís-Guzmán, J., Rivero-Camacho, C., Tristancho, M., Martínez-Rocamora, A., & Marrero, M. (2020). Software for Calculation of Carbon Footprint for Residential Buildings. In Environmental Footprints and Eco-Design of Products and Processes (pp. 55–79). Springer. https://doi.org/10.1007/978-981-13-7916-1_3

UNIT 4. Environmental indicators.

4.1 Comparison of materials, practical methodology.

Lesson 4.1.1. Comparison of materials

In the construction industry there are a vast variety of building materials. From the structural characteristics, durability, aspect, and more, from the most common materials as stone, concrete, wood, masonry, to composites materials and high-tech building materials and new technologies. Each has different strength, weight, and durability, which makes it right for various uses.

Lesson 4.1.2. Practical methodology

There are national and international standards, regulations and testing methods for the use of building materials in the construction industry.

4.2 Life cycle analysis (LCA) in constructions sector.

Lesson 4.2.1. Life-cycle assessments analyses

Life-cycle assessments (LCAs) involve cradle-to-grave analyses of production systems and provide comprehensive evaluations of all upstream and downstream energy inputs and multimedia environmental emissions. LCAs can be costly and time-consuming, thus limiting their use as analysis techniques in both the public and private sectors. Streamlined techniques for conducting LCAs are needed to lower the cost and time involved with LCA and to encourage a broader audience to begin using LCA. It has emerged as a valuable decision-support tool for both policy makers and industry in assessing the cradle-to-grave impacts of a product or process [1].

4.3 Normative frame of reference for LCA.

Lesson 4.3.1. LCA in Regulations

Life cycle assessment (LCA), one of the most important instruments that lead to the sustainable development by controlling the CO_2 fingerprint of materials or different investments, has a low level of interest for Romanian authorities, in comparison with other European countries. Such evaluation is often content of Environmental Product Declarations (EPD), which for construction products or materials, the private sector tends to show a growing importance. However, there are different initiatives of national interest, promoted by Romanian authorities, that tend to align with European regulations, mostly because obligative reasons. Unfortunately, the way in which the regulations are applied, are reflecting the lack of experience and consciousness regarding environmental issues, by Romanian authorities.

4.4 LCA examples.

The "life-cycle" impacts include the extraction of raw materials; the processing, manufacturing, and fabrication of the product; the transportation or distribution of the product to the consumer; the use of the product by the consumer; and the disposal or recovery of the product after its useful life.

Lesson 4.4.1. Components of LCA

Goal definition and scoping: identifying the LCA's purpose and the expected products of the study and determining the boundaries (what is and is not included in the study) and assumptions based upon the goal definition.

Life-cycle inventory: quantifying the energy and raw material inputs and environmental releases associated with each stage of production.

Impact analysis: assessing the impacts on human health and the environment associated with energy and raw material inputs and environmental releases quantified by the inventory.

Improvement analysis: evaluating opportunities to reduce energy, material inputs, or environmental impacts at each stage of the product life cycle [1] [3].

Lesson 4.4.2. Utilization of LCA method [2]:

• searching the most available life cycles, e.g., those with minimal negative impact on environment.

• assuming the decisions in industry, public organizations, or NGOs, which determine direction and priorities in strategic planning, design or design product, or process change.

• choose important indicators of environmental behavior of organization including measurement and assessing techniques, mainly in connection with the assessment of the state of its environment.

• marketing with the link on formulation of environmental declaration or eco-labelling.

Topic	Short title	Lesson	Short title
4.1	Comparison of materials, practical methodology .	4.1.1	Comparison of materials
		4.1.2.	Practical methodology
4.2.	Life cycle analysis (LCA) in constructions sector	4.2.1 .	Life-cycle assessments analyses
4.3.	Normative frame of reference for LCA.	4.3.	LCA in Regulations
4.4.	LCA examples	1.4.1.	Components of LCA

References Unit 4:

[1] Handbook of Clean Energy Systems, Jinyue Yan (Editor), Publisher: Wiley, 2015

[2] Iyyanki V. Muralikrishna, Valli Manickam, Environmental Management, Science and Engineering for Industry, Butterworth-Heinemann Publishing, 2017

[3] ISO 14040:2006

[4] Life Cycle Assessment: Principles and Practice, EPA/600/R-06/060, 2006.

THEMATIC AREA III. CONSTRUCTION AND DEMOLITION WASTE (CDW)

UNIT 5. Construction and demolition waste CWD.

The building sector is the largest producer of waste (PEMAR 2016-22, 2016), so minimising their production or not letting building materials and their packaging become waste is an important objective for the sustainability of the sector. Strategies for reduction include regulatory measures and control mechanisms. The objective is to achieve sustainable construction through prevention in the generation of waste, increasing reuse and recycling, and through controlled disposal, applying the principle of waste management hierarchy (González-Vallejo, Muñoz-Sanguinetti, & Marrero, 2019). To this end, a correct quantification of CDNs is essential. This allows the identification of the most favourable items to achieve a greater reduction, promoting their use and correct management (Solís-Guzmán, Marrero, Montes-Delgado, & Ramírez-de-Arellano, 2009). The contents of the lessons are summarised below:

Lesson 5.1.1. General aspects of the CDW.

CDWs have unique characteristics that are not found in other wastes and are clearly defined in order to understand and apply the didactic block.

Lesson 5.1.2. Regulatory context of the CDW

The regulations concerning the CDW, Royal Decree 105/2008 and its application in construction projects.

Lesson 5.1.3. Demolition and hazardous waste.

It presents the project of demolition, deconstruction or selective demolition, the management of its waste and in particular, the management of hazardous waste.

Lesson 5.1.4. Treatment of the CDW.

The procedure, transformation and valorisation of CDW in authorised treatment plants is explained.

Lesson 5.1.5. Budgeting of CDW.

The development and drafting of the waste management budget using the BCCA is explained, existing prices are evaluated and how to define new ones in the case of recycling or reuse work not covered by the BCCA.

5.2. Waste management study (WMS)

Lesson 5.3.1. Waste management study (WMS).

The parts that make up the WMS and its application on site are explained through the Waste Management Plan (WMP).

Lesson 5.3.2. Case Study.

The waste management plan is developed on an urbanization site.

Summary table of the thematic content of unit 5:

Unit 5: CDW

Topic	Short title	Lesson	Short title
5.1	Construction and Demolition Waste	5.1.1	General aspects
		5.1.2	Regulatory context of CDW
		5.1.3	Demolition and hazardous waste
		5.1.4	Treatment of CDW
		5.4.5	Budgeting of the CDW
5.2	Management Study CDW	5.2.1	Management Study CDW
		5.2.2	Case Study

References unit 5:

González-Vallejo, P., Muñoz-Sanguinetti, C., & Marrero, M. (2019). Environmental and economic assessment of dwelling construction in Spain and Chile. A comparative analysis of two representative case studies. Journal of Cleaner Production, 208, 621–635. https://doi.org/10.1016/j.jclepro.2018.10.063

Marrero, M., Rivero-Camacho, C., & Alba-Rodríguez, M. D. (2020). What are we discarding during the life cycle of a building? Case studies of social housing in Andalusia, Spain. Waste Management, 102, 391–403. https://doi.org/10.1016/j.wasman.2019.11.002

PEMAR 2016-22. (2016). Plan Estatal Marco de Gestión de Residuos. Retrieved from https://www.miteco.gob.es/fr/calidad-y-evaluacion-ambiental/planes-y-estrategias/pemaraprobado6noviembrecondae_tcm36-170428.pdf

Solís-Guzmán, J., Marrero, M., Montes-Delgado, M. V., & Ramírez-de-Arellano, A. (2009). A Spanish model for quantification and management of construction waste. Waste Management (New York, N.Y.), 29(9), 2542–2548. https://doi.org/10.1016/j.wasman.2009.05.009

THEMATIC AREA IV. BIM/GIS TECHNOLOGIES USED IN URBAN DEVELOPMENT PLANNING

UNIT 6. BIM/GIS technologies.

Lesson 6.1 BIM/GIS definitions.

How the ISO and IT enterprises define Building Information Modeling and Geographic Information System.

Lesson 6.2 Technical and environmental regulations related to BIM/GIS technologies in the constructions sector.

European BIM related legal acts are mentioned and explained, with examples of such acts from selected EU countries.

Lesson 6.3 The use of BIM/GIS in the design of urban elements.

Urban BIM usage is carefully shown and explained, with necessary and useful principles listed. Case studies from UE presented and discussed.

References unit 6:

https://www.ace cae.eu/fileadmin/New_Upload/3._Area_2_Practice/BIM/Other_Docs/1_S.Mordue_Definition_of_BIM_01.pdf

https://www.autodesk.com/solutions/bim

https://bimdictionary.com/

https://www.designingbuildings.co.uk/wiki/BIM_glossary_of_terms

Doan, Dat & Ghaffarianhoseini, Ali & Naismith, Nicola & Zhang, Tongrui & Rehman, Attiq Ur & Tookey, John & Ghaffarianhoseini, Amirhosein. (2019). What is BIM? A Need for A Unique BIM Definition. MATEC Web of Conferences. 266. 05005. 10.1051/matecconf/201926605005.

Davies, K., Wilkinson, S., & McMeel, D. (2017). A review of specialist role definitions in BIM guides and standards.

Abbasnejad, B., & Moud, H. I. (2013). BIM and basic challenges associated with its definitions, interpretations and expectations. International Journal of Engineering Research and Applications (IJERA), 3(2), 287-294.

Wildenauer, A. A. CRITICAL ASSESSMENT OF THE EXISTING DEFINITIONS OF BIM DIMENSIONS ON THE EXAMPLE OF SWITZERLAND. terminology, 23, 24.

Zhu, J., Wang, X., Wang, P., Wu, Z., & Kim, M. J. (2019). Integration of BIM and GIS: Geometry from IFC to shapefile using open-source technology. Automation in Construction, 102, 105-119.

Matrone, F., Colucci, E., De Ruvo, V., Lingua, A., & Spanò, A. (2019). HBIM IN A SEMANTIC 3D GIS DATABASE. International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences.

Jetlund, K., Onstein, E., & Huang, L. (2019). Information Exchange between GIS and Geospatial ITS Databases Based on a Generic Model. ISPRS International Journal of Geo-Information, 8(3), 141.

Wang, H., Pan, Y., & Luo, X. (2019). Integration of BIM and GIS in sustainable built environment: A review and bibliometric analysis. Automation in Construction, 103, 41-52.

Atazadeh, B., Rajabifard, A., Zhang, Y., & Barzegar, M. (2019). Querying 3D cadastral information from BIM models. ISPRS International Journal of Geo-Information, 8(8), 329.

Badea, A. C., & Badea, G. (2019). Geospatial Development Using GIS Smart Planning. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture, 76(2), 154-163.

UNIT 7. Calculation Tool (UrbanBIM).

Lesson 7.1 Use of UrbanBIM Tool.

Introduction to BIMvision computer program and showing its proper usage. Discussion on BIMVision project guide. BIMvision as IFC reader. Case studies and examples.

Lesson 7.2 Application of the practical case to the tool UrbanBIM.

Example of BIMvision URBANBIM project's plug-in usage on real-life structure. Case studies and examples.

Lesson 7.3 Analysis and study of results.

Depending on specific course of usage of mentioned URBANBIM technologies and obtained results, conclusions for different countries will be drawn, on the base of CO2, Energy and Water used from Spanish example.

Lesson 7.4 Constructive alternatives to adapt urban planning to reduce environmental impact.

Examples of other than BIM/GIS programs methods of achieving demanded result in urban development planning. Case studies and examples.

References unit 7:

BIMVision user guise: https://bimvision.eu/en/become-developer/

Official link to the plug-in: http://urbanbim.eu/ro/application/

Official link to the plug-in guide: O4-A1 Guideline notes and functional specifications. http://urbanbim.eu/reports/

Official link to the UrbanBIM project website: http://urbanbim.eu/

M. Marrero, M. Wojtasiewicz, A. Martínez-Rocamora,J. Solís-Guzmán, M. Desirée Alba-Rodríguez, Sustainability 2020,12, 4196; doi:10.3390/su12104196

THEMATIC AREA V: URBAN PLANNING

UNIT 8. Urban Planning and Sustainable Development. Practical examples.

This unit focuses on strategies to reduce energy consumption and associated emissions. The consumption of buildings represents more than 80% of the carbon footprint in their life cycle, with respect to direct and indirect emissions due to the manufacture of the materials (Solís-Guzmán et al., 2020). Methods have therefore been put in place to collect data from the entire construction process, but the inclusion of environmental concerns during the design stage represents one of the biggest challenges for designers. For this reason, the European Committee for Standardisation promotes, in the production phase of buildings, the integration of environmental concerns through the definition of European guidelines on sustainability in construction works (UNE-EN 15978, 2012). However, there are significant barriers to overcome, such as accessibility to environmental data, high experience requirements and difficult identification of alternative components or materials (Bey, Hauschild, & McAloone, 2013). The contents of the lessons are summarised below.

8.1 Environment Planning and Natural Resources Management.

Lesson 8.1.1. European environmental planning strategy.

The strategic regulation of sustainable development is defined at European level and its transposition into the regulations applicable to the construction sector.

Lesson 8.1.2. LCA and eco-labelling as a tool for managing material resources.

The application of LCA to the construction process, standardisation and related legislation, products and company assessment strategies and eco-labelling is developed. Software and assessment tools combining quantitative and qualitative environmental assessment of projects are also reviewed, as well as different approaches to include LCA and BIM in the environmental impact assessment of architectural projects. Finally, a case study of an urbanisation project supports this proposal, which will allow environmental awareness to be included in this type of project.

8.2 Sustainability and the Built Environment (N-zero communities).

Lesson 8.2.1. Life cycle cost analysis of N-zero communities.

The Net Zero Energy (NZE) concept is developed and the benefits of exporting this concept from a building scale to a neighbourhood or district scale, as it allows needs, costs and resources to be shared between multiple buildings. The importance of addressing energy aspects in urban planning at an early stage, integrating spatial and energy planning processes is underlined.

Lesson 8.2.2. Practical example.

It starts with a case study defining its climatic characteristics and urban systems to better understand the implications of NZE requirements for urban planning.

8.3 Buildings and Public Services. Quality of Life Assessment and Sustainable Housing solutions.

The park built prior to the implementation of the CTE (Vivienda, 2006), is very inefficient, requiring large-scale energy rehabilitation to reduce emissions (IDAE, 2008; Madrid, 2008). Because of the importance of the topic, general lessons will be drawn from the discussion of passive and active strategies. Another resource consumed in the use of buildings is water, which also has a significant impact on people's health and the environment. In the final lessons of the theme, water consumption and its potential savings in buildings and their developments will be discussed. To measure their environmental impact, ideas will be presented within the water footprint indicator and how it can be applied in the built space (Ruíz-Pérez, 2020).

Lesson 8.3.1. Legislative mark.

European and national regulations such as RITE, the Technical Code or the decree on energy certification are described.

Lesson 8.3.2. Passive and active strategies

Passive strategies are defined that reduce the energy demand of the building through improvements to the building envelope, waterproofing, natural ventilation and/or lighting. Active energy saving strategies are described that have to do with the efficiency and reduction of CO2 emissions from the sanitary hot water, air conditioning, heating and lighting installations.

Lesson 8.3.3. Water Saving and Water Footprint (WF)

Water saving strategies in buildings are described. The water footprint indicator, both direct and indirect, is defined and adapted for the evaluation of construction and urbanization projects.

Summary table of the thematic content of unit 8:

Unit 8: Urban planning and sustainable development			
Topic	**Short title**	**Lesson**	**Short title**
8.1	Environmental planning and management of material resources	8.1.1	European environmental planning strategy
		8.1.2	LCA and eco-labelling as a management tool
8.2	Sustainability and the built environment	8.2.1	Life cycle cost analysis of N-zero communities
		8.2.2	Practical example
8.3	Buildings and public services	8.3.1	Legislative mark
		8.3.2	Passive and active strategies
		8.3.3	Water Saving and Water Footprint (WF)

References unit 8:

Bey, N., Hauschild, M. Z., & McAloone, T. C. (2013). Drivers and barriers for implementation of environmental strategies in manufacturing companies. *CIRP Annals*, *62*(1), 43–46. https://doi.org/10.1016/j.cirp.2013.03.001

IDAE. (2008). Guía práctica de la energía para la rehabilitación de edificios. El aislamiento, la mejor solución. Asociación Nacional de Industriales de Materiales Aislantes (ANDIMA). Retrieved November 4, 2020, from https://www.idae.es/publicaciones/guia-practica-de-la-energia-para-la-rehabilitacion-de-edificios-el-aislamiento-la

Madrid, C. de. (2008). Guía de Rehabilitación Energética de Edificios de Viviendas. Retrieved November 4, 2020, from http://www.madrid.org/bvirtual/BVCM005835.pdf

Ruíz-Pérez, R. (2020). *Modelo de evaluación de las huellas hídrica y de carbono en la renovación del espacio urbano sensible al agua*. Universidad de Sevilla.

Solís-Guzmán, J., Rivero-Camacho, C., Tristancho, M., Martínez-Rocamora, A., & Marrero, M.

(2020). Software for Calculation of Carbon Footprint for Residential Buildings. In *Environmental Footprints and Eco-Design of Products and Processes* (pp. 55–79). Springer. https://doi.org/10.1007/978-981-13-7916-1_3

UNE-EN 15978. Sustainability of construction works. Assessment of environmental performance of buildings. Calculation Method. (2012).

Vivienda, E. M. de. (2006). *Código técnico de la edificación (CTE): Real Decreto 314/2006, de 17 de Marzo, por el que se aprueba el Código Técnico de la Edificación*. Ministerio de Vivienda.

5.4. Practices programme

Realization of 4 practical cases of 4 different urban planning 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 posed 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

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

Modeling Standard™ Version 1 - Part 1: Overview, Principles, and Methodologies U.S.A 2007

https://buildinginformationmanagement.files.wordpress.com/2011/06/nbimsv1_p1.pdf

Becerik-Gerber B, Rice S 2010 The perceived value of building information modeling in the U.S. building industry Electronic Journal of Information Technology in Construction 15:1874-4753 p 185

https://www.researchgate.net/publication/238307896_The_perceived_value_of_building_information_modeling_in_the_US_building_industry

IO2/A1.3 2019 Report on regulations rrelated to BIM technologies (UrbanBIM - Innovative Educational Integration of Urban Planning based on BIM-GIS technologies and focused on Circular Economy Challenges

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;

Marrero, M., Solís-Guzmán, J., Molero Alonso, B., Osuna-Rodriguez, M., & Ramirez-de-Arellano, A. (2011). Demolition Waste Management in Spanish Legislation. The Open Construction and Building Technology Journal, 5(1), 162–173. https://doi.org/10.2174/1874836801105010162

Guía sobre declaración ambiental de producto y cálculo de huella de carbono. 2014. Fundación de la Energía de la Comunidad de Madrid.

La declaración ambiental de producto. 1.ª edición. Enero 2015. Ihobe, Sociedad Pública de Gestión Ambiental. Departamento de Medio Ambiente y Política Territorial. Gobierno Vasco.

Marrero M, Martínez-Escobar L, Mercader-Moyano MP, Leiva-Fernández C. Minimización del Impacto Ambiental en la Ejecución de Fachadas Mediante el Empleo de Materiales Reciclados / Environmental impact minimization of façade construction through recycled materials use. Inf Constr 2013; 65(529):89–97

González, P., Solís, J., Llácer, R., Marrero, M. (2015). La construcción de edificios residenciales en España en el período 2007-2010 y su impacto según el indicador Huella Ecológica. Informes de la Construcción, vol. 67, nº539

Silgado, S. S. S. (2014). Viabilidad ambiental del reciclaje del yeso. Universidad politécnica de Cataluña. CONAMA 2014.

Solís-Guzmán, J., Meléndez, M. M., & García, D. G. (2014). Modelo de cuantificación y presupuestación en la gestión de residuos de construcción y demolición. Aplicación a viales. Carreteras: Revista técnica de la Asociación Española de la Carretera, (195), 6-18.

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 - Informati on 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.

UNE-EN ISO 14025:2010. Environmental labels and declarations. Type III environmental declarations. Principles and procedures.

UNE-EN 15804:2012. Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.

UNE- EN ISO 14020:2002 Environmental labels and declarations. General principles.

UNE-EN ISO 14040:2006 Environmental management. Life cycle assessment. Principles and framework.

UNE-ISO 14044:2006 Environmental management. Life cycle assessment. Requirements and guidelines.

UNE-EN 15978:2012. Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method.

ISO 15686-5:2008. Buildings and constructed assets. Service life planning. Part 5: Life-cycle costing.

Norma ISO 14001 y EMAS. Community Regulation of Eco-management and Eco-audit.

ISO 14021:2002. Environmental labels and declarations. Self-declared environmental claims (Type II environmental labelling).

ISO 14024:2001. Environmental labels and declarations. Type I environmental labelling. Principles and procedures.

Royal Decree 187/2011 relating to establishment of eco-design requirements for energy-using products - Article 10.

Order VIV/1744/2008, of 9 of June, which regulates General Technical Building Code Registry. Article 2. Organisation.

Decree 21/2006, of 14 of February, which regulates the adoption of environmental criteria and eco-efficiency in buildings - Paragraph 6.2

Royal Decree 105/2008, of 1 of February, which regulates the production and management of construction and demolition waste.

Royal Decree 238/2013, of 5 of April, amending certain Articles and Technical Instruction for the Regulation of Thermal Installations in Buildings, approved by Royal Decree 1027/2007, of 20 of July.

8.3. Online resources and other resources

http://urbanbim.eu/

http://oerco2.eu/

https://www.asro.ro;

http://www.allbim.net/home/ro.html

www.bimserver.org

http://www.csostenible.net/

http://www.magrama.gob.es

http://www.codigotecnico.org