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# Systems Thinking for Sustainability Education in Building and Business Administration and Management Degrees

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**Abstract:** In 2015, the United Nations set the 2030 Agenda, which established 17 Sustainable Development Goals (SDGs) including different areas—among them, Education—which determine the reality and the future of new generations. The data of SDG24 2021 establish that, by 2030, the reference values will be below those expressed in SDG 4. Education for sustainable development poses a series of competencies to achieve it; the challenge for teachers is to develop strategies, tools and methodologies that enable meaningful learning for the required complexity. Managing and solving sustainability problems requires people with systemic competences who are able to see the whole in the individuality, presenting a breadth of vision for a complex world. It is important that training takes place in universities so that students are equipped with a holistic understanding of systems. The aim of this research is to propose a didactic proposal for students of the double degree in Building and Business Administration and Management to acquire the competences of systems thinking, interdisciplinary work, personal and inter-collaborative relationships and tolerance to ambiguity and uncertainty using project-based learning and systems simulation. To achieve this, a classroom intervention proposal has been designed for the subjects Strategic Management and Sustainable Building in the fourth year of the double degree using the project-based learning and systems thinking. This practical proposal allows participants to develop a holistic view of the problems, enhancing the capacity for systemic and sustainable resolution in the design of more sustainable building systems, as well as promoting training in strategic decision making in environmental management in the medium and long term.

**Keywords:** systems thinking; education for sustainable development; PBL; strategic management; sustainable building

## 1. Introduction

We live in a society undergoing constant change, where transformations are unfolding faster and faster. In this context, human activities tend to be carried out in an accelerated manner, demanding greater speed in access to knowledge, data management, processing of tools, systems and ideas, etc. All this, in turn, takes place in a world with complex problems of sustainability that render every term obsolete in a single generation [1].

Since the 1980s, experts have referred to the situation affecting our society using the concept VUCA, whose acronym stands for: Volatile (constant and continuous change), Uncertain (uncertain and non-predictive), Complex and Ambiguous (with a distortion of reality). In March 2020, Jamais Cascio decided to come up with a new concept, which, together with the COVID-19 pandemic, better describes the current situation, thus giving rise to the acronym BANI for a world of chaos and disorder [2]. Long-term strategies are becoming less and less relevant, and we are moving towards short- and medium-term decisions in a complex civilization with marked uncertainty that requires new interdisciplinary

strategies. Added to all this is the growing concern for the environment, strongly affected by climate change, the depletion of natural resources and the high generation of waste, which forces nations to seek new models of economic growth and sustainable development [3]. Thus, the acronym BANI makes a lot of sense and includes the following terms:

- Brittle: Volatility makes gaps and disruptions in a visible reality, leading to more fragile economic and technological systems, with sharp downturns when they reach a certain level. This fragility requires the capacity for change and resilience to come out of these adverse situations with strength. To achieve this, it is advisable to establish short- and medium-term objectives that are achievable and revisable, to find a value proposition that is consistent with the constant changes, to know how to manage the transformations and to propose new ways of working.
- Anxious: the uncertainty of the environment can lead to a state of anxiety or agitation about the present and the future. To counteract this, it is necessary to have confidence in the decisions that are made, to have empathy to understand the people around us, to have full attention at every moment of the day and to promote self-awareness and self-knowledge. In this way, customer-centricity, design thinking and the cloud can be promoted both in the classroom and in the company.
- Nonlinear: the world is complex and is not always linear; any decision taken can affect future major projects. Therefore, it is not convenient to rush into any decision; it is preferable to have a systemic view of all the elements and their relationships, as well as the ability to adapt to new challenges that arise. Systemic thinking allows us to broaden our vision and understand the whole in each of the parts. Therefore, data governance and exponential organizations are important.
- Incomprehensible: it is impossible to have control and supervision over everything that happens around us; the world becomes incomprehensible and ambiguous. For this reason, it is necessary to support the training of transparent people who promote intuition and collaborative work. Likewise, Lean & Agile, OKRs, leadership and systemic coaching must be promoted [2].

Within this complex world, the United Nations set the 2030 Agenda for Sustainable Development and established 17 goals, including Sustainable Education. This educational model aims to ensure that students acquire theoretical and practical knowledge about sustainable development, promoting new management models with the incorporation of circular economy criteria that are committed to environmentally friendly production and consumption [4]. Currently, the reference values in the implementation process indicate that these objectives will not be achieved by 2030 unless the implementation process is promoted and accelerated [5].

Education for sustainable development poses the acquisition of a series of competencies; the challenge for teachers is to promote strategies, tools and methodologies that enable meaningful learning for the required complexity. This will allow us to better manage BANI environments and establish the soft skills that facilitate adaptation to these accelerated and unstoppable changes. The industry requires people trained in knowing how to be, knowing how to know and knowing how to do, who understand companies as living entities, a whole made up of different parts that interact with each other and maintain sustainability and environmental care. To achieve this, educational institutions must implement systemic competencies that develop this global vision and favor an environment of well-being and human sense at the personal and community levels [6,7]. Finally, the school promotes a joint apprehension of both the local and the global and both the person and the environment, i.e., multimodal learning for a complex system and an understanding of the environment for a multiple-human consciousness [8].

## 2. Literature Review

### 2.1. Systems Thinking

Systems thinking acquires significance in the field of education, favoring practical learning that consolidates a transformation of current social and environmental problems [9].

There are several definitions about what is meant by systems thinking; among them, it is worth highlighting the definition that states that "it is a computation of synergistic analytical skills used to improve the ability to identify and understand systems, predict their behaviors and devise modifications to produce the desired effects, working all these skills together" [10]. Systems thinking requires a comprehensive understanding of the environment and the interaction of its elements in a phenomenological way, seeing reality by considering its interactions and not only the parts that integrate it. From a professional point of view, the competency in systemic thinking helps to face reality in an integral, strategic and multidisciplinary way for decision making. Therefore, systemic thinking and the simulation of system scenarios enable the person to holistically appreciate the variables of a complex and non-linear problem, as well as to determine a series of medium- and long-term strategies [11–13]. The commitment of educational agents is to pursue the goal of sustainability set out in the SDGs set by the United Nations Organization, providing students with the ability to solve complex problems to meet the challenges of globalization, digital competence, the interaction of multiple environments and social movements. The areas of Social Sciences and Engineering, including Business Administration and Management and Publishing, require systemic thinking in addition to scientific thinking in Engineering. To achieve this, the person must perceive him/herself with the possibilities of being able to reach an adequate level of mastery for this complex thinking [12].

In this sense, the ability to think systemically is necessary for the solution of complex, dynamic problems in multiple situations, where it is important to transcend the view and see the underlying interrelationships between the isolated and atomized situations of the social or business organization. The structure is constituted by various non indivisible elements within the organizational levels; these levels are regulated by the principles of self-similarity and recursive iteration that join other components to constitute higher-level parts. By having a systemic view, we not only see each independent element but the whole picture of the organization [13]. The habits of the systemic thinker are [14]:

- In exploring cause–effect relationships, he/she recognizes the importance of considering delays.
- Locates unintended consequences.
- Shifts perspectives to broaden knowledge.
- Distinguishes the circular nature of complex cause–effect relationships.
- Identifies that the behavior of a system is determined by structure.
- Uses knowledge of systemic structures to test actions for greater effectiveness.
- Surfaces and tests assumptions.
- Verifies results and modifies actions if necessary: successive approach.
- Seeks to perceive the whole picture.

These described habits are increasingly demanded by companies and included when hiring. Thus, Peter Senge identifies five disciplines for intelligent organizations [15]: the first is systems thinking; the second discipline is personal mastery for constant learning and obtaining one's aspirations; the third is mental models, archetypes and beliefs that influence the way of understanding and understanding when acting; the fourth is the construction of a shared vision—people learn and work not because they are ordered to but because they want to; finally, team learning allows the person to increase the potential to create and train in locating what they want, taking advantage of the diversity of ways of seeing the group to change perspectives and increase their creativity. Senge's dialogic is based on positive and negative feedback and on its recursiveness for the reinforced or compensated construction of the systemic processes of the organization. He points out three levels:

practice—responding to what to do; principles—with guiding ideas and concepts; and essences—the state of the self for those who manage to master the five disciplines [15,16].

In short, systems, being autonomous, self-regulating and capable of detecting errors or deviations, require information and communication to moderate the interaction of their elements with the environment. Therefore, it is important to establish information gathering processes and improve communication channels to interconnect these interdependent parts [17]. This can be reflected by means of systemic maps with their different variables and cause–effect relationships (an example of a systemic map of business competitiveness can be seen in Figure 1).
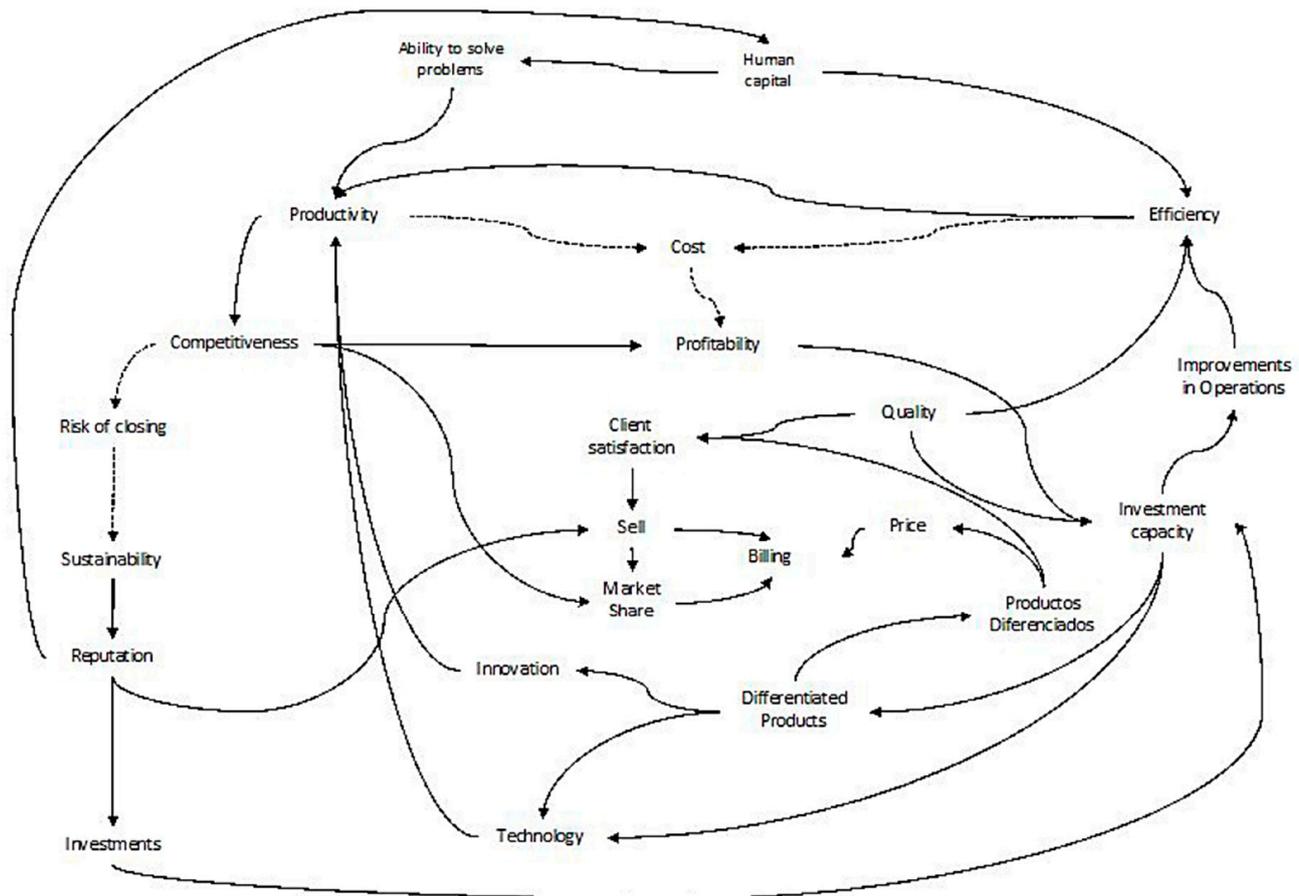


**Figure 1.** Example of a systemic map of business competitiveness (Source: Dresch et al., 2018 [18] (p. 77)).

Systems thinking has been adopted by some authors as a methodology for education in relation to the SDGs. Following this line, to enhance education on how to achieve sustainable development without compromising future generations, Meadows establishes 12 leverage points that are integrated into 4 characteristics: parameters, feedback, design and intention [7]. In Figure 2, the four characteristics are represented by an order of leverage, interacting with each other for the realization of interventions within a system.
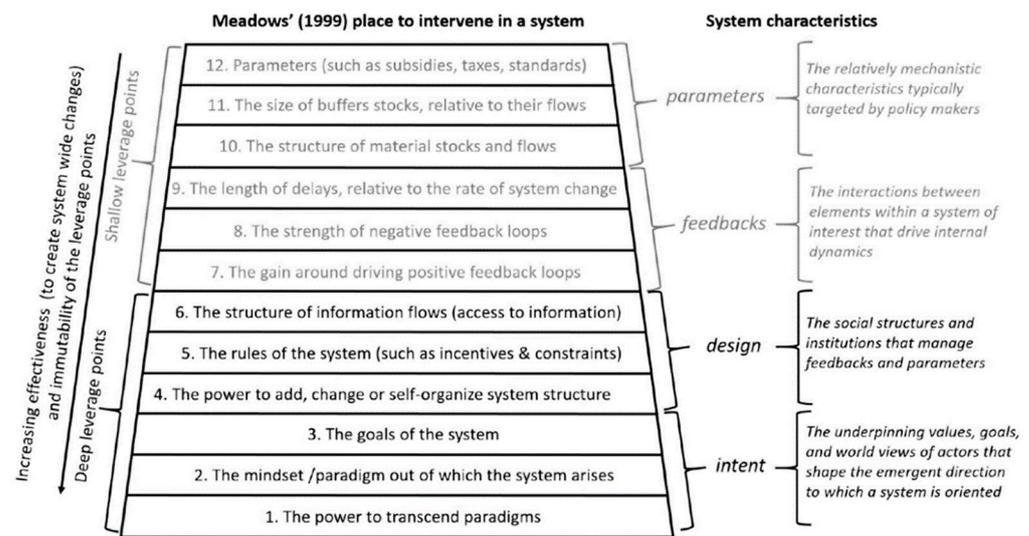
**Figure 2.** Characteristics and leverage areas (Source: Abson et al., 2017. [7] (p. 3)).

*2.2. Strategic Management*

Business schools focus their teaching on achievement and performance, two elements that, in many cases, do not promote sustainability and do not require systemic management. Peter Senge proposes a learning organization focused mainly on the discipline of systems thinking and responsible leadership reasoning, with the aim of not disassociating the ideas of economic growth and sustainable development [15,19].

The challenges in organizational improvement or learning are determined by the difficulty in observing and evaluating them. Additionally, the quality of interactions and the drive of the collective mind of the organization facilitate in-smart actions if the interrelationship of the different parties is fine tuned. Decision making and problem solving in the organization become relevant because of the non-linearity and interaction of communication processes in the organization, information biases, preferences, contradictions and ambiguities, among other elements [13,20].

An emerging perspective is business ecosystems, which facilitate the economic coordination of internal partners for value creation together with different stakeholders that produce complementary products or services. Structural and strategic factors affect the company's ability to generate and acquire greater value by having to organize and align business activity with the interests of the different ecosystem partners or stakeholders. To achieve this, the value proposition must be differentiated to capture not only the consumer but also the partner participating in the project. This is achieved through the company's broad outlook and systemic vision. Companies play an important role in the perceptions of all participants [21].

The great challenge of the new business school is the development of learning based on the UN Sustainable Development Goals. Sustainability is currently in vogue; however, most of the time, misguided strategies are taken into consideration in the pursuit of short-term results. There is no doubt that strategic management and organizational theories can benefit from a greater incorporation of time in decision making, because, if it were to be realized, a comprehensive sustainability of the strategy of companies would be achieved [22]. The incorporation of the long term, for sustainability in strategic decisions, helps to align the interests of the company with those of society. Sustainability is directly linked to the development of corporate responsibility, directly linking environmental ethics with economic growth in decision making and thus using sustainable development objectives as a source of competitive advantage. Today, the push by the United Nations to integrate the Sustainable Development Goals into society has led to them being extended to multiple areas, ranging from ecology and art to building [22].

When companies integrate environmental sustainability among their values, the provision and training of their employees become fundamental pillars for its achievement, i.e., the first step becomes a process of education for sustainable development. The issue of environmental sustainability offers interesting avenues of opportunity for the company, especially in the investigation of the relationship of strategic human resource management with supply chain management and companies involved in product development and sales. All of this will require new aligned strategic systems that will require new research, as is the case with the circular economy [23].

The circular economy is forged as one of the fundamental elements to advance towards Sustainable Development and is included as a line of action within the European Green Pact. The transition from the linear economy to the circular economy represents a systemic change and innovation that requires new knowledge, new technologies, new business models and new consumption behavior, among other things. This eco-innovation will be achieved through systems thinking, especially through cooperation, synergy and the hologram principle (the part represents the whole, which is coupled with circular causality) [16,24]. The list of successful companies that increase their performance by using system dynamics is growing in multiple sectors, including the building industry [25,26].

In short, the competencies required for new business managers are systems thinking, interdisciplinarity and the integration of diversity, inter and intrapersonal competencies, the capacity for action and strategic management [27]. The complex world requires a manager with a global and systemic vision, personal development and the ability to integrate and work with different interest groups. For this reason, education for sustainable development is of great relevance today and must be included in the university environment.

### 2.3. Sustainable Building

The need to reduce high greenhouse gas emissions and reduce the environmental impact of the building industry and the commitment to creating low-energy-consumption buildings (Net Zero Building) are driving the building of sustainable buildings in terms of design, materials, technologies and building techniques [28]. This philosophy is increasingly being transferred to new building and the retrofitting of existing buildings, driven by European regulations and global climate challenges. However, the use of operational energy in buildings does not meet design performance targets, and there is an urgent need to promote systemic approaches that span different developmental, institutional, operational and socio-cultural domains when building [29].

In building, we find factors that can be limiting and impelling. The driving factors are technological and environmental factors, which are factors that drive the management and administration of the project. Limiting factors can be political factors, legal factors, social factors, such as the aging of the population and the negative perception that leads to a shortage of manpower, and economic factors, the latter of which include the cost of building and productivity [30]. Building productivity can be understood as a complex system where various drivers and limiters interact with each other. The development of systems thinking in the training of future civil engineers and architects encourages the use of system dynamics models that help to improve productivity and the negative view of building of the end consumer [20,30,31].

To implement sustainable building processes, green building rating and certification systems have been established. The green building approach demands the use of a long-term systemic approach to sustainable building performance. Green rating and certification systems have been established in many countries to support the increasing demand for green housing and to provide a systematic, holistic and practical assessment [32,33].

In any case, in the literature review, no educational proposal has been found that promotes the development of systems thinking in the university context through the degrees of Building and Business Administration and Management. For this reason, this paper aims to fill the existing gap by showing a proposal for intervention in the classroom with students involved in the subjects of Strategic Management and Sustainable Building. Thus, the intention is to present a work methodology that is increasingly in demand by companies, which trains students in decision making and allows them to integrate different subjects, conceiving them as part of a whole. In this way, the aim is to develop the future competences that are increasingly in demand among technicians and professionals in the building industry, without losing sight of the horizon set for the achievement of the Sustainable Development Goals.

## 3. Methodology

The challenge of training new generations in the Sustainable Development Goals requires the implementation of interdisciplinary practical proposals that promote systemic thinking and sustainability with constructivist and educational action-research theories. The objective of this practical proposal is to implement the skills of the systemic thinker in an interdisciplinary project of the subjects of Strategic Management and Sustainable Building in the fourth year of the Double Degree in Building and Business Administration and Management at the Polytechnic University of Madrid. This practical proposal allows students to acquire systemic thinking skills that facilitate the resolution of complex, dynamic problems in multiple situations arising from the project to be carried out. These skills would allow students to employ a broad view to see the underlying interrelationship between isolated situations and the integrated management of natural resources, strategic decision making and the commitment to sustainable building systems in future building. This section shows the description of the context, the approach, the methods and the resources used in the practical proposal adapted to the curriculum of the two subjects. The possible achievable results are presented, and ideas and lessons for its development in the classroom are extracted.

The proposal has a multidimensional and holistic nature; it seeks training in the concepts, resources, methodologies and commitments of systemic people to help them understand and work on sustainable development in complex environments, coupling the different interpretations for the same problem. In this way, the initiative focuses on learning spaces that involve the two subjects such that the links between them can be appreciated. Given the dynamic and changing nature of knowledge management, mechanisms for the integration and incorporation of the content in the project must be established, which will have to be elaborated throughout the school year. Therefore, the program presents a complex structure in development with different levels of recursion that will concretize the multiplicity of concepts of the environment [19,34]. The learning outcomes with respect to systems thinking applied through the educational proposal presented are [19]:

- Encourage the systemic approach by reflecting on complex issues relevant to sustainability from the practice of chaos.
- Use systemic methodologies and their applicability in different contexts, businesses and sustainable building.
- Identify that each approach is partial—we have to reach a common point.

Table 1 below shows the competences that are worked on for each of the subjects involved in the proposal designed [35,36]:

**Table 1.** Competences worked on in the subjects included in the designed proposal.

| Sustainable Building (3ECTS) | Strategic Management (6 ECTS) |
|---|---|
| • Knowledge of the assessment of the environmental impact of building and demolition processes, of sustainability in building and of the procedures and techniques for assessing the energy efficiency of buildings.<br>• Managing new building technologies and participating in quality management processes in building; carrying out analyses, assessments and certifications of energy efficiency as well as sustainability studies in buildings.<br>• Respect for the environment.<br>• Recognition of diversity and multiculturalism. | • To understand the functional organization of the company: its objectives and technicians.<br>• To understand the company's mission, vision, values and strategy.<br>• To understand the principles and guidelines of strategic management.<br>• To understand, interpret, synthesize and critically evaluate information from different sources in the field of business administration and management.<br>• To work in multi-disciplinary teams, applying the knowledge acquired in the field of business administration and management and fostering team spirit and coordination in the tasks of the various members.<br>• To acquire an ethical commitment in their work in the field of business administration and management. |

On the other hand, the learning outcomes derived from the application of this practical proposal are as follows [35,36]:

1. To manage and qualitatively evaluate the factors with the environmental impact of the building.
2. To identify the qualities that a project must have to contribute to sustainable development.
3. To qualitatively evaluate the collaboration of the building in a sustainable development.
4. To identify the areas of action in existing buildings to improve their collaboration with sustainable development.
5. To develop the ability to search, store and process information for decision making and autonomous learning.
6. To know different alternatives of organizational configuration.
7. To mature the entrepreneurial spirit of the student in terms of their ability to find solutions to problems, to generate new ideas or to energize and lead groups.
8. To carry out simple analyses concerning the management of organizations and the knowledge of their internal reality and their environment.
9. To know the different functional areas that make up the organizations.

In addition to these competencies, transversal competencies related to systems thinking are worked on: critical thinking, problem solving, collaboration, communication, innovation and creativity, inter and intrapersonal skills, intercultural skills, social responsibility and leadership capacity for decision making [12].

For the development of this systemic thinking, the proposal is developed using Project Based Learning (PBL) as an active methodology. Project-based learning is a methodology that brings the real world into the classroom and allows students to acquire the knowledge and skills of the subjects by solving challenges. This is intended to involve students in a work experience close to what they will find in their future work, promoting self-learning and increasing their skills for solving real problems [37]. Thus, with the intention of increasing students' motivation in the university classroom and putting into practice the theoretical knowledge they have learned, PBL is likely to improve students' research skills and their capacity for self-reflection and self-evaluation. Therefore, the objective is that it becomes the main axis of the subject and acquires a relevance in the final evaluation since it is characterized by learning significant content and requires decision making, research to solve the challenge, planning the different phases, the evaluation of the process and the dissemination of the project outside the classroom. For this reason, it is a methodology that fits perfectly with systemic thinking.

## 4. Development of the Practical Proposal

This section describes the different application stages to carry out the development of the proposal designed in this research. The development of the proposal will be carried out during 9 weeks, with a dedication of 4 h per week. Table 2 shows the chronogram with the contents and the hours foreseen for its implementation.

**Table 2.** Practical Proposal Timeline.

| Week | Phase, Activities and Duration |
|---|---|
| 1 | **The initial stage of the project begins:**<br>Presentation of the project and launching of the challenge (1 h).<br>Explanation of subject concepts (3 h). |
| 2 | General assembly for the sensitization, motivation and justification of the project. Creation of groups. Generation of the cognitive conflict (1 h).<br>Exploration of previous knowledge. Explanation of systemic thinking: What is a system and systemic thinking? What are their properties? What is the problem and what information do we have about it? (2 h).<br>State the contents, learning objectives and evaluation criteria. Students will look for information at home for the development (1 h). |
| 3 | Project planning (2 h).<br>Presentation of the different project proposals (1 h).<br>Finalization of the final project (1 h). |
| 4 | Project planning and specification of the tasks to be performed (2 h).<br>Resolution of doubts and explanation of concepts to start the project (2 h). |
| 5 | **Project development stage begins:**<br>Pedagogical questions and key ideas (2 h).<br>Pedagogical practices and development and implementation of the pedagogical model (2 h). |
| 6 | Elaboration of prototype I (4 h). |
| 7 | Elaboration of prototype II (4 h). |
| 8 | **Final stage of the project:**<br>Presentation of projects. Evaluation of projects (4 h). |
| 9 | Dissemination (2 h).<br>Decontextualization and conclusions (2 h). |

### 4.1. Initial Stage of the Project

This first stage will be carried out by following these steps in the classroom:

1.1 *Presentation*: It begins by presenting the project to the students and explaining the most important concepts that will be the backbone of the project. At this point, the students should understand that systems thinking is a tool that facilitates the integrative analysis of inter and transdisciplinary problems, allowing them to see the different connections and the complexity of the different elements of a project. This will facilitate the evolution of holistic thinking and the dynamics between the different parts. Likewise, the objectives and goals of the United Nations Sustainable Development Goals addressed, and the relevance of their integration in the different subjects of the degree will be explained.

1.2 *Challenge*: After a brief explanation of these concepts, we proceed to launch the guiding question that seeks to formulate a problem that students must solve. This question will motivate the students in the approach and development of their project. In the case of this research, the guiding question could be formulated as follows: the Escuela Técnica Superior de Edificación of the Universidad Politécnica of Madrid has the purpose of designing a building project in line with the SDGs for the main building; for this, it is not known whether to carry out a rehabilitation of the building or build a new one. Would you be able to propose a sustainable building project? You

must choose which of the two modalities you select for your project; let us start the project here!

After creating the work teams, the next phase of the PBL is the next one (see Figure 3). Although the ideal number may vary according to the type of work or the complexity of the project, four or five students per group is usually considered adequate [38].
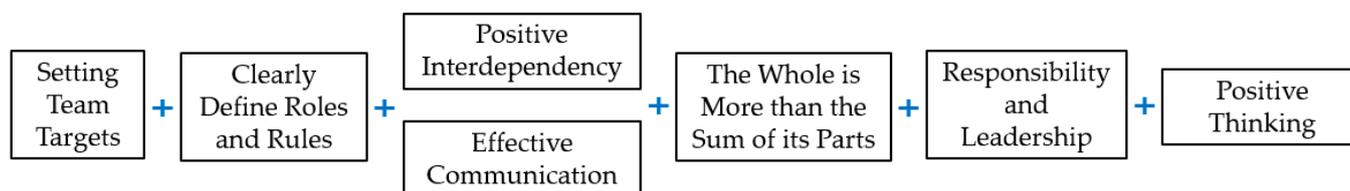
| Setting Team Targets | + | Clearly Define Roles and Rules | + | Positive Interdependency / Effective Communication | + | The Whole is More than the Sum of its Parts | + | Responsibility and Leadership | + | Positive Thinking |
|---|---|---|---|---|---|---|---|---|---|---|

**Figure 3.** Essential characteristics to be met by work teams.

1.3 *Generation of cognitive conflict*: At this point, the purpose of the proposal is defined and materialized by concretizing it in reference to the two subjects of the Double Degree on which the contents, competences and evaluation criteria are focused. They have to unite epistemologies, synchronize mental models, identify the sources of uncertainty and distinguish and conceptualize the system [39].

1.4 *Exploration of prior knowledge*: Students will search the Dual Degree learning plan for the different competencies, learning outcomes and concepts of the two subjects involved: Strategic Management and Sustainable Building. In addition, they will have to explore the concepts of the rest of the subjects taken that can serve the purpose of the project. This enables a multicausal and holistic identification of contents and their applicability to reality. Additionally, they should collect their idea about what they identify with systemic thinking and what elements it integrates. This first contact with previous knowledge will help the teacher to see the students' starting point and explain the most relevant elements of this tool that will help them to advance in their proposal. The aim is to transmit to the students involved that systems thinking is not a scheme of rigid ideas but rather resources and tools that guide them in the process of approaching and understanding scenarios for a specific context such that they will end up obtaining tools for the resolution of complex realities. This conceptual refinement facilitates the incorporation of the different ideas developed according to each of the learning situations or scenarios generated during the project [8]. To achieve this, the following questions can be asked: What is a system and systems thinking? What are their properties? What is the problem and what information do we have about it? [40].

1.5 *State the contents, learning objectives and evaluation criteria*: The teacher will explain the contents to be used in the realization of the project and the criteria to be used to evaluate it so that, from the first moment, the students know the requirements to successfully pass the proposal. It is important to include evaluation tools for the project and the work done by each student and group. The evaluation criteria will be adjusted to the acquisition of competencies and the expected learning outcomes.

1.6 *Information search for project development and planning*: The students will collect all the information of the project, consult all the interested parties and look for everything necessary—building information, economic resources, etc.—before analyzing the different proposals and choosing the way to approach the final project. Likewise, it is important to carry out a mapping of causal loops to identify, in a visual way, the variables of the proposed system and their interconnections; this will help them to identify the structure and the different behaviors [19]. The systemic questions we can ask are: What is the paradigm, design, process and materials of the intervention in our project system? What aspects are affected by time, space and indirect impacts? What are the interrelationships of the different elements of the project system structure? [40].

1.7  ***Presentation of the different project proposals***: After this information search, the teams will determine the different proposals for the project, both for the rehabilitation of the building and the creation of a new sustainable building. This presentation will be made in the classroom in front of their peers to generate ideas and focus on the problem addressed with the help of the teacher.

1.8  ***Concretization of the final project***: The teams will analyze their proposals, evaluate each of them and select the final project.

1.9  ***Project planning and specification of the tasks to be performed***: This phase takes place once the teams have already chosen the final project, and they will have to plan and specify the different tasks that each team member will perform. To do this, they must individually answer the following questions: Where am I in the system, how do I act or what rules am I able to incorporate into the project system and what are my weaknesses and strengths in working as a team? The class will then determine the qualities of people who work well in a team. Afterwards, each group of students will check to see if they meet these qualities and determine who can do so to form the final structure. If any quality is not covered in the team, guidelines will be established so that it can be achieved by everyone. Finally, according to the qualities of each member, the roles for working as a team should be established: secretary, spokesperson, coordinator and supervisor.

### 4.2. Project Development Phase

In this second phase, the teams have already defined the final project they intend to develop for the subjects. They then proceed to explain the project by intercalating the phases of systems thinking: pedagogical questions, ideas of strength, pedagogical practices, development and implementation of the pedagogical model and elaboration of the prototype.

### 4.2.1. Pedagogical Questions

This stage should be started by launching some systemic questions with the intention of looking for the interrelation between the two subjects involved. In order to work the project together with systemic thinking, it is convenient to create a learning community. Thus, the problem can be approached in the following way: Are you doing a sustainable building project in the faculty with your learning community? What ideas would you raise? Are there interactions with other groups and with teachers to have systemic thinking? What learning experience helps in sustainable building and strategic direction? How do you teach systemic thinking to find the UN sustainability goal? How would you jointly reinforce the learning? All the questions encourage autonomous learning and make it possible to acquire the theoretical concepts from the metacognitive process of the members of the learning communities.

Then, the collective elaboration of the project is proposed through the systemic simulation of scenarios and their consequences. Can the prototype favor the different realities of the United Nations Sustainable Development Goals and the uncertainty of the project to be elaborated? Uncertainty is intended to get students to not generate immediate certainties and to explore diverse ideas from creative and divergent thinking. On many occasions, students only propose the possibilities studied, without broadening the field of view of the different possibilities. How should directive strategies and sustainable buildings be generated to respond to the challenges of the complex and chaotic reality? Prototype explanations are sought that allow for the understanding of complex phenomena from explanations with open answers and with possibilities of modification. It is necessary to find an answer to what they think and feel about the problem posed and why.

The objective is that the prototype has to give life and materialize the different ideas that arise, building a model that starts from the concept and develops through the vision and feeling of the group members and receiving feedback from the teacher that transforms the original product [8,34]. By raising these questions, we make the underlying patterns

and interconnections visible and encourage discussion in the usual tendency to reduce the phenomenon and isolate forces in project approaches. Students can map the project to include all participating elements of the problem [13,20].

### 4.2.2. Ideas of Strength

At this point, the different groups are asked to choose a maximum of three words that define their project. Later, they are asked to reflect on the different approaches to the chosen words. The students' judgment is trusted, and they are encouraged to come up with their own ideas for solutions to the social, environmental and sustainability problems of the project. With the strong ideas of feeling–thinking and thinking–feeling, we go beyond preconceived ideas, and each student comes up with his or her own perspective on the problem posed. This multiplicity of perspectives facilitates the amplitude of the systemic vision and the opening to new interpretations and forms for the project. Based on these strong ideas, a prototype is launched and will begin to be developed. From the practice of doing, the teacher is in charge of introducing different concepts for the different subjects, and the student evolves in his teaching–learning process [8].

### 4.2.3. Pedagogical Practices

Teamwork, communication and support among members are fundamental for the approach of the different proposals. In order to make systemic progress in the development of the project, the roles of trainer and trainee must be defined. The role of trainer is carried out by a teacher of one of the two subjects through the practice of active and constant listening, facilitating joint reflection and understanding of the different concepts in each of the sessions. The training role is played by the rest of the teaching staff from the different subjects of the Double Degree, who must present an open mind for the development of the project according to systemic thinking. With all this, students acquire the ability to understand, interpret, synthesize and evaluate the various sources of the organization, the multidisciplinary teamwork and the ethical commitment in their work by having to raise a sustainable building project. In this way, they expand their way of thinking, approach complex problems and learn about non-linear interrelationships, patterns of reciprocal causality and states that generate changes for the regression or growth of processes [15].

Individual or group learning is facilitated by mental models open to new ideas, reflections, analyses of previous beliefs or decision making. With these learning communities, we provide spaces to promote non-linear thinking that allows new and innovative proposals to be reached [41,42]. Within the pedagogical practice, symbolic supports can be used in the form of narratives, process diagrams, flowcharts, etc. These tools make it possible to see the problems in each of the phases and within the proposed context, as well as the dynamic relationships of the inhibiting or reinforcing forces of the problem [13,31].

### 4.2.4. Development and Implementation of the Pedagogical Model

The implementation of the model for the project requires the team to identify the different stakeholders within the company that would carry out the project, as well as their objectives, roles and implications for the strategic direction. For this, they must understand the mission, vision, values, strategies, principles and guidelines of the strategy formulated in the context of the sustainable building project being developed.

Therefore, the pedagogical model used has been the inductive-deductive one, where we start from the learning process carried out by the student through the project and, subsequently, advance to higher levels of conceptual abstraction. This approach to theory from practice facilitates learning and the connection of concepts to reality. The difficulty then lies in the abstraction of systemic concepts and the adaptability to the project; it is a tool that is not worked on in previous stages, and the student is not used to it. A fundamental element is the cohesion of the team that allows for the construction of shared thinking in order to achieve a shared learning community in which all members are supported and valued.

4.2.5. Prototype Development

The groups design the project prototype, putting into practice the idea of sustainable building, in such a way that they have to manage and evaluate the factors with the environmental impact of the building, identify the quality of the project so that it is in line with the SDGs and qualitatively assess the collaboration of the various agents that make up the building process. At this point, special care must be taken to choose eco-efficient materials that reincorporate Building and Demolition Waste in their manufacturing process and favor circularity and reduction of the carbon footprint. Students should be committed to the integration of constructive solutions that reduce energy demand and improve the thermal comfort and habitability of the chosen building. In this sense, systemic thinking allows for the adoption of passive solutions that put into practice the concepts learned in other subjects.

*4.3. Final Stage*

Finally, the last steps are carried out to complete the development of the project and to give visibility to the finished product:

1.1 ***Product presentation, communication and dissemination***: The different groups present the different projects developed to the rest of the class and classmates of the Double Degree, justifying the decision making and determining the impact on the sustainability of the project. Likewise, they will determine the strategic decisions to follow that would allow the project to be developed in reality. As part of the communication and dissemination, a period can be established for the collection of assessments of the different projects and even for the university to evaluate which project has best adapted to the Sustainable Development Goals. In order for the project to reach the highest level, the project could be presented to the Technology Transfer Office of the University to see if there is any interest in the project presented and the possibility of its realization.

1.2 ***Decontextualization***: At this point, it is intended to expand the systemic vision of students; for this, each team is asked to transfer the ideas embodied in their project to other buildings chosen by their peers and analyze how they could complement the solution proposed by them. Therefore, they must conduct research on the sustainable building needs of each decontextualized project and the strategic direction needed for its implementation.

1.3 ***Conclusions***: After dissemination and decontextualization, each group will present a synthesis of the experience: initial ideas, objectives, systemic questions posed, group work competencies acquired and learning evolution. After this step, they move on to the next phase, the reflection on the acquired learning: competences, acquired learning results, contents and metacognition of their learning process.

Project Evaluation

When evaluating the project, it is convenient to use several tools, such as: a student self-evaluation (to be aware of the metacognition of learning), a group co-evaluation (promotes the understanding of learning from a systemic point of view, evaluating all the elements of the group), an evaluation of the project and, finally, an evaluation of the teachers of the subjects involved in the PBL experience carried out. Likewise, the use of learning diaries is important so that, in each session, the objectives achieved, the challenges posed, the systemic questions formulated and the objectives for the work outside the classroom are established. The evaluation of the project will be carried out by means of a rubric (Table 3), in which the criteria for the achievement and acquisition of the competencies and learning outcomes of the two subjects will be collected. This rubric will have been available to the students from the beginning of the experience in such a way that it will serve as a guide to know how to achieve the maximum score.

**Table 3.** Final product evaluation rubric.

| | Distinguished (10) | Above Mastery (7.5) | Mastery (5) | Below Mastery (2.5) | Novice (0) |
|---|---|---|---|---|---|
| **Final product content (20%)** | Original, appropriate, well defined, precise and interesting | Original but not as adequate. Profiled and interesting | Tailored and adequate but less profiled and interesting | Elaborated with some underdeveloped parts but has some quality | Poor development and lack of quality. Nothing interesting |
| **Knowledge acquired (20%)** | It demonstrates a very good acquisition of the knowledge worked on. The information provided is accurate, interesting and well synthesized. You have extended the work beyond what was required | You have acquired the knowledge you have worked on. The information provided is accurate and well synthesized | It seems to have acquired the knowledge worked on. The information provided is accurate | Their knowledge of the topics worked on is partial. The information provided is somewhat confusing and not very synthesized | Their knowledge of the topics worked on is scarce. The information provided is confusing and extensive |
| **Development of systemic thinking (15%)** | It has made 100% correct proposals following the guidelines of systems thinking | It has made 75% correct proposals following the guidelines of systems thinking | It has made 50% correct proposals following the guidelines of systems thinking | It has made 25% correct proposals following the guidelines of systems thinking | It has not put forward proposals along the lines of systemic thinking |
| **Teamwork (15%)** | All team members are fully aware of each part of the project. There is a climate of tolerance and respect among them and towards the other teams | All team members know each part of the project, but not all of them know how to defend it. There is a climate of tolerance and respect among them and towards the other teams | Each team member knows a specific part of the job and has a general idea of the rest. The atmosphere among them is correct | Each team member knows a specific part of the job and has a general idea of the rest. The atmosphere among them is correct | Some team members know their part of the job; none of them know the work of the others well; no team feeling |
| **Presentation of the final product (10%)** | Entertaining, attractive, coherent and balanced | Entertaining and appealing; coherent or balanced | Entertaining or attractive. Coherent or balanced | Boring, unattractive and unbalanced | Incomprehensible, unattractive, unbalanced |

**Table 3.** *Cont.*

| | **Distinguished (10)** | **Above Mastery (7.5)** | **Mastery (5)** | **Below Mastery (2.5)** | **Novice (0)** |
|---|---|---|---|---|---|
| **Correctness and linguistic richness (10%)** | Very correct writing. Understands and produces oral and written messages on project topics with great accuracy and fluency; rich and varied vocabulary | More or less correct writing. Understands and produces oral and written messages with adequate accuracy, coherence and fluency. More or less varied vocabulary | Writing with errors. Able to produce oral and written messages, and, although he/she often uses the language in an inappropriate manner, his/her speech is understandable. Repetitive vocabulary | Difficult to understand. Has trouble understanding and producing oral and written messages. Poor fluency and accuracy in oral and written communication. Makes many lexical and grammatical errors. Poor vocabulary | Very poor writing skills: Inability to understand and produce oral and written messages. Very poor fluency and correctness for oral and written communication. Makes many lexical and grammatical errors. Very poor vocabulary |
| **Dissemination of the final product (10%)** | The product has an excellent design | The product has a high-quality design | The result of the product is adequate | Product could be improved | Product with many deficiencies |

For the evaluation of the other elements, it is convenient to use evaluation tables using Linkert responses, for which the scales proposed by Sáenz [43] can be used as an example.

## 5. Discussion

The practical proposal proposed in the double degree of Building and Business Administration and Management, in the subjects of Strategic Management and Sustainable Building, shows that the implementation of systemic and team activities facilitates attitudes and skills of openness and trust, generating an active participation in the open dialogues and exploratory conversations carried out. This is done in such a way that it could be linked to a cognitive synergetic dynamic of overcoming problems thanks to their group work and a transformation of learning, both in innovation in strategic business decisions and in sustainable building [13].

In this sense, a direct and positive link is found in the resolution of problems of sustainability and the reduction of environmental impact with the profiles of the two subjects proposed in practice, along with the development of student competencies for each of the two areas of knowledge involved and their learning style. The current changes and the complex and chaotic society request a specific profile of university students with interdisciplinary competences and complexity skills, which requires an adaptation of the curricula and a joint work between the teaching staff of the different subjects, especially in the university double degrees that cover different areas of knowledge. The practical proposal promotes the development of expanded and comprehensive competencies in the classroom using tools that unify the curricular contents from a vision of the whole to face the complex challenges that will have to be solved in the future [12].

Project-based learning and systemic thinking favor the creation of harmony in the work environment that directs the energies of the group towards the achievement of the learning objectives and the established project. Consequently, it is possible to increase the satisfaction, reception and connection of individual and group learning and the acquisition of useful knowledge that increases the desire to learn and improve. The proposed methodology, in turn, develops Peter Senge's five disciplines by creating intelligent organizational groups that think systemically and create joint mental models thanks to the individual and shared learning groups, which, in turn, facilitate the development of adaptive intelligence networks for the diagnosis of possible solutions with the shared vision of the team. [15,44].

Increasingly, companies are requesting qualified people with knowledge assets for the creation of organizational value. The proposal proposed facilitates the acquisition of knowledge from practice and systemic thinking; this improves the knowledge assets of students and is a good form of management to avoid the misallocation of resources. The shared vision of the project makes it possible to broaden the view and examine the effects of knowledge assets and their management on performance, avoiding erroneous decisions. The mapping of relationships and connections of ideas is a valuable tool to reveal and evaluate how these individual and collective knowledge assets participate in the company's proposal and value creation [45]. However, it is necessary to take into consideration organizational learning incapacities, strategic decisions that do not consider the long-term vision and current decisions and policies that influence future capabilities and lead to errors that are not appreciable in the short and medium term but are appreciable in the long term. Systems thinking and system simulation through mapping can identify these interconnections that have a long-term impact on business performance [46]. Normative competence in behavior must be considered with decisions and strategic dimensions oriented toward action, the acceptance of diversity and inter and intrapersonal competences in order to place a strategic management of the chosen building project [5].

Other aspects to be assessed at the time of the project realization is the result of possible quality deviations, delays and delays in the scheduling and planning of sustainable building. In this part, the two subjects of the double degree are connected, since the strategic organizational decision influences the prototyping schedule, and this schedule influences

the project organization. This is related to resilience engineering that proactively manages safety during the building project. Consequently, students must establish the affected resilience control methods and predict the potential impacts resulting from erroneous initial planning [47].

Meaningful and highly leveraged actions must be taken if progress is to be made towards achieving the UN Sustainable Development Goals by 2030. Systems thinking is a key approach to study complex and changing problems by offering a different way of thinking and investigating, from the holistic view, different solutions [48]. The success of the practical approach lies in its multidimensional nature. The criteria are not independent; rather, they come together in complex causal interactions. Students have to understand that projects must consider cultural and environmental factors, organizational culture, the environment and size of the company, circular economy criteria and the reduction of the environmental impact of the building activity, being favorable to the adoption of intelligent learning communities with proposals for constant improvement that are linked to the project [49].

Thus, there is no single solution for the implementation of a project but rather multiple ones, the future impact of which will depend on present actions. Universities play a fundamental role in achieving sustainable development, and it will depend on their ability to adapt to this complex, chaotic, fragile, non-linear and incomprehensible BANI world to ensure that their students acquire the skills required by the society of the future. In this sense, universities must create learning spaces and environments that enable their students to face the challenges of sustainable development and the resolution of complex and dynamic problems; this will allow them to translate their knowledge into the future companies where they carry out their activities, contributing to responsible economic growth [50].

## 6. Conclusions

The United Nations has given society the great challenge of advancing towards the achievement of the Sustainable Development Goals in different areas. In building projects, it is essential to reduce carbon emissions, achieve energy efficiency and improve the health and well-being of the population. To achieve this, in a complex and changing world, we need a systemic approach that considers institutional, operational, developmental and socio-cultural variables. It requires a broad and dynamic system with interrelated factors that adapt to the management of the building process in the execution and delivery times and its subsequent near-zero energy consumption and sustainability requirements.

From a strategic management point of view, systems thinking is important for the dynamics of knowledge assets, both theoretical and practical. From a theoretical point of view, it enriches the analysis perspective on the relationships between knowledge and strategic results of organizations, thanks to empirical research. From a practical point of view, systems thinking drives future managers towards the design, implementation and evaluation of the projects developed and their dynamic impact on the performance of the activity linked to sustainable building. The implementation of systems education will depend on how teachers incorporate systems thinking in the different curricula of the subjects and how they are able to adapt them to the resolution of complex, chaotic and constantly changing situations. In line with this, the practical proposal put forward in this research shows how to develop the curricular contents of the Sustainable Building and Strategic Management subjects through a PBL experience that favors the development of systems thinking.

The possibilities of incorporating this methodology in university curricula require efforts on three fronts: the way of structuring the decision-making process for academic and resource aspects; the openness of the teaching staff to this new methodology and its application in the classroom; and the honesty in the establishment of goals and their actual implementation in the classroom. One of the obstacles to its application is the resistance to change and the protection of the methodology used for many years. Promoting a systemic

methodology in the classroom is not only a challenge for students but also for teachers, as it forces them to challenge themselves and to be critical, so we must first reflect on the question: Are teachers prepared to be critical of their own theoretical and practical academic paradigm?

In any case, there is no doubt that it is important to educate citizens who incorporate systems thinking into their work and personal reality for this world that experts have described as BANI. The use of this methodology will provide students with a transformative experience, facilitating the acquisition of global knowledge and connecting the concepts taught in the different subjects, increasing their confidence to carry out inter, intra and transdisciplinary research. In this way, students will be able to acquire systemic and complex curricular competencies that they can apply in different areas of their personal and professional lives.

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