

Education and Sustainability in the Curriculum of the Technical Course in Buildings: Implementation and Challenges

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Abstract

Increasingly, humanity has established a predatory relationship with nature due to the consumerist and capitalist model of production. As a result of this lifestyle, humanity is rapidly approaching a scenario of environmental disaster. Teaching and learning how to take care of the world, how to care for the collective, how to reduce, recycle, and reuse should be themes addressed in schools in a relevant and effective way. This would not only raise awareness among students, but also among the entire faculty of educational institutions, the professionals who work in them, the community, society, and the world. Only through education will we be able to cultivate behaviors and habits consistent with sustainability. To achieve this, the curriculum needs to be restructured, allowing for an integrated approach to incorporate sustainability concepts and sustainable development with school knowledge and experiences. Considering that the disciplines of the Pedagogical Project Course (PPC) of the Integrated Technical Course in Buildings do not currently include the theme of sustainability, this work aims to identify and propose the inclusion of teaching sustainability concepts and sustainable development in the syllabi of technical courses in the integrated modality in buildings within the civil construction area of the Federal Institute of Amazonas (IFAM).

Keywords

Construction, Education, High School, Subjects, Sustainability

1. Introduction

It is known that education is a phenomenon of human beings. Therefore, understanding the nature of education involves understanding human nature. Now, what differentiates men from other phenomena, what differentiates them from other living beings, what differentiates them from other animals? The answer to these questions is already known. Indeed, it is known that, unlike other animals, which adapt to natural reality having their existence naturally guaranteed, man needs to continuously produce his own existence. Therefore, instead of adapting to nature, he has to adapt nature to himself, that is, transform it and this is done by work.

Therefore, what differentiates man from other animals is work. And the work is established from the moment its agent mentally anticipates the purpose of the action. Therefore, work is not any kind of activity, but a purposeful action. It is therefore an intentional action. In order to survive, man needs to actively and intentionally extract the means of subsistence from nature. In doing so, he begins the process of transforming nature, creating a human world (the world of culture). To say, therefore, that education is a phenomenon proper to human beings means to state that it is, at the same time, a requirement of and for the work process, as well as being itself a work process (Saviani, 2015).

According to the International Construction Council (CIB)/Ministry of the Environment, the construction industry is the one that most exploits and consumes natural resources and uses energy intensively, thus generating considerable environmental impacts. The capacity for destruction is immense, such as the inexhaustible use of withdrawal from nature without proper sustainable use, which can raze mountains, silt up rivers and lakes, deplete deposits of clay and sand, deforest without any limit, poison rivers and the air itself and even annihilate other species. The progression of these practices destroys habitats and affects the environmental balance, making it essential to awaken environmental awareness and the need to seek sustainable ways within the teaching of the educational institution.

1.1. Environment and Sustainability

As humanity increases its ability to intervene in nature in order to satisfy its growing needs and desires, tensions and conflicts appear regarding the use of space and natural resources. Currently, concerns around environmental perspectives have become a constant, as humanity lives a reality endowed with uncertainties, from an ecological point of view, considering that environmental degradation has increased significantly in recent decades, causing a redirection of attention to atmospheric pollution, acid rain, death of rivers, seas and oceans by the devastating action of man, as well as the emergence of genetically modified products.

Describing this scenario in detail and emphasizing carelessness and irresponsibility with which the productive sectors exploited nature, without any kind of preoccupation with the consequences of its polluting activities, international unrest was triggered after the publication of the chronicle book *Silent Spring*, in

1962, by Rachel Carson, which would become a classic in the history of global environmental movement (Dias, 2002). The terminology “sustainability”, despite not having been discussed at that time, is indirectly suggested as a future alternative, where the indiscriminate use of pesticides and insecticides in North American crops and its consequences with the degradation of the soil, air, water and life was portrayed, human, animal and plant. The effervescence of the 1960s and 1970s was marked by the worsening of progressive environmental deterioration, raising a debate for a new form of development and economic growth that culminated in the United Nations Conference on the Human Environment (UNECA), held in Stockholm in 1972. The conference centered on the idea of sustainability, initiating the discussion on the possibility of achieving economic and industrial growth without harming the environment.

New approaches, integrating the various areas of knowledge, need to be created for the environment in order to raise awareness, especially of children and adolescents, so that new habits can be formed, directing the human species to use the natural resources of sustainably (Souza et al., 2013).

Consensus had been building since the 1970s, and it progressively asserted itself as the understanding of climate change evolved. This is not a matter of making a history of the notion of sustainability or its evolution within the paradigm of post-war development, but we will present a timeline relating the main historical moments of this process (Figure 1).

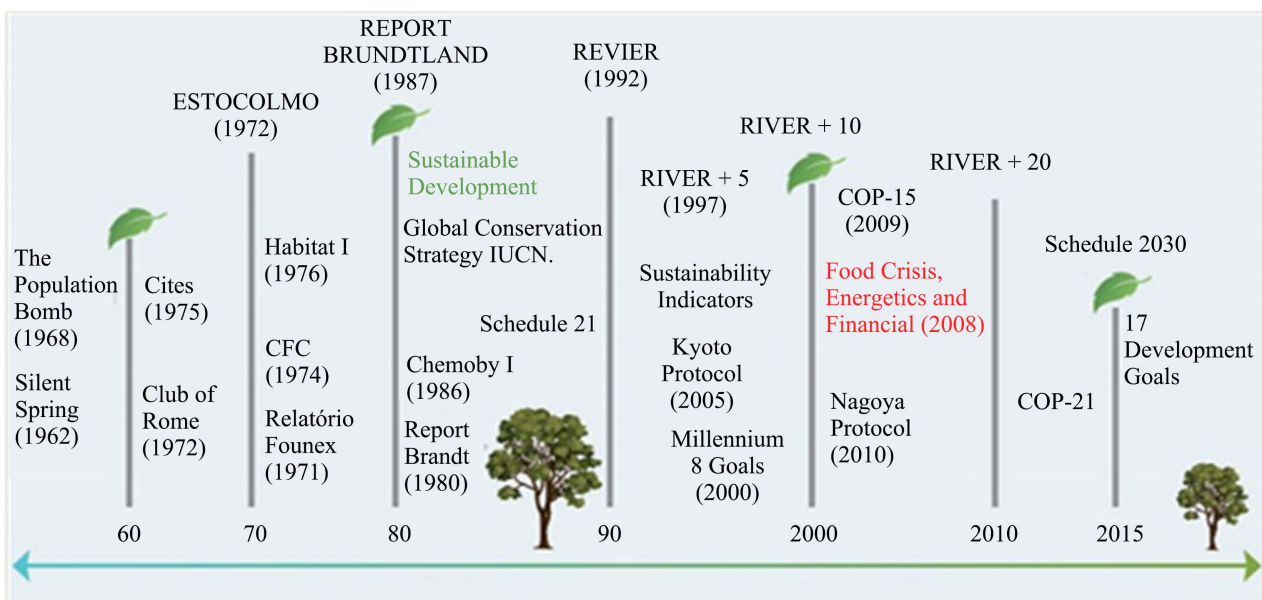


Figure 1. Sustainability timeline. The concern for the environment gained strength from the 1960s, but the great world movement in 1970 with the United Nations World Conference on the Environment and Development, held in Stockholm, Sweden. There begins the concern with the degradation of the environment. In the 1990s, a series of global conferences within the framework of the United Nations (UN) made the notion of sustainability an indispensable agenda in discussions about the future of the planet, Alves, 2015. From the 2000s onwards, the social, economic and ecological challenges of the quest for sustainability were synthesized in a series of goals to be achieved by 2015: the Millennium Development Goals (MDGs), with sustainability indicators and institutional ideas.

1.2. Education and Sustainability

The development of skills is of paramount importance to collaborate with the promotion of the individual's well-being, in the same way that it provides a professional contingent that favors the economic development of a country. Creating qualified people for the world of work is the duty of all educational institutions and, mainly, of the governmental structure of a country, in which good governance must contemplate economic development associated with personal development, through job opportunities that enable inclusion and social justice through work. However, we cannot think of a 21st century society that is only concerned with developing technical skills aimed at work (Froufe et al., 2020).

Therefore, other skills and knowledge must be stimulated, especially those geared towards promoting a fairer, more inclusive society and concerned with environmental issues. Some teaching institutions still remain centered on the old model of knowledge transmission focused only on serving the labor market or producing scientific material, making it necessary to take initiative in projects to change this pattern, with the aim of promoting a world more sustainable and that brings future benefits to all beings on the planet (Amador et al., 2015). Projects in this sense should be more effective and seek tangible results instead of just promoting knowledge, since the moment unfolds in a situation where thinking is no longer enough, but acting. For this, one cannot remain in the superficiality of theory when the moment demands forceful actions.

The fact is that sustainability requires considering the challenge of new teaching and learning models, but there are no magic formulas for working on education for sustainability. This challenge involves a variety of didactic-pedagogical strategies, as well as the use of different management instruments, which are still not sufficiently well positioned in the traditional disciplines of the courses or which lack adequate treatment due to the lack of integration between disciplines (Gonçalves-Dias et al., 2013).

The main instrument of emancipation and transformation of the human being is education (Bebiano, 2014), making it very important to facilitate access to knowledge in the most democratic way possible, seeking to provide interaction between all aspects of social life with the issues linked to a deeper understanding of sustainability concepts (Jacobi, 2003).

Once knowledge is disseminated and educating for sustainability, these efforts would be collaborating for the emergence of social actors more committed to causes linked to the preservation of the environment, in the same way that there would be greater participation of the population in issues related to social justice and to control pernicious economic growth, seeking to “promote the growth of environmental awareness, expanding the possibility for the population to participate at a higher level in the decision-making process, as a way of strengthening their co-responsibility in the inspection and control of agents of environmental degradation” (Jacobi, 2003: p. 192).

Figure 2 shows that the development that is sought to be achieved on a global scale must be socially fair, as the objectives of development are always ethical and social; economically viable, because economic viability is a necessary condition, a tool to advance towards equal income distribution, on the path of inclusive, sustainable and environmentally correct development, as development must take place respecting ecological conditionalities, from the ethical concept of diachronic solidarity with future generations (Sachs, 2009).

1.3. Sustainability and Civil Construction

According to UN Habitat (2015), it is estimated that by 2050, the world population living in urban areas will increase from the current 55% to approximately 70%. The great challenge will be to meet the demand for infrastructure and housing resulting from this greater urban concentration with the lowest possible environmental impact. To date, the growth of human well-being and economic development have been associated with the rapid increase in the use of natural resources such as energy, materials and water (UN Environmental, 2011). However, in view of the depletion of natural resources and the increasing concentration of greenhouse gases in the atmosphere, it is essential to decouple development from the use of new natural resources and, simultaneously, generate less CO₂ emissions. Within this context, it is of fundamental importance to develop technologies and innovative solutions that make it possible to obtain gains from the point of view of sustainability, either using waste for a more efficient, safe, quality construction with a reduction of the environmental impact, or through the development of new materials and processes.

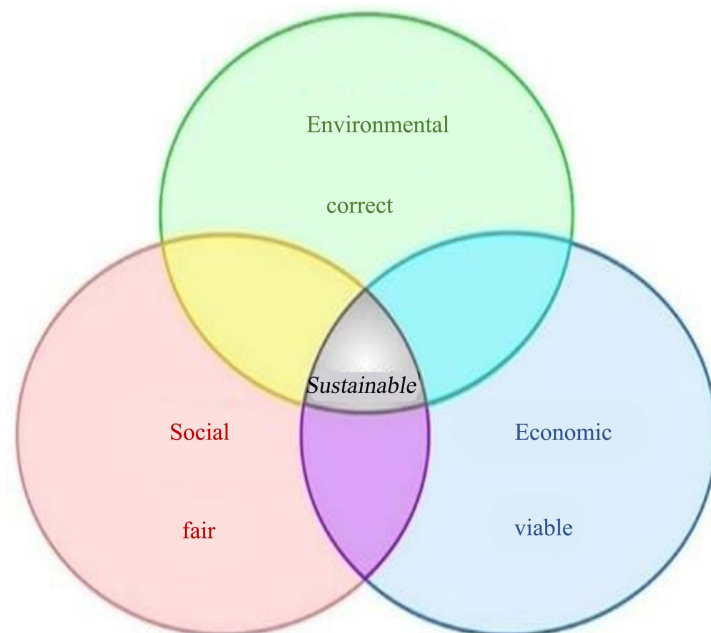


Figure 2. Sustainable management for development (Sustainability Tripod) (Sachs, 2009).

In recent years, studies have sought to identify the main barriers to the application of sustainable techniques in civil construction. The factors that make the application of sustainable technologies in civil construction difficult and vary according to the level of development of a country. The most significant barrier is the high cost of such strategies. Then, on different scales, lack of knowledge about the subject, lack of incentives and support (government, for example), lack of interest and demand from customers, as well as the insufficiency of legislation to implement strategies in construction were identified (Darko and Chan, 2016).

This is a relatively new topic for Brazilian civil construction. Guidance and certification related to sustainable buildings began to be applied in 2007. Among them are LEED, AQUA, Procel Edifica, Casa Azul and PBQP-H (Conto et al., 2017). Several studies point to the benefits of sustainable strategies applied to civil construction in this context (Marques et al., 2017), however, there are still obstacles to the adoption of sustainable strategies. Projects generally apply economic strategies without considering water, energy and waste management (Queiroga and Martins, 2015). Data collected from certified buildings are not used to improve waste management (Froufe et al., 2020).

2. Materials and Methods

To obtain the data, the level of integrated technical education was chosen, as it was understood that at a younger age the result of the research would be more fruitful.

For the first stage of documentary investigation, the Pedagogical Projects of the Courses were analyzed, which is a document that defines the guidelines, goals and methods so that the educational institution can achieve the objectives they propose, also analyzing the PPI of the institution which embraces institutional policies such as mission, vision and values and the IFAM's Institutional Development Plan—PDI, a basic instrument for management, which aims to integrate the efforts of elements in a purpose that contemplates excellence in processes and effectiveness in results, all closely linked to the challenges of the Amazonian reality. Through the analysis of these documents, the presence and absence of sustainable or environmental projects within the courses were verified.

In the second stage, the flowcharts and syllabi of the Curricular Components were evaluated—This document is like a summary or synopsis of a certain theme or area. In this regard, it was verified whether there is a presence of the Environmental Education and Sustainability theme in the curricular components. All analyzed documents are available on the Institutional portal of the Federal Institute of Amazonas—IFAM.

Finally, the possibility of preposition and updating of the PPC was analyzed, based on the premise that, in this analysis, the first criterion for alteration would be the change of mentality within the institution. The search generated a reflec-

tion on the institutional documents of the IFAM/CMC in view of the federal guidelines for environmental education for sustainability, since initially there seemed to be a gap between theory and pedagogical praxis, making the process of building critical individuals and protagonists difficult, such as foreseen in the institutional mission. The preposition of inserting sustainability must be present in the content of the disciplines with great commitment on the part of the academic community.

Table 1 shows the summary with the disciplines in the PPC of the technical course in Buildings and it is possible to verify that there is no mention of the sustainable theme. The disciplines contain environmental content, but do not delve into sustainability in an alternative way and possibilities that contemplate diversity and sustainability, enabling the individual to feel prepared, when leaving school, to face the world of work in constant transformation and participate responsibly. A survey was carried out of subjects related to sustainable practices of environmental education in the curricular matrix, which are included in the PPC of the said course.

The Middle Level Technical Course in Buildings in Integrated Form has its curricular organization based on the legal guidelines present in Law n° 9.394/96, amended by Law n° 11.741/2008, in the National Curriculum Guidelines for Secondary Education, in the National Curricular Guidelines for Education Middle Level Technical Professional, in Decree n° 5.154/04, as well as in the principles and guidelines defined in the Pedagogical Political Project of IFAM.

Table 1. Summary of the disciplines of the intermediate level technical course in buildings in the integrated form (IFAM, 2019).

DISCIPLINE	Series	Weekly Workload	Total Workload	Core
Geography	2°	2	80	Basic
SUMMARY: Brazil in the context of the globalized world. Natural ecosystems and the environmental issue in Brazil. The space of production and circulation in Brazil. Population dynamics and the environment in Brazil.				
Management	3°	2	80	Technician
SUMMARY: Historical context and precursors of the Scientific Organization of Work. Study of the company and its evolutionary structure. Human relationships at work. Globalization—Social, political and economic aspects. Identification of the Biotic Environment: Fauna and Flora. Characterization of the Physical environment: Air, Water, Soil. Environmental impact assessment (environmental planning instruments): EIA/RIMA, PCMAT. Study of waste generated by civil construction. Conceptualize and identify environmental management instruments. Basic references of quality management in the process. Principles and evolution of the concept of quality—general aspects of quality management. Quality Methodology and Tools. Normative Reference: NBR ISO 9000 and 14,000. Organization of the Quality and Environmental Manual in Civil Construction.				
Environment, Health and Safety	3°	2	80	Technician
SUMMARY: Law no. 6514 regulatory standards. Atmospheric pollution. Accidents. First aid basics. Personal protective equipment. Types of collective protection. Basic concepts of psychology and safety at work. Activity control technique in ergonomics. Security programs—CIPA/SIPAT. Analysis of the environmental risk prevention program (PPRA). Implement prevention programs and environmental risks.				

Based on legal provisions, the curricular organization of IFAM's Middle Level Technical Courses provides for the articulation of Basic Education with Professional and Technological Education, from the perspective of integration between specific knowledge for the production of knowledge and social intervention. Likewise, it emphasizes the indissociability between theory and practice in the teaching-learning process, to be verified, mainly, through the development of professional practice.

The PPC of the Medium Level Technical Course is analyzed based on the curricular organization of the vocational technical course, which points to a Basic Nucleus—General Training, a Polytechnic Nucleus and a Technological Nucleus (**Table 2**).

Let us see how this organization is characterized:

- 1) The Basic Core—General Training—comprises 03 (three) areas of knowledge (Language and Codes and their technologies; Human Sciences and their technologies and Natural Sciences, Mathematics and their technologies);
- 2) The Polytechnic Core—includes components aimed at a better understanding of existing relationships in the world of work;
- 3) The Technological Core—integrates specific components of the course itself.

In view of the analysis, it was concluded that of the subjects listed (**Table 3**), with a total workload of 3680 h of the curricular components analyzed, only 16% present in their PPC subjects that deal with the environmental theme, with a workload of 80 hours, distributed within a specific content according to the discipline, representing a percentage far from the acceptable minimum. Based on

Table 2. Number of components, according to the curriculum organization of professional technical courses (integrated modality) of IFAM/CMC (IFAM, 2019).

COURSE	BASIC CORE-GENERAL FORMATION	POLYTECHNICAL CENTER	TECHNOLOGICAL CENTER	TOTAL
Buildings	2280	120	1280	3680

Table 3. Percentage of credit hours for curriculum components involving the environmental approach in vocational technical courses Source: IFAM (2019).

Discipline	Workload (h)	Basic core—general training (%)	Polytechnic core (%)	Technological core (%)	Total (%)
Geography	80	3.5	-		3.50
Management	80	-	-	6.25	6.25
Environment, Health and Safety	80	-	-	6.25	6.25
		Total (%)			16

this diagnosis, gaps in learning the environmental theme are perceived, such as the non-inclusion of the theme in the PPC of public institutions in its entirety, as well as the workload that may not be enough to educate students with a critical-reflective sense and the non-compulsory nature of several disciplines that may distance students from the possibility of knowing environmental issues.

So that there are alternatives for teaching sustainability in education and in the curriculum of few environmental themes, it is extremely important that we involve the formation of conscious and responsible citizens in relation to the environment and society. This discussion on sustainability in education covers different aspects, such as:

Responsible practices in schools: Educational practices can become examples of sustainability by adopting environmentally responsible practices in their structure and operations. This includes the implementation of energy efficiency measures, use of renewable energy, proper water management, reduction of paper and plastic consumption, promotion of sustainable transport, among other actions.

Curricular integration: Sustainability must be integrated into the school curriculum, permeating all disciplines and levels of education. Themes related to sustainability can be thought of in a transversal way, showing the connections between the different areas of knowledge. In addition, interdisciplinary projects and practical activities can be offered so that students experience the principles of sustainability in practice.

Community involvement: Education for sustainability is not limited to the school environment. It is important to establish partnerships with the local community, involving parents, companies and non-governmental organizations. This collaboration can provide practical opportunities, such as environmental conservation projects, community gardens, recycling programs and other initiatives that contribute to building a more sustainable society.

Critical and ethical thinking: Sustainability in education also involves developing critical thinking and ethics so that students can reflect on the consequences of their actions and make decisive decisions. Education should encourage reflection on values, ethical principles, social justice and equity, promoting a more sustainable and responsible worldview.

The construction of the theoretical framework allowed a greater understanding of the concepts and processes related to sustainability and its institutionalization, through public policies, as well as the possibilities of its insertion in the Mid-level Technological Professional Education—EPTNM. Bibliographical research enabled this connection between the various concepts, through a survey of documents, legislation, books and scientific articles, which were conducted from the keywords listed as representatives of the project, namely: formal environmental education, education policies environmental, political-pedagogical project, curriculum, federal institute and professional education.

Among the analyzed documents, several stand out: The Conceptions and Guidelines for the Federal Institutes of Education, Science, and Technology;

IFAM's Institutional Development Plan (PDI); Institutional Pedagogical Project (PPI); and Course Pedagogical Project (PPC) of Buildings. These documents were obtained from the institution's website and the relevant course departments. Specifically, the PDI, PPI, and PPC, which constitute the curriculum, are considered the political, philosophical, and technical-pedagogical instruments of action for IFAM, as they guide academic practices. Therefore, a critical study was conducted, considering their organizational structure, history, mission, objectives, guidelines, and concepts related to Environmental Education—EE.

Finally, the PPC of the mentioned course was also analyzed, pointing out skills and abilities related to the environmental theme, through the identification of keywords (nature, environment, environmental, sustainability, sustainable development) and analysis of their contexts. This process provided a perception of the EE policy at IFAM/CMC, making it possible to see where, how and what content of the course disciplines EE was inserted. It also made it possible to collect information associated with the character political/pedagogical/ideological of EE at IFAM/CMC, allowing a current photograph that served as an initial reference point for the research work.

The second step was to confront the institutional data obtained in the documentary research and the legal framework of EE in Brazil, especially the National Curriculum Guidelines for EE (DCN-EE), the National Policy for Environmental Education (PNEA), and the DCN EPTNM. It should be noted that, for this research, content analysis was used as a working method, which is a fundamental instrument in the evaluation of documents, allowing identifying the insertion of guidelines defined by public policies on EE in the documents that structure the IFAM/CMC. This method is defined by [Bardin \(2011\)](#) as [...] a set of communication analysis techniques, aiming to obtain, through systematic procedures and objective description of the content of messages, indicators (quantitative or not) that allow the inference of knowledge related to the conditions of production/reception of these messages [...].

The choice was based on the principle that content analysis requires that the discoveries have theoretical relevance and should imply textual comparisons directed, among other aspects, by the researcher's intentionality, markedly intended to confront the institutional documents of the IFAM/CMC and the framework EE legal in Brazil. This comparison is motivated by the similarities and differences between EE approaches in the confronted materials ([Franco, 2008](#)).

In addition to the exploratory phase, described above, the research also had a participatory and interventional bias, if we consider that the content of the analysis was used in parallel as a basis for raising debates in the spaces for dialogue in the Institution. Therefore, we approach action research, considering it as a form of research [...] carried out in close association with an action or with the resolution of a collective problem, in which researchers and participants representing the situation or problem they are involved in a cooperative or participatory way ([Thiollent, 2011](#)).

This method may enable the socialization of data and the exchange of knowledge. One of these moments will be the reformulation of the PPC of the researched course. Data were organized in the form of a field diary and a compilation of documents constructed throughout the research. However, at other times they were also used in socialization or intervention, always based on research data.

3. Results and Discussion

Before proceeding with the data analysis, documentary research was conducted to examine how sustainability is institutionalized in the Institute's regulations, including the Institutional Development Plan and the Pedagogical Plans of the courses under investigation. The following information was collected from this research.

The Institutional Development Plan—PDI 2019-2023 of the Federal Institute of Amazonas (IFAM) states its mission as follows: To promote education, science, and technology for the sustainable development of the Amazon (IFAM, 2019).

The delimitation of the research corpus was decisive for the search for the validity and reliability of the qualitative research, since several careful readings of the research corpus were carried out, here understood as institutional documents of the IFAM, so that the writings of the texts that were finally delimited could be delimited would help to answer the research formulations. This action is in line with the guidelines of Moraes and Galiazzi (2016: p. 38), when they argue that “[...] one does not work with the entire corpus”, considering the need for rigorous reading to find the relationships of interest between the writings and the research object.

Also considering that Strategic objective 15 Consolidate extension courses articulated with teaching, promoting vertical integration, the action provides:

Insertion of themes related to entrepreneurship, sustainable development, science, technology, and technological innovation in the pedagogical projects of the courses (IFAM, 2019). This document that guides IFAM's proposals and actions, in this section, makes it clear how knowledge is conceived, pointing out that:

“[...] the theory that knowledge is constructed from the teacher-student interaction and object of knowledge. IFAM believes that, for that, it is important to realize that knowledge makes sense for the individual when he satisfies his curiosity, his need to understand the world in which he lives. In this sense, we consider some objectives when working with knowledge at the School: criticality, creativity, autonomy and durability” (IFAM, 2019).

Based on the research in the curricular conception, a curriculum associated with the concept of integral formation is understood, based on a discussion about the conception of the world, of society and culture, of human beings, of education and work, based on ethical, political, cognitive principles; that is, in

the formation of a critical subject who knows his rights and duties in the construction of a less unequal society. In this perspective, a curriculum is needed that favors the integration between basic education and professional training, the inseparability between teaching, research and extension, considering, in the same way, sustainability, in view of the social and economic context of the Amazon region in which IFAM operates (IFAM, 2019).

In Figure 3, it is possible to observe that the results obtained are in line with the study of the theoretical framework, since such advantages listed come from the analyzed documents that go beyond economic and social issues, showing that sustainability in civil construction is the way to preserve the environment.

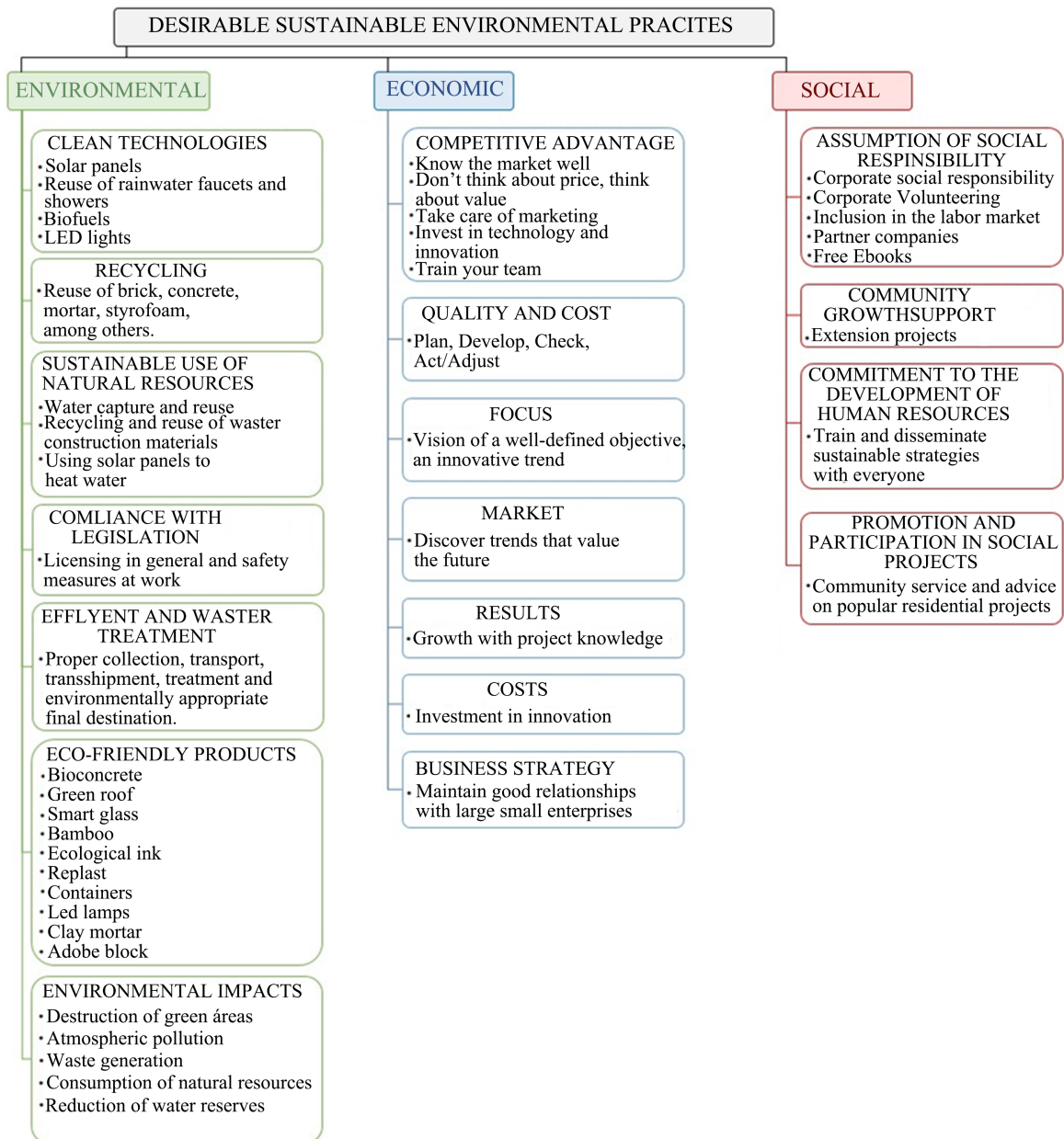


Figure 3. Flowchart of prepositions for the Buildings PPC.

4. Conclusion

When approaching a theme as evident and important as sustainability, we were supported by theories that broaden the perspective of this topic, extending beyond mere environmental education. This approach brings sustainability back into educational practices for the well-being of our children's lives. It is crucial to consider that restructuring the curriculum is both possible and feasible in order to incorporate an education focused on sustainability practices. This approach can lead to a new perspective for students as they enter the workforce.

During the analysis of the Pedagogical Plans, the concept of a technical education that integrates the dimensions of work, science, culture, and technology was identified. The aim is to implement a curriculum that emphasizes the interconnectedness between general education and professional development, thus providing a comprehensive human education.

In the investigation of the teaching plans, it was found that environmental themes, in general, were occasionally addressed but in a contextualized manner with the content. This approach is considered valid as it facilitates students assimilation of the topics.

Despite specific approaches, it was observed that the environmental theme was not limited solely to disciplines in the humanities field but also encompassed disciplines in the exact sciences area. However, it is deemed important to conduct a review of the Pedagogical Project Courses (PPCs) that allow for the effective integration of the environmental theme as a pedagogical practice. As an educational output, a guide addressing environmental issues was compiled, which will serve as a reference for incorporating new content into the PPC of the researched course.

Sustainability in education is a topic of extreme importance, as it involves the formation of citizens who are aware and responsible in relation to the environment and society. Environmental issues discussed in the classroom with the students, awakening from a critical view as citizens and future professionals, active participation in the construction of knowledge, motivation, autonomy, creativity and self-confidence, to pursue an academic career building skills that allow these students to exercise, in the future, leadership both in aspects of personal life and in the professional aspect, with social and environmental responsibility.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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