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Curricular Innovation in Architecture: Academic Training and Building Rehabilitation for the 21st Century

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Abstract: Architecture and Urban Planning education must keep pace with the technical, social, and environmental transformations of the 21st century. Among the fields that best demonstrate this need is the rehabilitation of degraded buildings, a practice that requires precise diagnoses, compatibility between old and new construction systems, heritage preservation, and sustainable solutions. This study combines data analysis from the Brazilian Council of Architecture and Urban Planning (CAU/BR) with student questionnaires, identifying curricular gaps in the teaching of structures and construction pathologies. More than simply identifying deficiencies, it proposes guidelines for an integrated education that articulates theory and practice, encourages interdisciplinarity, and strengthens applied skills. It argues that curricular updating, combined with active methodologies and collaborative practices, is essential to prepare architects capable of intervening with technical quality, heritage sensitivity, and a commitment to sustainability.

Keywords: Integrative Curriculum; Academic Training; Building Rehabilitation; Construction Pathologies.

1. Introduction

In the contemporary context, architecture and urban planning education faces the challenge of addressing increasingly complex professional demands, which require architects not only to possess technical expertise but also to integrate knowledge, engage across disciplines, and propose sustainable solutions. Within this scenario, the rehabilitation of degraded buildings emerges as a key field for evaluating and enhancing academic training, as it demands competencies that combine theory and practice, interdisciplinarity, and sensitivity to heritage values.

In Brazil, studies by the Brazilian Institute of Geography and Statistics (IBGE) and authors specializing in building pathology and maintenance estimate that approximately 30% of the national building stock presents some level of degradation capable of compromising its functional, structural, or aesthetic performance (HELENE, 2003; SILVA; SOUZA, 2008). These findings align with analyses by the Brazilian Council of Architecture and Urbanism (CAU/BR), which highlight the lack of systematic maintenance practices as a factor aggravating the problem. The issue, however, extends beyond the national sphere: reports from international organizations identify the rehabilitation of existing buildings as a global strategic priority, integrating goals of sustainability, heritage preservation, and reduced consumption of natural resources in light of the environmental impact of new construction.

Historically, technical and design disciplines have been taught in a fragmented manner, hindering an understanding of structural and construction systems as intrinsic components of the creative process. Current demands call for integrative curricula that transcend isolated content, incorporating active methodologies and real-world experiences. Rehabilitation projects, which require diagnosing construction pathologies, ensuring compatibility between old and new systems, and safeguarding historical and cultural significance, thus represent a strategic domain for rethinking curricula.

Curriculum development in higher education must reflect not only market demands but also the pedagogical and epistemological principles that support students' critical and reflective development. Integrative, competency-based curricular models are essential, combining theoretical and practical knowledge to prepare future architects to intervene in the built environment with safety, efficiency, and social responsibility. In architecture and urban planning education, the study of construction pathologies—understood as manifestations that compromise the functional, structural, or aesthetic performance of buildings—offers an opportunity to integrate technical and design disciplines. This integration fosters active and applied learning, enabling students to develop both diagnostic capabilities and the ability to propose rehabilitation strategies. Incorporating such approaches into curricula broadens the understanding of construction phenomena while aligning academic training with contemporary demands for preservation, sustainability, and efficiency.

Rehabilitation practice also requires sustained interaction with structural engineering and other technical fields, reinforcing the importance of interdisciplinary communication as a core professional skill. This article therefore examines how academic training can evolve to address current technical, social, and environmental demands, using building rehabilitation as a case study to discuss curriculum update guidelines. Drawing on data from CAU/BR and student feedback, it identifies existing gaps and proposes pathways toward competency-based training that is inclusive and aligned with contemporary architectural practice.

Structural education plays a central role in architectural training, as understanding structural logic extends far beyond applying calculations and quantitative methods. It involves bridging concept and reality, ensuring that works meet sustainability, safety, and aesthetic criteria. The symbiotic relationship between form and structure is both evident and necessary, demanding that structural conception be regarded as an intrinsic part of the design process rather than peripheral knowledge. In this regard, Perrenoud (1999) emphasizes that competency-based training requires an interdisciplinary approach that connects theory and practice, preparing students to address real-world challenges.

2. Methodology and Curricular Approach

The research adopted two complementary measures to ensure a more comprehensive and rigorous analysis of the data. The first consisted of collecting and processing information provided by the Brazilian Council of Architecture and Urbanism (CAU/BR), allowing the identification of patterns and trends in the professional field, based on widely recognized institutional data. This choice is justified by the reliability and comprehensiveness of the information provided by this regulatory body, ensuring a consolidated view of the current landscape of the profession.

The second involved administering questionnaires to students, aiming to capture individual perceptions and direct experiences on the topic under investigation. This qualitative approach allowed us to understand not only the quantitative data obtained by CAU/BR, but also to interpret how students experience and evaluate training in construction pathologies and repair techniques.

At the end of the process, the results of the two methodologies were compared, which made it possible to assess the convergence or divergence of the information obtained. This cross-referencing of data allowed for a more in-depth analysis, ensuring greater robustness of the study's conclusions and providing a more holistic view of the topic.

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2.1 Data collection from the Brazilian Council of Architecture and Urbanism (CAU/BR)

To obtain and analyze data from the Brazilian Council of Architecture and Urbanism (CAU/BR), 27,785 records were collected for the period 2012 to 2024, covering 12 years of operation in the Federal District. The information was organized by neighborhood, administrative region, and type of activity performed, including design, execution, and management. The following map illustrates the administrative regions mapped by CAU/BR.

Figure 1 - Map of the administrative regions of the Federal District mapped by CAU/BR

The map below demonstrates the distribution of administrative regions mapped by CAU/BR in the Federal District, highlighting the survey's territorial diversity and comprehensiveness. The inclusion of different areas of the Federal District is crucial for understanding the varied dynamics of professional practice in Architecture and Urban Planning, as well as reinforcing the representativeness of the data collected within the sample space.

2.1.1 Data processing

Data processing is an essential step in scientific research, enabling the organization, analysis, and interpretation of collected information. According to Creswell (2014), the way data is processed directly impacts the validity and reliability of the results, making it essential to adopt appropriate methods to ensure rigor and consistency in the analysis.

In this study, the processing step followed a set of systematic procedures to transform the collected responses into interpretable information. Categorization and visualization techniques were applied to identify relevant patterns and trends, while statistical tools, as recommended by Hair et al. (2019), were used to ensure greater accuracy in the analysis of the results.

The data from the Brazilian Council of Architecture and Urbanism (CAU/BR), upon receipt, contained duplicate data and inconsistencies that required a refinement process to ensure accuracy. Cleaning and standardization procedures were applied, including removing duplicate records, checking for errors, and organizing the information into a format suitable for analysis. These steps were essential to ensure data quality and reliable interpretation of the results.

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2.2 Questionnaires administered to Structural Systems I and II classes

Regarding the approach of this work, administering questionnaires to the Structural Systems I and II classes, offered in the evening classes at the University of Brasília, represented an essential research strategy, aiming to understand students' perceptions of the curriculum's effectiveness and applicability in the classroom. The questionnaires provided a close approximation to the reality of the training, representing a valid way to investigate perceptions of teaching and rehabilitation. Student opinions are of great importance, as they are the primary recipients of the academic content and can provide valuable information about class dynamics, the learning process, the difficulties faced, and other relevant aspects. The students demonstrated great receptiveness and interest in answering all the questions posed.

The instrument consisted of seven questions, which sought to capture students' opinions on various aspects of Structures teaching. The questions addressed the following topics:

Em sua opinião, a composição curricular do ensino de Estruturas do seu curso está alinhada com os novos mecanismos e ferramentas tecnológicas recentes?

1. Do you perceive any communication difficulties between architects and structural engineers?
2. In your opinion, is the course load for Structures sufficient for a deeper theoretical and practical understanding of the topic?
3. Do you believe that Structures teaching could be better connected to disciplines such as architectural design, sustainability, and construction, expanding architectural practice?
4. Do you believe that integrating theory and practice could foster the development of practical skills in real projects?
5. Is the course curriculum adequate regarding sustainability, including guidance on the use of low-impact resources?
6. Given the issues addressed above, would you suggest any adjustments to your course curriculum?

For the seven questions, each student could choose one of the following options: Adequate, Somewhat Adequate, Inadequate, or Very Adequate. In short, the purpose of the questionnaire was to conduct a detailed analysis of students' perceptions of the curriculum. The responses provided valuable data for identifying potential gaps in teaching and offering suggestions for course improvement.

3. Results and Implications for Academic Training

Given the two proposed analyses, the CAU/BR data collection enabled a quantitative and qualitative analysis of architects' work in the field of structural rehabilitation. In the Federal District, records indicate that only 20% of Technical Responsibility Records (RRTs) signed by architects are linked to structural projects, while 80% refer to conventional architectural projects (Figure 2). Regarding construction execution, structural projects represent only 25% of the records, highlighting a significant gap in architects' work in this segment.

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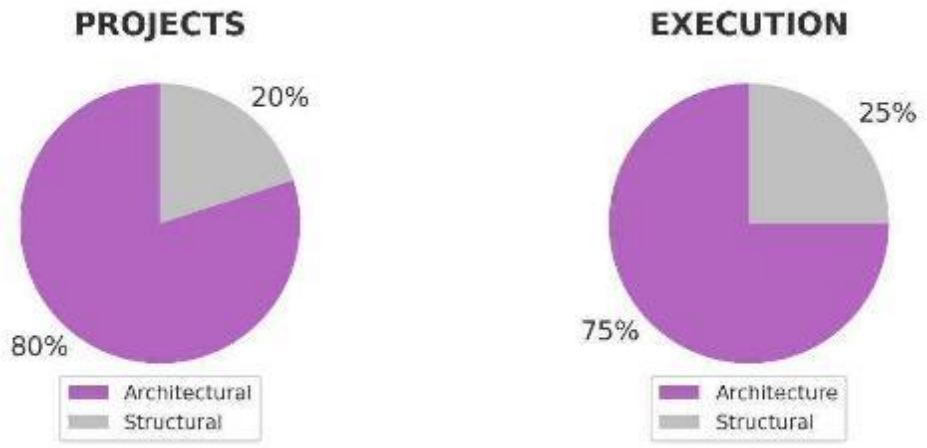

Figure 2 – RRTs related to architectural and structural projects

Analysis of the data provided by the CAU/BR suggests that academic training for architects still does not sufficiently prioritize the teaching of structural systems and rehabilitation techniques, resulting in low demand for this type of professional service.

Furthermore, the survey revealed that the distribution of structural projects in the Federal District is not homogeneous across administrative regions. Areas with higher population density and a history of older buildings concentrate most of the RRTs for structural rehabilitation, indicating a geographically localized demand for such services. This disparity reinforces the need for broader and more specialized training for architects working in diverse urban contexts, taking into account construction specificities and the preservation of built heritage.

The mapping of RRTs for structural projects also shows that most of these services are concentrated among a small number of professionals, which may suggest that only architects with complementary training in structural design and building pathology specialize in this field. This scenario underscores the urgency of curricular reform in Architecture and Urbanism programs, aiming for a more integrated approach between theory and practice in building rehabilitation.

In the context of the questionnaires applied, results indicate that 64% of respondents consider the workload dedicated to structural education insufficient for solid training in the field, while 78% report difficulties in communicating with structural engineers, further highlighting this gap.

Based on the above, for each of the seven questions presented, the distribution of responses across the four available options can be observed, as shown in Table 1.

Table 1 – Results of the Questionnaires Applied

Questionnaires	Adequate	Somewhat adequate	Inadequate	Very adequate	Total
1. Curriculum Composition	14	22	4	2	42
2. Communication between engineers and architects	11	22	5	4	42
3. Workload for Structural Teaching	15	18	5	4	42
4. Expansion in Structural Teaching and connection with other areas	18	2	2	20	42
5. Integration between Theory and Practice	16	1	1	24	42

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6. Structural Sustainability	6	15	17	4	42
7. Need for curriculum readjustment	27	5	2	8	42

For the analysis of the questionnaires and to provide a clearer visualization of the responses, the radar chart proves to be an extremely effective tool. This type of chart allows the simultaneous comparison of multiple variables in a polar format, where each variable is represented by a radial axis. The values obtained for each variable are connected by lines, forming a polygon that facilitates the visualization of relationships among the variables. This chart type is widely used in various fields, such a performance evaluation, product comparison, and competency analysis (Harris, 2001).

The main advantage of the radar chart lies in its ease of visual interpretation, enabling differences and similarities among the analyzed variables to become evident. The way the variables are distributed on the chart makes it clear which aspects stand out and which require attention, providing a quick and intuitive analysis. This representation is particularly useful when identifying patterns and trends in an agile and comprehensible manner. Accordingly, the seven questions are presented in Figure 3.

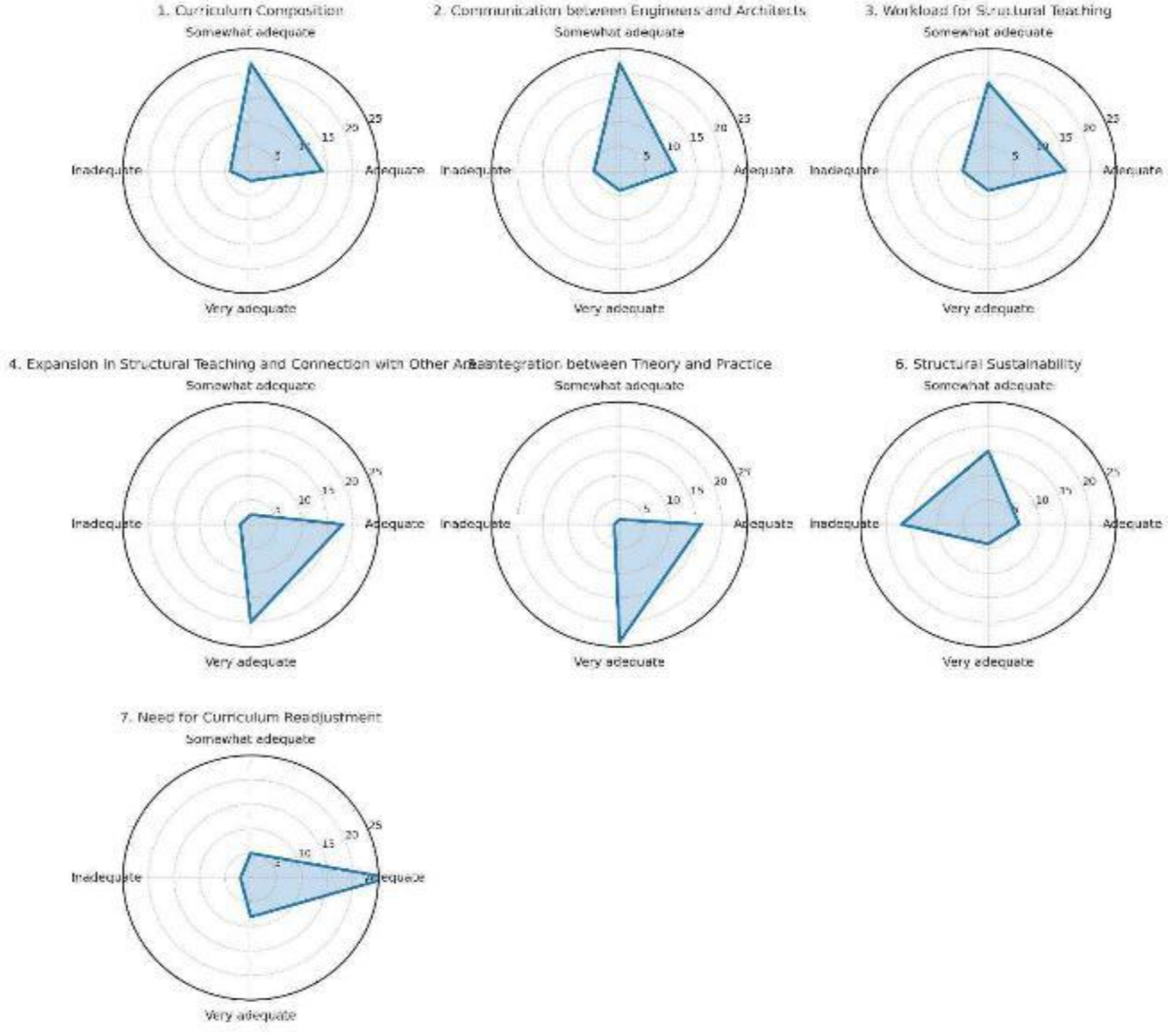

Figure 3 – Radar Charts for the Results Obtained

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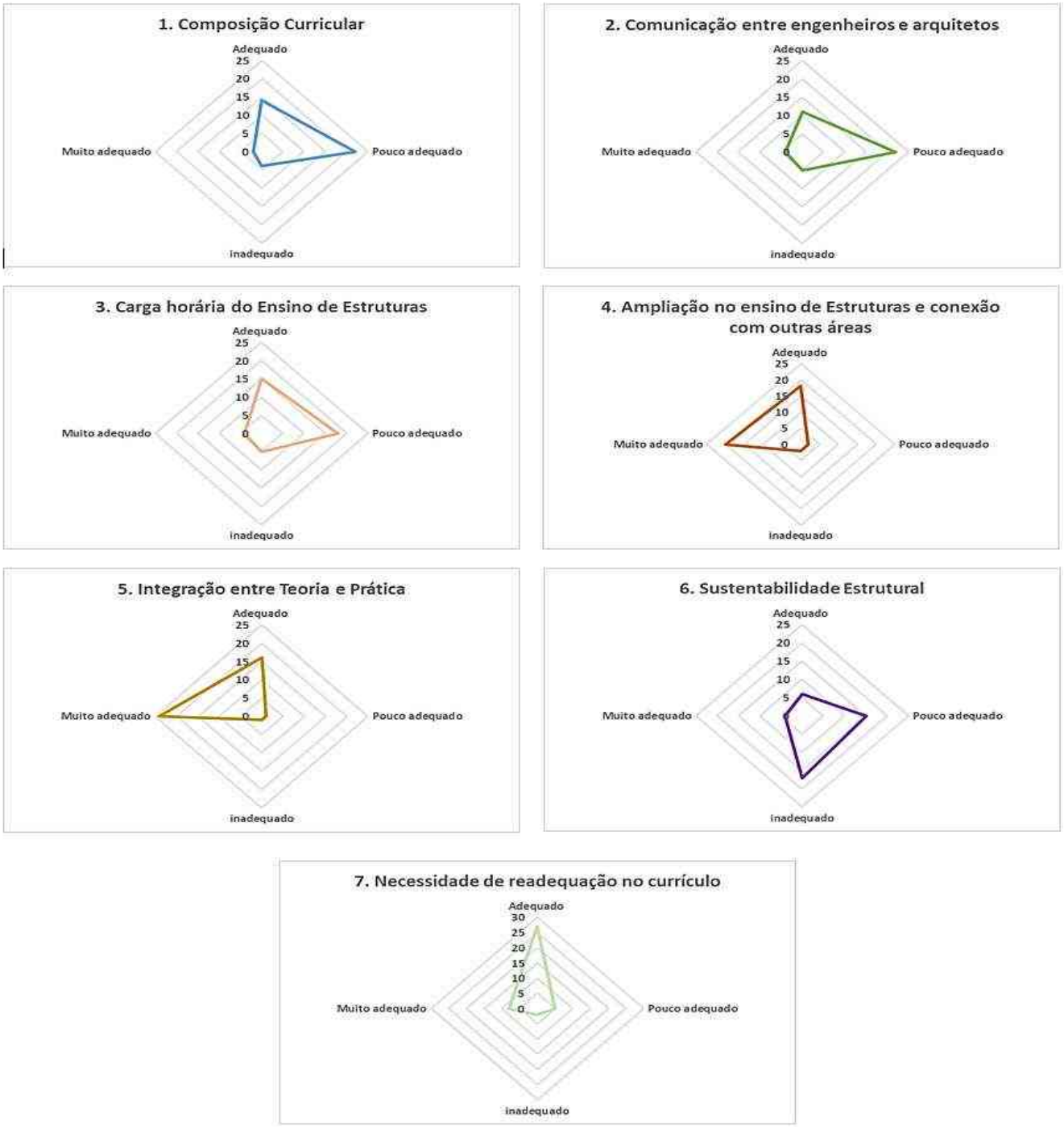

Figure 3 – Radar Charts for the Results Obtained

Following the analysis of student responses, the results reveal important perceptions regarding various aspects of Structural Education within the Architecture program. Concerning the adequacy of the curriculum in relation to technological innovations, many students indicated that, although the curriculum is considered partially aligned with technological changes, adjustments are still needed to more effectively incorporate new tools and advancements in the field.

Regarding communication between architects and structural engineers, a significant portion of students perceive difficulties in the interaction between the two professions, suggesting that the curriculum should include more content aimed at fostering interdisciplinary

collaboration and overcoming such barriers. In terms of the workload dedicated to structural education, many students pointed out that the time allocated is insufficient for deeper and more applied learning of the concepts, highlighting the need to revise the curricular schedule.

As for the connection between structural education and other areas of knowledge, such as architectural design and sustainability, students expressed support for greater integration among these disciplines, which could provide more comprehensive training aligned with the demands of contemporary practice. Student opinions on the integration between theory and practice suggest that many believe the program would be more effective if more real-world projects were combined with theoretical content, enabling a more concrete application of the knowledge acquired.

With respect to building sustainability, students expressed the need for a more in-depth approach to sustainable practices and materials, indicating a gap in the current curriculum. Finally, when asked about potential curriculum adjustments, students suggested significant changes, particularly regarding the incorporation of more interdisciplinary practices. Overall, the results point to a clear student desire for a more integrative curriculum.

4. Proposed Curricular Guidelines

Based on the analysis of CAU/BR data and student perceptions, it is possible to identify a set of objective guidelines for updating the Architecture and Urbanism curriculum, particularly in the field of structural education and building rehabilitation. These recommendations aim to strengthen theory–practice integration, expand interdisciplinarity, and bring academic training closer to the real demands of the market and heritage preservation.

Proposals:

- Increase the workload and depth of courses on structures and rehabilitation to enable greater technical proficiency and the capacity for qualified interventions.
- Introduce interdisciplinary modules involving Architecture and Engineering, fostering the development of a shared technical vocabulary and encouraging collaboration between the fields.
- Implement active methodologies, such as real case studies, technical visits, and practical activities in partnership with public agencies and companies in the sector.
- Integrate sustainability and heritage preservation content into rehabilitation education to align with contemporary environmental and cultural requirements.
- Encourage participation in integrative projects in which students can develop complete solutions, from architectural design to structural coordination, with an emphasis on diagnostics and interventions in existing buildings.

These guidelines, directly derived from the collected data, offer a practical and well-founded path for curricular renewal, strengthening the training of architects capable of responding effectively and innovatively to the technical, social, and environmental challenges of the 21st century.

Conclusion

Academic training in Architecture and Urbanism must go beyond the fragmented transmission of content, incorporating curricular models that articulate theory and practice, promote interdisciplinarity, and stimulate the development of applied competencies. The analysis carried out, based on data from the Brazilian Council of Architecture and Urbanism (CAU/BR) and on students' perceptions, shows that the current curricular structure still does not satisfactorily meet the complex demands of contemporary professional practice.

The rehabilitation of buildings, used in this study as a field of observation, has proven to be a strategic example for understanding the limitations of the current training model and identifying pathways for its improvement. The diagnosis of construction pathologies, structural

compatibility, and interdisciplinary dialogue are essential skills, yet they are underexplored in current curricula, resulting in professionals who are less prepared to work in an integrated and responsible manner.

Revising the curriculum matrix, expanding the workload and depth of content related to rehabilitation and the teaching of structures, is not merely a technical adjustment but a strategic necessity to train architects capable of facing real challenges with precision, heritage sensitivity, and a commitment to sustainability. This entails incorporating active methodologies, practical experiences, and formative actions that strengthen collaboration between fields, particularly between Architecture and Engineering.

Therefore, it is argued that curricular updating should be understood as a priority educational policy, capable of aligning academic training with the demands of the 21st century. By integrating theory, practice, and interdisciplinarity, architectural education will not only fill current gaps but also anticipate future demands, preparing professionals capable of transforming the built environment in a qualified, ethical, and sustainable manner.

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