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METHODOLOGICAL ARCHITECTURE IN ARTIFICIAL INTELLIGENCE-MEDIATED DESIGN, SÃO PAULO, BRAZIL

ARQUITECTURA DEL MÉTODO EN DISEÑO MEDIADO POR INTELIGENCIA ARTIFICIAL, SÃO PAULO, BRASIL

ARQUITETURA DO MÉTODO EM PROJETOS MEDIADOS POR INTELIGÊNCIA ARTIFICIAL, SÃO PAULO, BRASIL

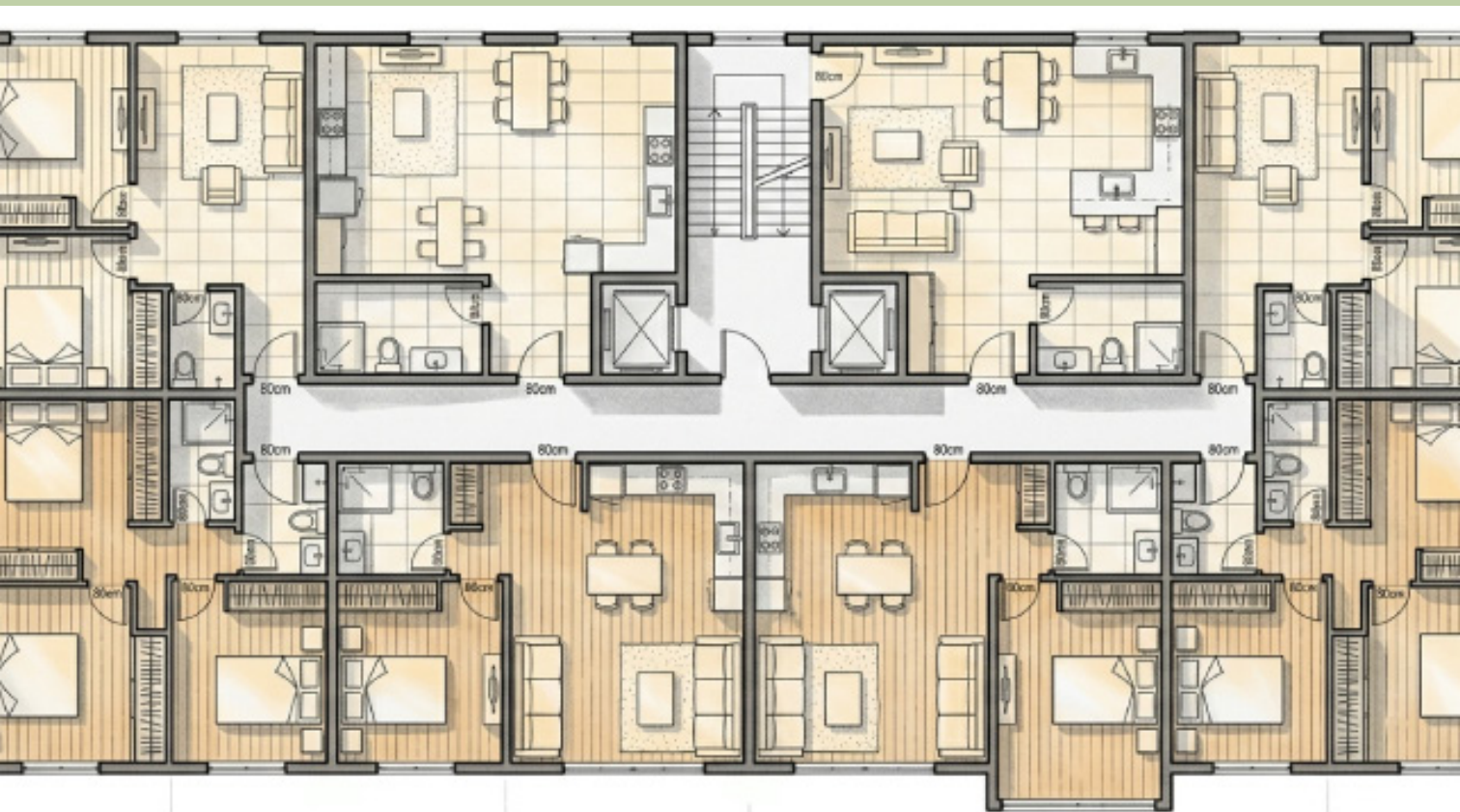


Figure 0. The first results of the exercise. Source: Prepared by the authors.

ABSTRACT

The incorporation of artificial intelligence (AI) into architectural design processes in Latin America has been predominantly instrumental and fragmented, lacking explicit methodological frameworks that articulate design decisions, disciplinary responsibility, and technological mediation. This paper proposes and qualitatively demonstrates a constructive methodological framework to integrate AI as a structural component of design reasoning, organized into three interdependent levels: theoretical, operational, and critical/evaluative. The core of the method is a matrix and an application protocol that relates project phases, cognitive tasks, and functional categories of AI, requiring the declaration of inputs, criteria, operations, and trace records at each intersection. A pilot study in an academic context revealed consistent improvements in process traceability and procedural clarity, strengthening the capacity to justify, audit, and communicate decisions without implying automatic formal optimization. Results indicate that the primary transformation introduced by AI lies not in task automation, but in the reconfiguration of the cognitive power that structures the space of design possibilities. As an original contribution, the study formulates a transferable methodological architecture that, through algorithmic design thinking, governs algorithmic mediation through explicit criteria, verifiable records, and design responsibility, shifting innovation from technical novelty toward the epistemological organization of the process. It concludes that the critical integration of AI in architecture depends on traceable methodological structures capable of making limits, risks, and zones of opacity visible, constituting an internal condition of disciplinary, ethical, and scientific validity in contemporary design practice.

Keywords: BIM, algorithmic governance, design process, decision-making, traceability

RESUMEN

La incorporación de inteligencia artificial (IA) en el proyecto arquitectónico ha sido predominantemente instrumental y fragmentaria en América Latina, al carecer de marcos metodológicos explícitos que articulen decisiones proyectuales, responsabilidad disciplinar y mediación tecnológica. Este artículo propone y demuestra cualitativamente un marco metodológico constructivo para integrar la IA como componente estructural del razonamiento proyectual, organizado en tres niveles interdependientes: teórico, operacional y crítico/evaluativo. El núcleo del método es una matriz y un protocolo de aplicación que relaciona fases del proyecto, tareas cognitivas y categorías funcionales de IA, que exigen la declaración de insumos, criterios, operaciones y registros de traza en cada intersección. La demostración mediante un estudio piloto en contexto académico evidenció mejoras consistentes en la trazabilidad del proceso y en la claridad procedimental, al fortalecer la capacidad de justificar, auditar y comunicar decisiones sin implicar optimización formal automática. Los resultados indican que la principal transformación introducida por la IA no reside en la automatización de tareas, sino en la reconfiguración del poder cognitivo que organiza el espacio de posibilidades del diseño. Como aportación original, el estudio formula una arquitectura del método transferible que, por medio del pensamiento algorítmico de proyecto, gobierna la mediación algorítmica mediante criterios explícitos, registros verificables y responsabilidad proyectual, que desplaza la innovación desde la novedad técnica hacia la organización epistemológica del proceso. Se concluye que la integración crítica de IA en arquitectura depende de estructuras metodológicas trazables capaces de hacer visibles los límites, riesgos y zonas de opacidad, al constituir una condición interna de validez disciplinar, ética y científica del proyecto contemporáneo.

Palabras clave: BIM, gobernanza algorítmica, proceso de proyecto, toma de decisiones, trazabilidad.

RESUMO

A incorporação da inteligência artificial (IA) ao projeto arquitetônico tem sido predominantemente instrumental e fragmentária na América Latina devido à ausência de referenciais metodológicos explícitos que articulem decisões projetuais, responsabilidade disciplinar e mediação tecnológica. Este artigo propõe e demonstra, qualitativamente, um referencial metodológico construtivo para integrar a IA como componente estrutural do raciocínio projetual, organizado em três níveis interdependentes: teórico, operacional e crítico-avaliativo. O núcleo do método consiste em uma matriz e um protocolo de aplicação que relacionam as fases do projeto, as tarefas cognitivas e as categorias funcionais da IA, e exigem a declaração de insumos, critérios, operações e registros de rastreamento em cada interseção. A demonstração, por meio de um estudo piloto em contexto acadêmico, evidenciou melhorias consistentes na rastreabilidade do processo e na clareza procedimental, ao fortalecer a capacidade de justificar, auditar e comunicar decisões, sem implicar otimização formal automática. Os resultados indicam que a principal transformação introduzida pela IA não reside na automação de tarefas, mas na reconfiguração do poder cognitivo que organiza o espaço de possibilidades do projeto. Como contribuição original, o estudo formula uma arquitetura do método transferível que, por meio do pensamento algorítmico de projeto, rege a mediação algorítmica com base em critérios explícitos, registros verificáveis e responsabilidade projetual, deslocando a inovação da novidade técnica para a organização epistemológica do processo. Conclui-se que a integração crítica da IA na arquitetura depende de estruturas metodológicas rastreáveis, capazes de tornar visíveis os limites, os riscos e as zonas de opacidade, uma vez que constituem uma condição interna de validade disciplinar, ética e científica do projeto contemporâneo.

Palavras-chave: BIM, governança algorítmica, processo de projeto, tomada de decisão, rastreabilidade

INTRODUCTION

The incorporation of artificial intelligence (AI)- based tools can reconfigure how architectural projects are conceived, organized, and evaluated in professional and academic contexts (Bernstein, 2025; Coeckelbergh, 2024; Leach, 2025).

From a theoretical, conceptual, and practical digital perspective—without exhaustive pretension, but oriented to the scope of this article's interest—it is proposed to understand the architectural project as a representational process of spatial intentions within parametric and complex informational structures. Unlike studies that treat AI as a set of tools or as a strictly technical problem, this study assumes it as a methodological mediation that reconfigures the feedback loop between data, decisions, and form, and stimulates the development of algorithmic project thinking.

Recent literature has addressed AI in architecture through historical, informational, taxonomic, and technical-operational approaches, focusing on data, digital manufacturing, automation, BIM, or the classification of project processes, especially along the US-Europe axis (Bernstein, 2025; Chaillou, 2022; Leach, 2025).

However, in Latin America, this process has developed — inferentially and in the absence of systematic statistical evidence — in a difficult, fragmented and predominantly experimental way. Dispersed evidence indicates that the technological approach has been promoted largely by academic environments and research networks rather than by consolidated professional practice. In practical terms, this Latin American dynamic has generated some local project behaviors, but with a limited methodological systematization and scarce structured and expanded transfer towards the daily work of the architectural project (Britto, Pereira, & Checcucci, 2025; Donoso, Pardo, & Cabrera Arias, 2025; Felipe & Nome, 2025; Nunes & Tramontano, 2025; Quedas Campoy, 2025; Santos Fischer & Leoni Schmid, 2024).

In these cases, AI is used as a generator of basic formal alternatives, a visualization assistant, or an organizer of preliminary information, without clear articulation of its role within the cognitive, decisional, and ethical phases of the design process. The explicit formulation of methodological frameworks that integrate AI as a constituent part of project reasoning — in a certain sense, as an epistemological approach — is left in the background, or left open to expansion.

Research in the field of applied methodology has pointed out that, without operational and epistemological frameworks, digital tools tend to reinforce practices dependent on external technical logics and implicit criteria not controlled by the designer, which limits their professional value (Bonilla-Vallejo & Tramontano, 2024; Jones, Gold, & Claxton, 2023; Kasanen, Lukka, & Siitonen, 1993; Nunes & Tramontano, 2025; Sarzosa Soto, 2025). In this context, AI risks remaining an operational black box or

opaque workflows, rather than a reflective means of producing design knowledge.

The central problem addressed by this research lies in the absence of explicit methodological structures, together with technological frameworks (namely parameters, decisions, and representations), within the Latin American context, that allow understanding and operating AI as an integrated project instrument and as an epistemological platform (cognitive and ethical).

The objective is to propose and demonstrate a Latin American methodological framework qualitatively, in the form of a matrix and an application protocol, to integrate AI into the project process, aimed at the academic and professional communities, epistemologically articulated in three dimensions: theoretical, operational, and critical/evaluative — which will be outlined later in this article.

In pioneering approaches to informational modeling, the project process was understood as the construction of symbolic models that integrate form, function, and behavior under a single logic, shifting the emphasis from the final object to the process as a system of interdependent decisions (Mitchell, 2009).

The increase in the computerization of design implies a transformation of the digital formalization of project reasoning into explicit informational structures. Digital environments, databases, and parametric systems extend simultaneous operation over multiple layers. They operate as a network of metadata, rules, and relationships that organize the transit between program, form, materiality, and performance, particularly in Building Information Modeling (BIM) and parametric modeling, where each formal decision is associated with informational attributes and internal dependencies (Bonilla-Vallejo & Tramontano, 2024; Eastman et al., 2008; Nunes & Tramontano, 2025).

Thus, the architectural project is not limited to graphic representation as a final product, but also includes conceptual decision-making processes, technical parameters, logical relationships, and systematic reviews (Bernstein, 2025; Coeckelbergh, 2024; Leach, 2025). To project, in this framework, is to structure information: to declare, organize, and transform data into coherent spatial configurations.

AI is incorporated as a new mediation, especially interesting for the non-computer science specialist architect: it not only generates alternatives easily - (from friendly interfaces)- but also processes, correlates, and reorganizes large volumes of data, which intensifies the informational character of the project, without replacing architectural reasoning (Bernstein, 2025; Bonilla-Vallejo & Tramontano, 2024;

THEORETICAL FRAMEWORK

Coeckelbergh, 2024; Leach, 2025).

Based on complex thinking (Castro, 2025; Morin, 2005), the project is configured as a network of technical, cognitive, and social interdependencies, irreducible to predictable variables, crossed by uncertainty and multiple causalities. In this sense, AI constitutes a multidimensional active space for the conditions of design possibility.

Algorithmic systems, based on statistical models and data structures that are not always transparent (Bernstein, 2025; Coeckelbergh, 2024; Leach, 2025), introduce technical mediation, correlation, and prediction processes. AI (algorithmic and parametric) operates as an active partner of the complex design system - not as an autonomous subject - by participating in feedback loops between data, decisions, and formal results; it accelerates generation, expands exploration, but can reduce critical capacity if it is not integrated into an explicit methodological framework (Bonilla-Vallejo & Tramontano, 2024).

In this framework, Latin America constitutes a theoretical and methodological opportunity: academic tradition, regional networks, and experience in contexts of limited resources that favor critical approaches to technology, by incorporating AI as an object of methodological and pedagogical project reflection (Britto et al., 2025; Donoso et al., 2025; Felipe & Nome, 2025; Santos Fischer & Leoni Schmid, 2024).

The structured incorporation of AI - as it has been presented from the theoretical and operational dimensions - can reconfigure the distribution of cognitive power in design, so the methodological discussion should include algorithmic governance (Coeckelbergh, 2024).

Therefore, in line with the article's objective, the methodological structure of the critical/evaluative dimension is organized into verification criteria, trace records, ethical rules of use, and critical review and audit. Regulatory and qualitative coherence, tectonic consistency, and contextual adequacy are also sought.

In short, integrating AI into architecture requires moving from a paradigm of instrumental adoption - obeying opaque technical infrastructures, statistical correlations, and external regulatory patterns as implicit authority-, or from a simple delimitation of tasks, to one of procedural responsibility: innovation depends less on automating than on building methodological architectures that make the relationship between data, criteria, and decisions traceable.

Therefore, the central methodological issue is how AI is integrated into the process's complex decision network. The scientific relevance lies in the method's architecture and in the importance of developing algorithmic project thinking.

The research is applied and methodological in nature, based on the tradition of constructive research - where the artifact (methods, models, or structures) constitutes a scientific result subject to development, demonstration, and systematic evaluation for its internal coherence (Jones et al., 2023; Kasanen et al., 1993)— and articulated by analytical generalization (Yin, 2015). Its applicability lies in its ability to generate transferable knowledge.

To ensure evaluability, the study is initially presented in three questions: (i) to what extent the phases–tasks–AI matrix increases the traceability of decisions against conventional flows; (ii) whether the framework improves procedural clarity by making actions, criteria and justifications explicit; and (iii) what limits and risks emerge when integrating AI as methodological mediation.

The methodological artifact (matrix and protocol) is organized in three interdependent dimensions. The theoretical dimension frames the project as an informational structure and a complex process that incorporates notions of feedback and technical mediation. The operational dimension translates these principles into procedures that relate project phases, cognitive tasks, and functional categories of AI. These two dimensions constitute the core of the matrix. The critical/evaluative dimension, which acts as a cortex over the others, defines qualitative criteria that enable evaluation and auditing of the process — an algorithmic governance relationship.

From this organization, the matrix ceases to operate solely as an implementation instrument and assumes an epistemological and strategic role within the project process. The artifact is not limited to systematizing operations, but establishes a structuring support for design reasoning mediated by data and algorithms.

The framework was demonstrated through an extended pilot study in an academic context, developed as a Graduation Final Project (TFG) course at Universidade São Judas Tadeu in São Paulo, Brazil, over four consecutive semesters between 2024 and 2025. Forty-six students, organized into six teams, participated and worked with three residential typologies at small and medium scales, including a compact single-family house, low-rise collective housing, and a social housing complex. In all cases, the projects were developed only within the scope of the Preliminary Study, covering context and regulations, definition of the needs program, volumetric exploration and preliminary organization (surroundings, circulations and accesses), initial definition of the structural system, enclosures and basic carpentry, and initial environmental assessments, without advancing to the executive project, technical documentation or complete interdisciplinary compatibilization.

The study was conceived as a qualitative methodological demonstration aimed at observing the framework's operability across different educational moments, the capacity for systematic recording of decisions, the coherence among project intention, procedure, and result, and the explicit identification of limits and risks. These processes will be analyzed by analog transfer to the professional field. Small and medium-sized architectural firms tend to work more with these

METHODOLOGY

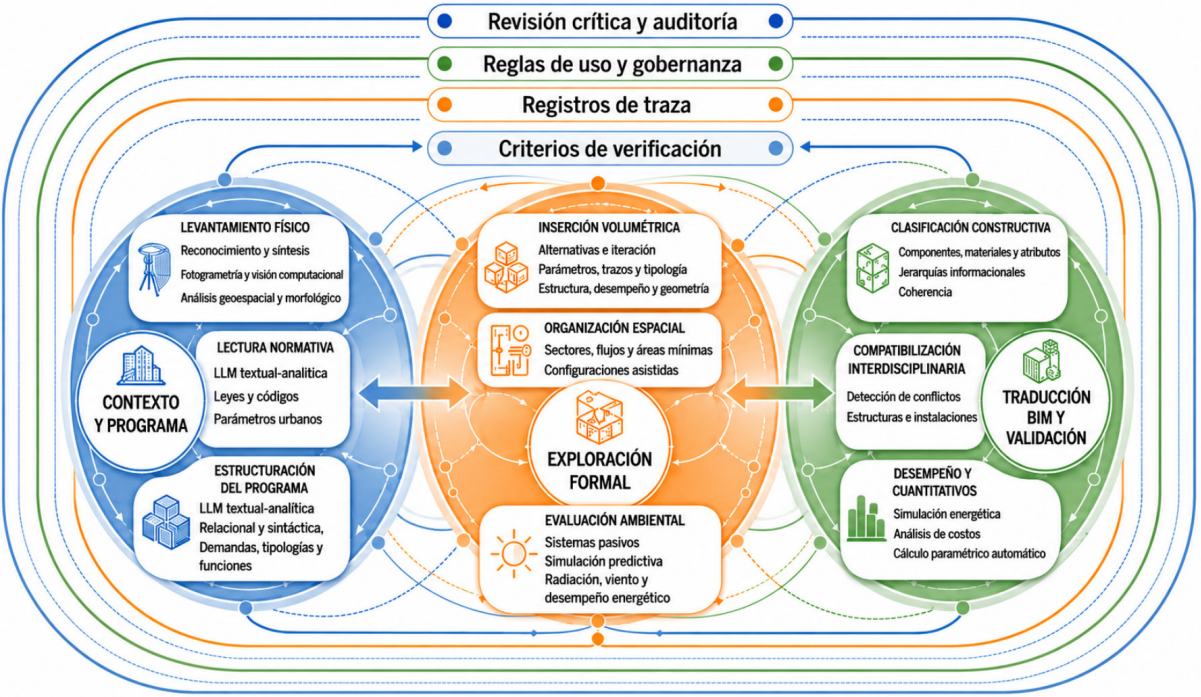


Figure 1. Matrix. Source: Prepared by the authors.

residential typologies than with larger scales. In addition, they face conditions comparable to those in academic contexts, including fragmented tools, time constraints, and the need for continuity between phases. The matrix can serve as a mechanism to reduce operational dispersion and as strategic support for documenting decisions in front of teams, clients, and regulatory frameworks.

The protocol was organized in five steps: presentation of the matrix and its criteria; application by project phase; registration of inputs, prompts, parameters, versions, and decisions; qualitative comparison with equivalent exercises without the structured use of the matrix; and teaching review using rubrics derived from the framework. The latter procedure is fundamental to the validations and incorporates the practical experience of the teachers involved, but was especially addressed by the methodological, theoretical, and conceptual references on the architectural design process developed through composition/modularity (Bernstein, 2025; Chaillou, 2022). The analysis was carried out by directed coding and considered four qualitative criteria: procedural clarity of the decisions, project consistency, identification of risks/opacities, and pedagogical feasibility. The evidence was triangulated between logs, matrices, decision diagrams, final deliverables, and critical reflections. Validation, therefore, is understood as an analytical demonstration of internal consistency and situated applicability, not as a statistical extrapolation.

DEVELOPMENT

In this section, the matrix configuration and the application protocol are defined. Up to this point, the configurations of the three dimensions

of the proposed methodological artifact have been presented. The critical/ evaluative and peripheral (cortex) comprise four layers. Although it is extremely relevant, their graphic organization is facilitated in the matrix. On the other hand, the theoretical and operational dimensions, which form the core of the matrix, have many internal elements, which tend to make graphic organization difficult. Therefore, they should be related to the cognitive and design tasks of the Preliminary Study and oriented by the typology under study. Thus, the theoretical and operational core is subdivided into three main phases, each with specific cognitive tasks, connected in a complex network: Context and Program (Physical Survey; Regulatory Reading; Program Structuring); Formal Exploration (Volumetric Insertion; Spatial Organization; Environmental Evaluation); and BIM Translation and Validation (Constructive Classification; Interdisciplinary Compatibilization; Performance and Quantitative). Their respective internal elements are reorganized following this design approach. The matrix is presented below (Figure 1):

The application protocol is started. In the Context and Program phase, specifically in the cognitive task of Physical Surveying, artificial intelligence serves as a mediator of recognition and synthesis. Photogrammetry, computer vision, and geospatial analysis systems reconstruct the material condition of the place from topographic, environmental, and imagery data. The operation consists of producing verifiable spatial models and comparable morphological readings. In Regulatory Reading, linguistic AI models - of the Large Language Model (LLM) type extract, classify, and synthesize rules from urban laws, codes, and parameters. The operation is textual-analytical. In the structuring of the Program, the AI, also a textual-analytical LLM, organizes demands, typological references, and functional relationships. The operation is relational and synthetic - oriented by criteria stipulated by the clients, users, or the title of the academic exercise, in this case.

The Formal Exploration phase is associated with the controlled expansion of the project's space of possibilities. AI operates as a system of regulated generation, systematic comparison, and analytical simulation, without determining the final form. Based on this approach, its specific operational functionalities are of less interest, and its role as a mediator in architectural decision-making is more important. In the cognitive task of Volumetric Insertion, without presupposing a single linear sequence, parametric models and generative systems produce alternatives based on legal, programmatic parameters, terrain limits and typological criteria - which would depend on the completion of the previous stage, but which do not end there, since they can also be developed based on structural, environmental or performance parameters, as well as geometric logics, through iterative operations of variation and adjustment. In Spatial Organization, generative tools distribute sectors, flows, and minimal areas through assisted configurations. In Environmental Assessment, analytical systems simulate solar radiation, wind, and energy performance through predictive operations.

The BIM Translation and Validation phase integrates moments of information formalization and auditable project control, in which the architect adopts a

linear sequence that follows the previously described phases. However, if the design process starts on the BIM platform itself and in validation environments, no translation is configured; rather, it begins with algorithmic-parametric thinking based on geometric attributes linked to the construction industry and computational simulation systems. It is entirely plausible, especially with the support of artificial intelligence and parameterization, to start a project from a formal study or even from a system performance evaluation within the BIM platform. In any of these scenarios, AI and the associated systems operate as an algorithmic-parametric semantic structure, an inconsistency detection mechanism, and a verifiable automated calculation support.

It is important to note that the artificial intelligence tools relevant to the Formal Exploration phase have interchangeable applications and extensions with the BIM platform. Thus, the instrumental transition between the last two mentioned fields is unnecessary.

In the cognitive task of constructive classification, AI-assisted BIM environments operationally organize components, materials, and attributes into coherent informational hierarchies. In interdisciplinary compatibilization, conflict detection algorithms compare architectural, structural, and facility models using systematic validation procedures. In performance and quantitative verification, the energy simulation and cost analysis systems are applied to the BIM model through automated parametric calculations.

Next, the protocol relevant to the critical/evaluative dimension is organized. The verification criteria constitute the first inner layer of the AI's critical control cortex in the Architectural Preliminary Study. They articulate geometric precision, coherence with the surveyed reality, and data consistency with respect to regulatory, legal, and programmatic compliance. AI helps verify spatial, functional, circulatory, and proportional relationships and also supports the evaluation of contextual relevance, comfort, efficiency, and technical and economic feasibility. It is an instance of qualified filtering of the alternatives, oriented by normative documentation, occupancy parameters, and project adequacy criteria.

The trace records are the documentary layer that makes the process traceable, comparable, and auditable. Point clouds, analytical maps, documented formal versions, change history, programmatic matrices, metric reports, geometry collision reports, comparative diagrams, and a series of alternatives are included. These records allow the reconstruction of the decision path, explicit iterative review cycles, and the preservation of the memory of parameters, queries, simulations, and choices made. The AI stops operating as an opaque instance of generation and starts integrating a critical documentation system of the project transformations.

The ethical rules of use define the epistemological limits of algorithmic mediation in the Preliminary Study. They demand transparency of sources, reliability checks, information standardization, methodological clarity in simulations, and the explicit articulation of the parameters mobilized. They delimit the scope of automatic generation, reaffirming that algorithmic interpretation must be used critically and subordinated to human design judgment. The architect's authorship,



Figure 2. The first results of the exercise. Source: Prepared by the authors.

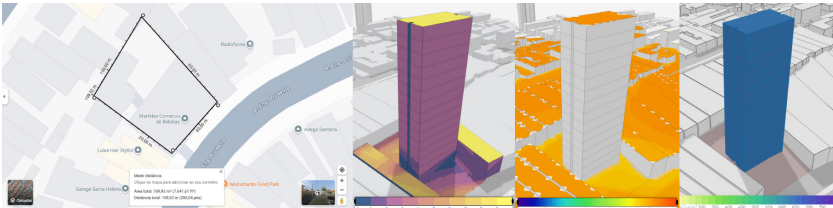
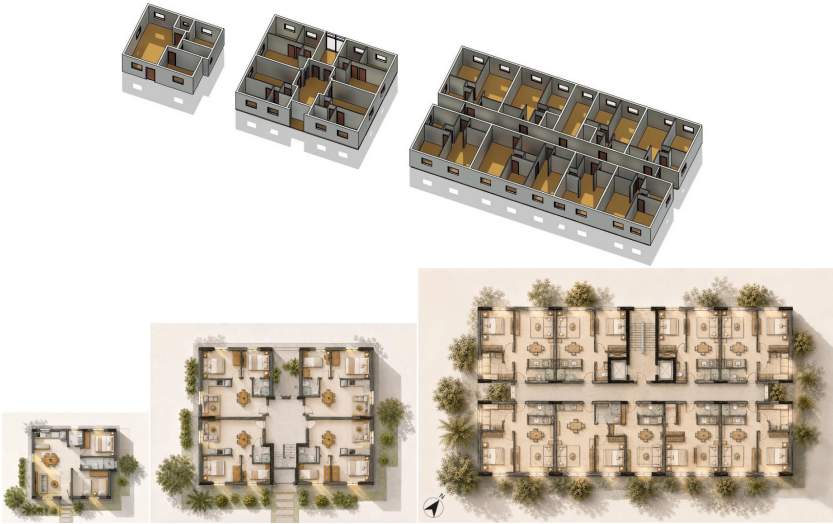


Figure 3. Results of the exercise with the matrix and the protocol. Source: Prepared by the authors.



decision-making responsibility, and technical responsibility are preserved, especially in the face of socio-environmental, legal, and contextual implications.

The critical review and audit constitute the layer of reflective validation for AI-mediated results. Its role is to verify the survey's consistency, the model's semantic integrity, the legal validity of the solutions, the calculation conditions, and the correspondence between initial parameters and achieved results. This review must be argued by the architect, open to contrast with clients, users, or academic instances, and complemented by multidisciplinary evaluation. In this way, the audit is not reduced to the automatic verification of performance, but operates as a qualitative exercise in judgment, cross-validation, and design accountability.

Pilot study as a qualitative demonstration

The first round of exercises was performed without the matrix and the protocol. The students were asked to develop typologies for a piece of land in São Paulo's Cambuci neighborhood, as well as for its legal and regulatory framework. The results are presented below (Figure 2):

Subsequently, the matrix and the protocol were introduced. The results presented below (Figure 3) were developed under the same conditions, but with a more robust architectural approach and an algorithmic project mindset.

DISCUSSION

The graphical results are important, but in the evaluation, it was not sought to measure productivity, technical performance, formal superiority, or constructive impact; rather, the aim was to verify whether the matrix and the protocol allowed making the relationships among inputs, operations, criteria, and decisions explicit with greater precision.

In Figure 2, it is evident that the spatial arrangements are inadequate to ensure activities and circulation can take place. Certain legal and regulatory issues were not addressed. The dimensioning of structural systems is not included. In the buildings (low-rise collective housing and a social housing complex), some access to the housing units is mistakenly occurring through the bathrooms; in some cases, access is impossible. The bioclimatic study across all options is deficient, meaning that in the three typologies, a facade is entirely south-facing, i.e., without solar incidence throughout the year, in rooms where people spend a lot of time.

Figure 3 shows, in the upper part and from left to right, the location map and three studies: solar, microclimate, and incorporated carbon; in the center of the image, the modeling in the BIM interface, where the data of the studies were verified; and below, the floor plans of the three typologies. The results indicate that the problems above were solved. The studies enabled optimization of the structure from an economy-of-means perspective, with direct implications for the carbon footprint and the cost-benefit ratio. In addition, in the low-rise collective housing, a storage area was included on the ground floor; and in the social complex, there were shafts for the passage of uprights, which reveal attention to the installations. Therefore, there was not only problem-solving, but also the advancement of project thinking.

The pilot allowed the identification of four recurring patterns, important for the internal verification of the investigation protocols:

- P1. Early formalization of restrictions: Regulatory, environmental, and programmatic restrictions are declared from different starting points and reappear as tectonic selection and discard criteria in other instances of the process.
- P2. Stabilization of parameters and iterations: Induces a registered iteration logic (purpose of the change, adjusted parameter, and verification criterion), avoiding *ad hoc* modifications.
- P3. Explicit design judgment: The selection of alternatives is based on declared criteria (functional, environmental, compositional, and contextual), which make the decision reviewable.
- P4. Visibility of opacity and dependencies: The method requires declaring what is delegated to the AI, what is manually corrected, and what is rejected due to bias or contextual mismatch.

Observed dimension	Flow without the matrix (instrumental use of AI)	Flow with matrix (methodological use of AI)	Evidence recorded in the pilot
Declaration of inputs	Dispersed inputs; regulatory and environmental restrictions appear late or partially	Inputs declared at the beginning by phase; explicit and prioritized restrictions	Logs and matrices completed with a list of inputs, restrictions and sources
Generation/ analysis parameters	Prompts and unstable configurations; unjustified changes	Declared parameters; changes recorded as iterations with explicit purpose	Iteration log (version, parameter, purpose of change)
Selection criteria	Selection based on implicit preferences or better appearance	Selection based on declared criteria (functional, environmental, compositional, regulatory)	Comparative tables and discard/acceptance annotations by criterion
Continuity between phases	Jumps between contextual reading, preliminary project and technical consolidation	Continuity reinforced by traces: Initial decisions reappear as constraints and attributes	Decision diagrams and links between phases in matrices
Verification/ control	Ad hoc verification; little critical review of biases or local adequacy	Explicit verification: Contextual and regulatory consistency checks; identification of biases	Critical reflections and risk lists/opacity zones by phase
Algorithmic opacity	Non-thematic opacity; results treated as neutral suggestions	Registered opacity: What is delegated, what is manually corrected, what is rejected	Black box sections and dependencies in logs; justifications
Documentation for communication	Reconstructed later narrative; difficult to explain why an alternative was chosen	Narrative derived from traces; communicable decisions to teacher, team and client	Presentations and deliveries with decision sequence supported by trace

Table I extends the explanation of the differences observed between workflows without structured use of the matrix and those with methodological use of the framework, based on evidence from the pilot study. The previously described patterns are summarized using these differences.

Table 1. Evidence from the pilot study: Qualitative comparison with and without matrix. Source: Prepared by the authors.

The results support a central thesis: Artificial intelligence does not transform the architectural project by automating tasks, but by reconfiguring the cognitive power that organizes the space of design possibilities. The study's scientific contribution lies in the method's architecture and the project's algorithmic thinking, not in instrumental novelty.

From the constructive research, a structure was proposed and demonstrated that makes the algorithmic mediation observable, debatable, and governable - between intention, technical mediation, and form -as an active dimension within the project process with the capacity to produce transferable knowledge, since the proposal and validation lie in the epistemological field, not in a specific environment. This condition was evidenced by the four identified patterns, even though they do not

CONCLUSIONS

constitute a statistical sample and cannot be weighed directly in the professional field.

The qualitative evidence from the pilot study indicates consistent improvements in procedural clarity and in the explanation of selection criteria, strengthening the argumentative capacity against algorithmic-parametric systems without implying automatic formal superiority. At this point, the value of the framework is measured by the traceability and auditability of the project reasoning.

In the Latin American context, given the aforementioned common characteristics, the matrix and the protocol operate as a methodological denaturalization device by requiring the explicit declaration of context, norm, tectonic criterion, and decisional justification in each phase, by shifting the discussion from technical efficiency to the epistemological, even ethical, responsibility of the project. In this sense, algorithmic mediation shapes the definition of what is possible in design by determining which procedural alternatives emerge as viable and which remain invisible, thereby allowing the architect to assume explicit responsibility for the criteria that guide the delegation of decisions to automated systems.

In concrete terms, the matrix requires, for example, that a volumetric alternative generated by AI indicate which urban planning restrictions were used, which environmental parameters guided the selection, which option was discarded, and why. Similarly, in a residential program, it forces recording whether the AI barely reorganized demands, whether it suggested functional relationships, or whether it produced solutions incompatible with regulations, context, or design intent. Thus, it shifts from operating solely on abstract concepts to operating through procedures for verification, documentation, comparison, and discarding.

From a pedagogical perspective, the proposed structure reinforces understanding the project as a cognitive decision-making process. The explanation of traces allows us to reflect critically on biases, limits, and areas of opacity of AI. In this way, technology ceases to operate as an apparently neutral resource and becomes a generative and analytical object within the training process itself.

The limitations of the study arise from its qualitative, academic, and demonstrative nature. The pilot study depended on internal teacher validations. External replicability requires testing in other courses, professional offices, building scales, and later stages of the project and construction. It also demands comparable metrics, such as decision time, number of justified iterations, regulatory consistency, parameter stability, and documentation quality. In the studies carried out here, the decisions were developed within one academic semester, which lasts between four and five months. The average number of justified iterations to meet the aforementioned regulatory, parametric, and documentation requirements was approximately equal to the number of weeks in the period: about

eighteen. Comparing these variables constitutes the framework's future agenda.

In continuity with this, future developments focus on its integration with heritage modeling environments, digital urbanism, and advanced educational platforms, expanding the scale of application from the building to more complex territorial and cultural systems. In the pedagogical field, the method can serve as a basis for curricular structures that integrate critical thinking, technological mediation, and project practice from the early stages of training, promoting situated and responsible algorithmic literacy.

From a disciplinary point of view, the study's contribution tends to reconfigure the relationship between shape, norm, context, and decision in the contemporary architectural project, shifting the focus from formal production to the methodological dimension of the process, mediated by algorithmic project thinking. In summary, the proposed innovation depends on the development of transferable methodological architectures that govern technological mediation with transparency and a sense of project responsibility.

Conceptualization, C.Q.C., C.I.; Data curation, C.Q.C., C.I.; Formal analysis, C.Q.C.; Acquisition of financing; Research, C.Q.C.; Methodology, C.Q.C.; Project management, C.Q.C.; Resources, C.I.; Software, C.I.; Supervision, C.Q.C.; Validation, C.Q.C.; Visualization, C.I.; Writing - original draft, C.I.; Writing - revision and editing, C.I.

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