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Prof. Dr. Gökçen Firdevs YÜCEL CAYMAZ

The Vertical City Studio: A Pedagogical Research Design for Integrating Vertical City Concepts into Fourth-Year Architectural Education at Khon Kaen University*

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Abstract: This study presents a three-year longitudinal pedagogical research design examining the integration of "Vertical City" studio projects into the fourth-year architectural curriculum at Khon Kaen University (KKU), Thailand. The research involved 12 students per cohort enrolled in a design studio of five studio hours per week, utilizing Khon Kaen Municipality and its surrounding non-urban periphery as the primary site contexts. Unlike conventional high-rise typologies or mixed-use towers, the "Vertical City" is defined here as a self-contained, multi-scalar urban ecosystem vertically organized to integrate residential, productive, ecological, and infrastructural systems within a single structural framework. The research employed a structured evaluation matrix assessing four dimensions: (1) creative thinking, (2) systems thinking, (3) engineering integration, and (4) structural feasibility, scored on a four-point rubric applied consistently across three cohorts through formal review panels. Results indicate progressive competency development across all four dimensions, with creative thinking and systems thinking demonstrating the most significant gains, while structural feasibility remained the least developed domain throughout all three cycles. The findings suggest that iterative thematic studios foster interdisciplinary design capability; however, structural realism and engineering collaboration require deliberate curricular reinforcement. This study contributes to the body of knowledge on speculative design pedagogy in Southeast Asian architectural education by proposing a replicable, evidence-based studio model that balances imaginative exploration with technical rigor.

Keywords: Architectural Pedagogy, Vertical City Design, Sustainable Urbanism, Design Studio Education, Longitudinal Studio Research.

Dikey Şehir Stüdyosu: Khon Kaen Üniversitesi'nde Dördüncü Sınıf Mimarlık Eğitimine Dikey Şehir Kavramlarını Entegre Etmek İçin Pedagojik Bir Araştırma Tasarımı

Özet: Bu çalışma, Tayland'daki Khon Kaen Üniversitesi'nde (KKU) dördüncü sınıf mimarlık müfredatına "Dikey Şehir" stüdyo projelerinin entegrasyonunu inceleyen, üç yıllık uzunlamasına bir pedagojik araştırma tasarımını sunmaktadır. Araştırmaya, haftada beş saatlik bir tasarım stüdyosuna kayıtlı her kohorttan 12 öğrenci katılmıştır; çalışma, Khon Kaen Belediyesi ve çevresindeki kentsel olmayan alanları birincil saha bağlamı olarak kullanmıştır. Geleneksel yüksek katlı tipolojiler veya karma kullanımlı kulelerden farklı olarak, "Dikey Şehir" burada, konut, üretim, ekoloji ve altyapı sistemlerini tek bir yapısal çerçeve içinde bütünleştirmek üzere dikey olarak organize edilmiş, kendi kendine yeten, çok ölçekli bir kentsel ekosistem olarak tanımlanmaktadır. Araştırmada, dört boyutu değerlendiren yapılandırılmış bir değerlendirme matrisi kullanılmıştır: (1) yaratıcı düşünme, (2) sistemsel düşünme, (3) mühendislik entegrasyonu ve (4) yapısal uygulanabilirlik; bu boyutlar, resmi değerlendirme panelleri aracılığıyla üç kohort boyunca tutarlı bir şekilde uygulanan dört puanlık bir derecelendirme ölçeğine göre puanlanmıştır.

* This article was presented as a paper at the ICCAUA 2026 Conference.

Sonuçlar, dört boyutun tamamında kademeli bir yetkinlik gelişimi olduğunu göstermektedir; yaratıcı düşünme ve sistemsel düşünme alanlarında en önemli ilerlemeler kaydedilirken, yapısal uygulanabilirlik üç döngü boyunca en az gelişme gösteren alan olarak kalmıştır. Bulgular, yinelemeli tematik stüdyoların disiplinlerarası tasarım yeteneğini geliştirdiğini ortaya koymaktadır; ancak yapısal gerçekçilik ve mühendislik işbirliği, müfredatın bilinçli bir şekilde güçlendirilmesini gerektirmektedir. Bu çalışma, hayal gücüyle yapılan keşif ile teknik titizliği dengeleyen, tekrarlanabilir ve kanıta dayalı bir stüdyo modeli önererek, Güneydoğu Asya mimarlık eğitimindeki spekülatif tasarım pedagojisi alanındaki bilgi birikimine katkıda bulunmaktadır.

Anahtar Kelimeler: Mimari Pedagoji, Dikey Şehir Tasarımı, Sürdürülebilir Şehircilik, Tasarım Stüdyosu Eğitimi, Boylamsal Stüdyo Araştırması.

1.INTRODUCTION

The accelerating pace of global urbanization has emerged as one of the defining challenges of the twenty-first century. According to recent projections, more than 68% of the world's population is expected to reside in urban areas by 2050 [1], placing unprecedented demands on urban infrastructure, ecological systems, and spatial governance. Within this context, architectural education faces a dual imperative: to equip graduates with technically rigorous professional competencies while simultaneously cultivating the visionary and speculative capacities required to reimagine urban futures beyond conventional paradigms [2, 3].

Historically, conventional architectural curricula in Southeast Asia have prioritized pragmatic training aligned with professional licensing requirements, often at the expense of speculative, systems-level design thinking[4, 5]. This pedagogical orientation tends to produce competent practitioners capable of replicating established typologies but less prepared to confront complex, cross-scalar urban problems that demand interdisciplinary synthesis [6]. The resulting gap between technical proficiency and visionary capacity represents a significant challenge for programs seeking to prepare architects for roles that extend beyond conventional building design into urban strategy, environmental stewardship, and social innovation.

The concept of the "Vertical City" offers a productive framework for addressing this pedagogical gap. Distinguished from conventional high-rise buildings, mixed-use towers, or isolated megastructures, the Vertical City is theorized in this study as a self-contained urban ecosystem that vertically integrates residential, productive, ecological, and infrastructural systems within a coherent structural and spatial logic. This definition, elaborated in the theoretical framework section, draws on and critically extends the metabolist urban visions of the 1960s [7], contemporary proposals for ecological urbanism [8], and speculative competition platforms such as eVolo and Vertical Cities Asia [9, 10].

Introducing the Vertical City as a recurring studio theme at KKU responds to two specific institutional conditions. First, the fourth-year studio structure at KKU allows students to elect specialized thematic studios aligned with faculty research, creating conditions for sustained, iterative engagement with complex design problems. Second, the regional context of Khon Kaen — a rapidly growing secondary city in northeastern Thailand confronting issues of urban densification, agricultural land loss, and climate vulnerability — provides an empirically grounded site framework for speculative design inquiry.

This paper presents the findings of a three-year longitudinal pedagogical research project examining how students' competencies in creative thinking, systems thinking, engineering integration, and structural feasibility develop across successive iterations of the Vertical City studio. The study addresses the following research questions:

- RQ1: How do students' creative thinking and systems thinking capacities develop across three successive cohorts of the Vertical City studio?
- RQ2: To what extent does iterative thematic pedagogy support the progressive integration of engineering systems in student design proposals?
- RQ3: What are the persistent gaps and limitations of the current studio model, and how might they be addressed in future iterations?

The contribution of this study is twofold: methodologically, it proposes a structured evaluation rubric applicable to speculative design studios; pedagogically, it offers an evidence-based model for integrating vertical city design into architectural education in a Southeast Asian regional university context.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Defining the "Vertical City": A Critical Distinction

The term "Vertical City" is employed in both professional and academic discourse with considerable variation, often conflated with adjacent typologies that differ in scalar, programmatic, and systemic terms. For the purposes of this study, a precise definitional boundary is necessary.

A conventional high-rise building is defined as a structure exceeding a threshold height (typically 35 meters or approximately 12 floors) designed primarily for a singular functional category — office, residential, or hotel — within an existing urban fabric [11]. A mixed-use tower extends this model by stacking multiple functional categories — typically retail, office, and residential — within a single vertical structure, but remains fundamentally dependent on surrounding urban infrastructure for mobility, energy, water, and food systems [12].

A megastructure, as theorized by Banham (1976) and elaborated through the Metabolist movement, refers to large-scale structural frameworks designed to accommodate urban growth through the insertion of interchangeable, modular units [13]. While megastructures share the scalar ambition of the Vertical City, they are distinguished by their explicit reliance on a base infrastructure that supports rather than integrates urban systems.

The Vertical City, as operationalized in this study, is defined as a vertically organized, self-contained urban ecosystem that integrates, within a single architectural framework, the following interdependent systems: (a) residential and social program, (b) food production (typically vertical agriculture), (c) renewable energy generation, (d) water collection and recycling, (e) waste processing, and (f) internal mobility networks. This integration is not merely additive or diagrammatic; it implies genuine systemic interdependence, wherein the outputs of one subsystem constitute the inputs of another, approximating a closed-loop metabolic logic. This definition aligns with and extends the concept of "ecological urbanism" proposed by Mostafavi and Doherty [8], while also engaging with emerging research on building-scale urban metabolism [14].

This definitional framework distinguishes the Vertical City not only from high-rise and mixed-use typologies, but also from competition-based speculative proposals (such as eVolo entries) that prioritize formal and conceptual innovation without requiring systemic feasibility, and from Metabolist and Archigram precedents, which envisioned urban adaptability at the infrastructure level rather than the self-contained ecosystem level.

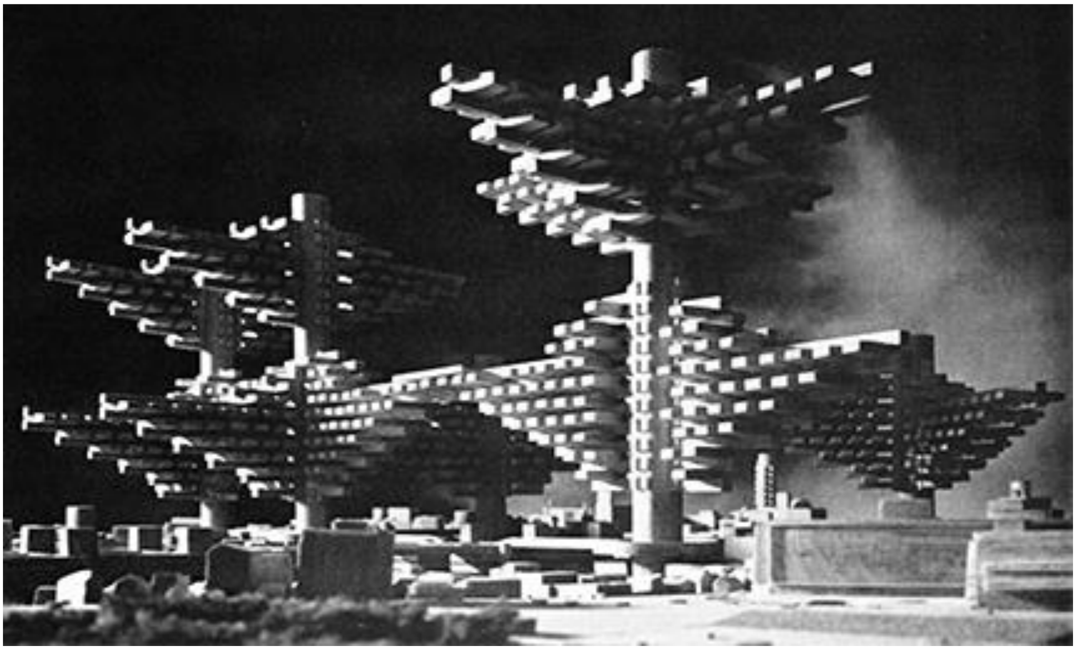

Figure 1. The City in the Air by Arata Isozaki in the Metabolism movement [15]
Sources: https://architizer.com/blog/inspiration/collections/beyond-metabolism/

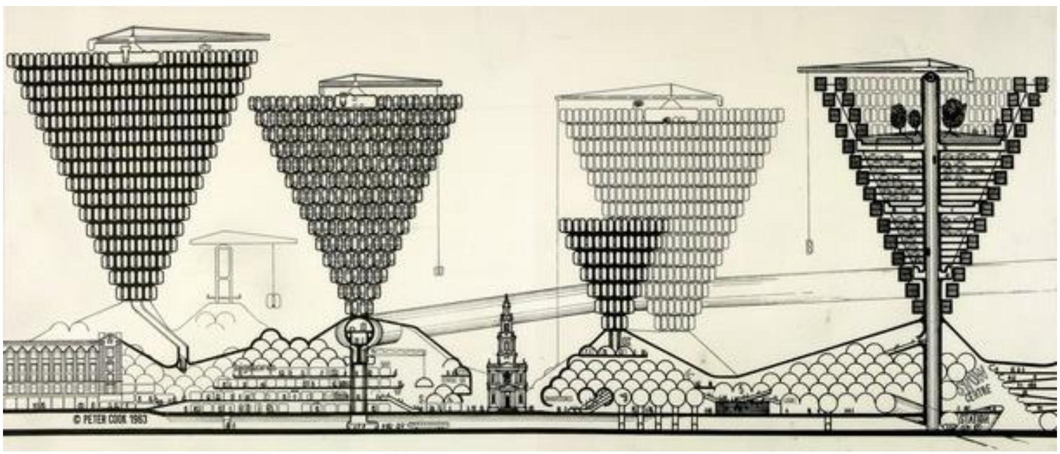

Figure 2. The Plug-In City by Peter Cook in the Archigram movement [16]

Studio-Based Teaching and Vertical City Pedagogy

Studio-based learning remains the epistemological core of architectural education, functioning as a site of reflective practice in which students engage in iterative cycles of proposal, critique, and revision [17]. Within this tradition, the design studio serves simultaneously as a laboratory, a community of practice, and a space for disciplinary socialization [18].

The integration of vertical city themes into design studios has been explored at several leading institutions. Programs at the National University of Singapore have emphasized bioclimatic adaptation within dense tropical contexts. Researchers and students at the NUS Department of Architecture integrate traditional passive design with cutting-edge technology to achieve sustainable, comfortable urban environments [19]. Studios at the University of Hong Kong have interrogated the phenomenological dimensions of vertical living in high-density environments [20]; and initiatives at MIT have applied systems-based analysis frameworks to evaluate the performance of speculative urban proposals [21]. These precedents share a commitment to framing the studio as a site of analytical rigor rather than purely formal exploration.

In the Southeast Asian context, and specifically within Thai architectural education, research on speculative urban design pedagogy remains relatively sparse [22]. Most documented studio experiments in the region focus on heritage conservation, tropical climate-responsive design, or community-based participatory methods, leaving a gap in the literature concerning radical urban speculation as a pedagogical tool. This study addresses that gap directly.

Theoretical Foundations: Bruner, Frampton, and Ecological Urbanism

Three theoretical frameworks inform the pedagogical design of the studio and the interpretation of its outcomes.

First, Bruner's (1960) concept of the Spiral Curriculum provides the structural logic for the three-year iterative design. Bruner proposed that any subject can be taught effectively in some intellectually honest form to learners at any stage of development, provided that the curriculum returns to foundational concepts with increasing complexity and abstraction [23]. In the context of this studio, the recurring theme of the Vertical City functions as the spiral axis, with each annual cohort confronting the same conceptual territory at a progressively higher level of systemic complexity — from programmatic organization (Year 1), to specialized conceptual investigation (Year 2), to integrated systems synthesis (Year 3). Critically, Bruner's model is not merely applied as a rhetorical analogy in this study; it is operationalized through the deliberate incremental modification of studio briefs and the structured accumulation of evaluation criteria across cohorts.

Second, Frampton's (1995) concept of tectonics — the poetics of construction as an expression of structural and material logic — provides the theoretical basis for evaluating structural feasibility in student proposals [24]. Frampton argues that architectural integrity cannot be separated from the material and constructive reality of a building; speculative design that neglects tectonic grounding risks becoming scenographic rather than architectural. In this study, Frampton's framework is employed not to constrain student imagination but to identify the boundary between productive speculation and constructive implausibility — a boundary that, as the results indicate, students consistently struggled to negotiate across all three cohorts.

Third, Mostafavi and Doherty's (2010) framework of Ecological Urbanism informs the environmental dimension of the studio brief. Ecological Urbanism proposes that urban design must move beyond efficiency — reducing harm — toward regenerativity — actively restoring ecological functions. This framework directly shaped the Year 3 brief's emphasis on distributed renewable energy, closed-loop water and waste systems, and biophilic integration, and provides the conceptual language for interpreting the observed improvements in systems thinking across cohorts.

Research Gap and Originality

While vertical city design has been explored in competition contexts (eVolo, VCA) and in studios at globally prominent institutions, no documented study has examined a multi-year, iterative vertical city studio within a regional Southeast Asian university context using a structured longitudinal evaluation framework. Furthermore, existing pedagogical literature on speculative urban design studios does not offer a replicable evaluation rubric capable of quantitatively tracking competency development across the four dimensions identified in this study. This research therefore contributes an original, context-specific, and methodologically transferable pedagogical model to the existing literature.

3. RESEARCH DESIGN AND METHODOLOGY

Research Design

This study employs a longitudinal, quasi-experimental single-case research design, examining three successive cohorts of students enrolled in the Vertical City elective studio at the Faculty of Architecture, Khon Kaen University, over a period of three academic years. The case study approach is justified by the bounded, context-specific nature of the phenomenon under investigation [25] and by the absence of comparable documented precedents in the Thai architectural education context.

It is acknowledged that the single-case, single-instructor design introduces limitations regarding generalizability and the potential for observer bias. These limitations are addressed in Section 7 (Limitations and Future Research).

Participants and Context

Each cohort consisted of 12 fourth-year architecture students who voluntarily selected the Vertical City studio from among six available elective studio options. Selection was self-directed, with no formal pre-screening criteria applied; however, all participants had successfully completed the foundational three-year core curriculum, ensuring a comparable baseline level of design competency. Demographic data (age, gender, prior GPA) were recorded but are not reported here in order to protect participant anonymity in accordance with institutional ethical guidelines.

The studio was conducted over a 16-week semester, with five studio contact hours per week, supplemented by individual consultations and two formal review panels per semester. All participants provided written informed consent for the use of their work in this study. The research protocol was reviewed and approved by the Faculty of Architecture's internal academic review process prior to data collection.

Site Context: Khon Kaen as a Research Setting

Khon Kaen, the administrative and economic capital of northeastern Thailand, was selected as the primary site context for this study on the basis of three criteria: (1) its status as a rapidly growing secondary city confronting documented challenges of urban densification and agricultural land conversion [26]; (2) its geographic and cultural distance from Bangkok, which reduces students' tendency to replicate metropolitan typologies and encourages contextually grounded speculation; and (3) its institutional proximity to KKU, which affords students direct access to site documentation, municipal planning data, and community stakeholders.

In Year 1, students worked with real urban sites within Khon Kaen Municipality, selected through a structured site analysis exercise based on criteria including land availability, transportation access, and proximity to existing services. In Years 2 and 3, students were directed to a designated non-urban peripheral site in Khon Kaen Province, chosen to eliminate existing infrastructural constraints and maximize programmatic autonomy.

Studio Brief and Assignment Structure

Each year's brief was designed to build incrementally on the conceptual and technical demands of the previous cycle. The briefs shared a common core requirement — the design of a vertically organized, self-contained urban community — but differed in site context, programmatic emphasis, and systems integration requirements, as summarized in Table 1 below.

The assignment was structured in four sequential phases: (1) site and precedent analysis, (2) conceptual proposal and schematic design, (3) systems integration and technical development, and (4) final design presentation and formal review.

Data sources comprised: (a) student design portfolios (drawings, models, diagrams, and technical documentation) submitted at the end of each semester; (b) studio instructor field notes recorded during desk critiques and review sessions; and (c) brief post-review verbal reflections from students, summarized by the instructor. Portfolio data were analyzed.

4. RESULTS

Year 1: Programmatic Application on Urban Sites

In the first cycle, students were tasked with applying the Vertical City concept to real urban sites within Khon Kaen Municipality. Site selection was guided by a structured analysis exercise evaluating land availability, transportation connectivity, and proximity to existing municipal services. The studio brief required students to design a vertically organized community accommodating residential, retail, agricultural, public, and support functions.

Analysis of the Year 1 portfolios revealed that the predominant design strategy consisted of the vertical replication of conventional horizontal urban patterns. Programs were organized in recognizable configurations — retail at the lower levels, residential in the mid-section, and agricultural or public space at the upper levels — that closely mirrored standard mixed-use tower typologies.

The most significant finding of the Year 1 cycle was the near-complete absence of substantive engineering integration. Structural logic, mechanical services, and vertical circulation systems were either absent from proposals or represented only symbolically, without dimensional, material, or technical specificity. This observation suggests that fourth-year students, despite three years of foundational technical training, had not yet developed the cognitive frameworks necessary to translate structural and services knowledge into the context of a radical, large-scale speculative project.

Pedagogically, the Year 1 results indicated that the principal barrier to deeper design development was not lack of technical knowledge per se, but an insufficient conceptual framework for understanding the Vertical City as a systemic entity rather than a stacked collection of conventional programs. This finding directly shaped the modified brief for Year 2.

Figure 3. The students' works, 1st year

Year 2: Specialized Conceptual Innovation on Non-Urban Sites

In response to the Year 1 findings, the Year 2 brief introduced two significant modifications: (1) the site was relocated to a non-urban peripheral area of Khon Kaen Province, eliminating existing infrastructural constraints; and (2) students were organized into thematic interest groups and asked to design a cluster of functionally specialized Vertical Cities that together would constitute a self-sufficient community.

The resulting proposals represented a marked expansion of conceptual ambition. Distinct thematic clusters emerged organically from students' self-selected interests: (a) residential-focused vertical communities emphasizing social cohesion and shared space; (b) agriculturally-focused towers centered on vertical farming and food sovereignty; (c) energy-producing structures organized around renewable generation systems; (d) a vertical Buddhist temple community integrating contemplative space with sustainable living; and (e) air-purification-focused towers designed to address regional particulate matter challenges.

A notable secondary outcome of the Year 2 cycle was the significant social visibility of student proposals: several projects were shared widely across Thai social media and architectural online platforms, generating public interest in the speculative potential of vertical city design. While this visibility is not a formal research outcome, it suggests that the studio's speculative framework resonated with broader public curiosity about urban futures in the Thai context.

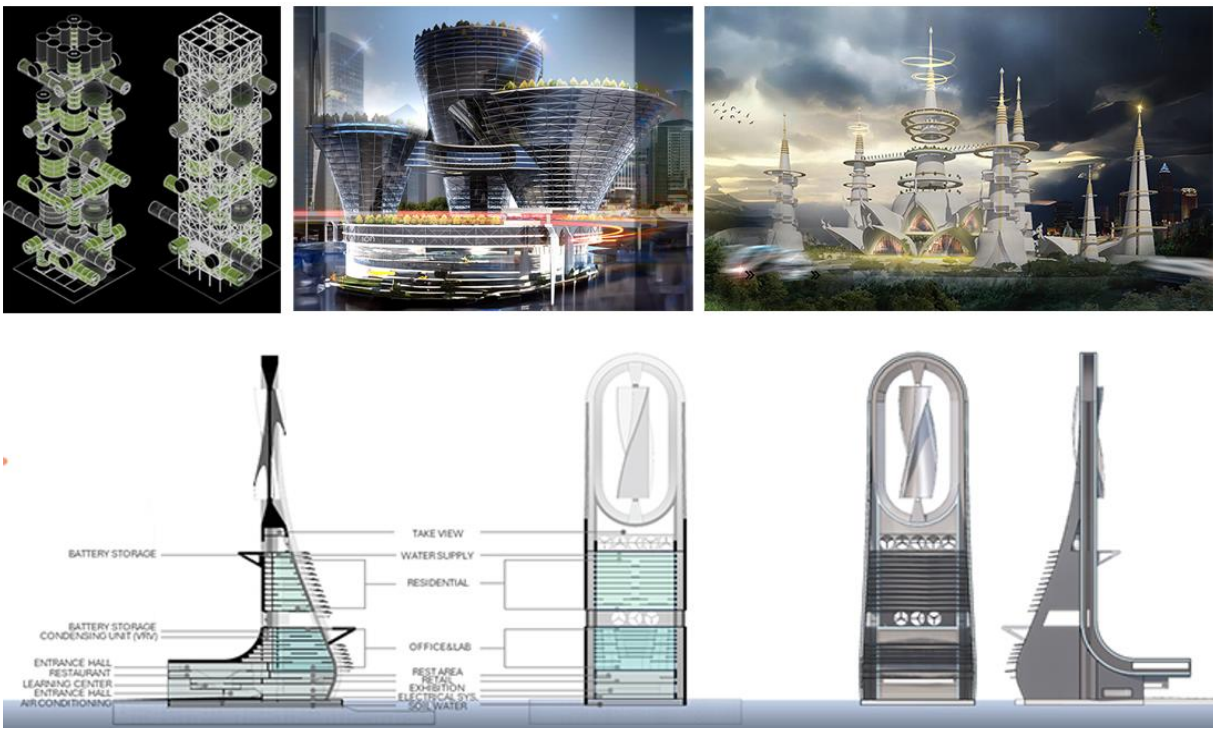

Figure 4. The students' works, 2nd year

Year 3: Integrated Systems Synthesis

The Year 3 brief retained the non-urban Khon Kaen Province site established in Year 2 and directed students toward the design of mixed-use Vertical Cities integrating residential and agricultural programs as primary functions. The critical modification was the explicit requirement for distributed, integrated engineering systems: renewable energy generation (solar, wind, and biogas) was to be embedded across the building fabric rather than concentrated in a dedicated functional zone, and students were required to develop substantive technical diagrams for water recycling, climate control, and waste processing systems.

Portfolio analysis revealed the most substantive improvements recorded across the three-year study, particularly in systems thinking and engineering integration. Several proposals demonstrated genuine systemic interdependence — for example, projects in which biogas generated from composted food waste powered building mechanical systems, while grey water from residential units was treated and redistributed to vertical farming zones. These proposals moved meaningfully beyond diagrammatic representation toward technically informed systems logic, including preliminary calculations of energy demand, waste volumes, and water cycling capacity.

Creative thinking scores remained high, suggesting that the increased technical demands of the Year 3 brief did not suppress conceptual ambition. This finding is pedagogically significant, as it challenges the common assumption that technical rigor necessarily constrains creative exploration in design education. However, structural feasibility remained the most underdeveloped dimension. While Year 3 proposals demonstrated a more developed awareness of structural systems relative to previous cohorts, the translation of ambitious formal concepts into constructible structural solutions remained limited. Several proposals incorporated structurally implausible formal gestures without accompanying tectonic justification, confirming Frampton's (1995) observation that the tectonic dimension requires deliberate, sustained disciplinary attention that cannot be achieved through brief modification alone.

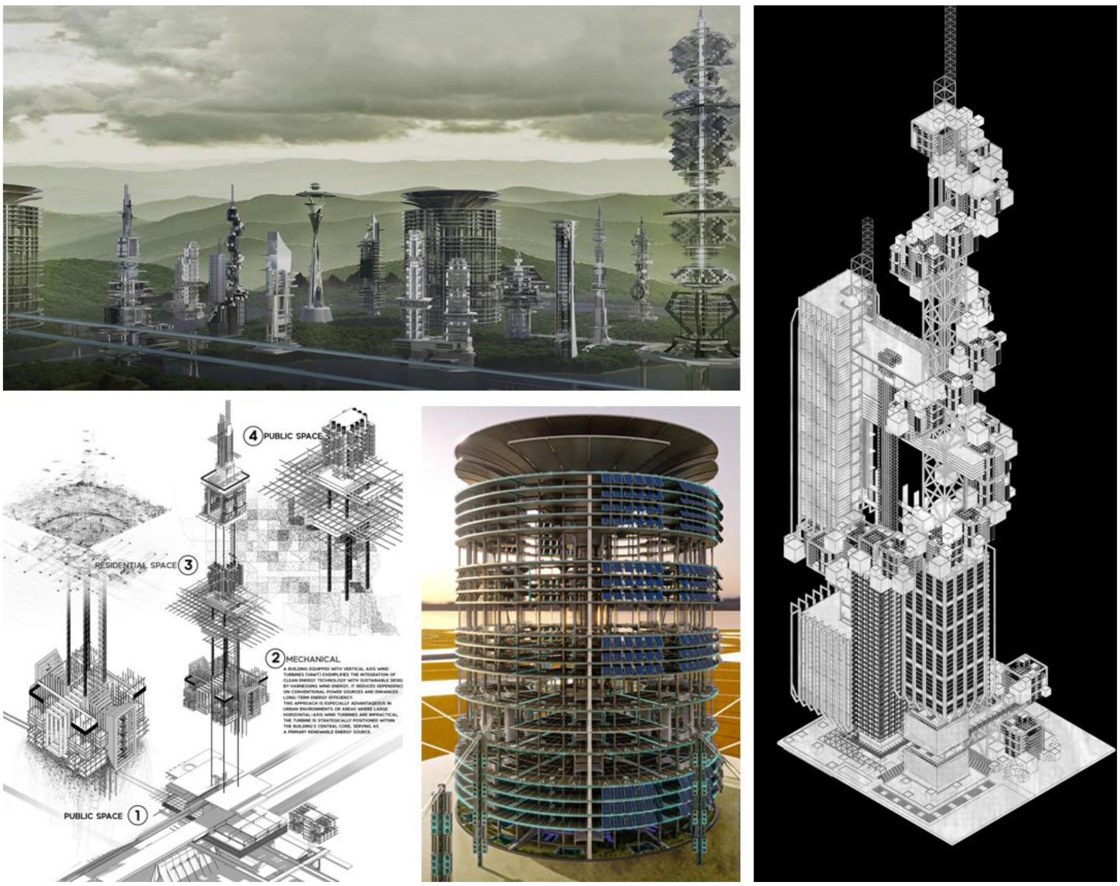

Figure 5. The students' works, 3rd year

Summary of Longitudinal Evaluation Results

From Table 1, the three-year trajectory of the Vertical City Studio demonstrates a clear maturation in student competency, moving from mimicry (Year 1) to innovation (Year 2) and finally to integration (Year 3).

Table 1. Three-Year Trajectory of the Vertical City Studio: Brief, Process, and Pedagogical Findings

Year	Site Context	Primary Brief Focus	Key Outcomes	Pedagogical Finding
Year 1	Urban sites, Khon Kaen Municipality	Application of vertical city concept to existing urban fabric	Programmatic competence; replication of conventional typologies; minimal engineering or systems integration	Breaking conventional typological thinking requires more explicit conceptual scaffolding; systems integration must be foregrounded from the outset
Year 2	Non-urban periphery, Khon Kaen Province	Specialized self-sufficient community as a cluster of thematically distinct Vertical Cities	Significant creative expansion; high conceptual ambition; engineering integration remained schematic	Specialization drives depth of conceptual investigation but may inhibit holistic systems thinking; the liberating constraint of a non-urban site is pedagogically generative
Year 3	Non-urban periphery, Khon Kaen Province (same site as Year 2)	Mixed-use Vertical City with integrated residential, agricultural, and engineering systems	Highest systems thinking and engineering integration scores; structural feasibility remained underdeveloped	Iterative brief refinement supports cumulative learning; technical integration is achievable without suppressing creative ambition; structural realism requires dedicated disciplinary reinforcement

5. DISCUSSION

The Iterative Studio as a Spiral Curriculum in Practice

The capacity for integrated, multidimensional design thinking is not fixed at entry to the fourth year but is developable through structured, cumulative engagement with increasing complexity. This trajectory corresponds directly to Bruner's (1960) spiral curriculum model: students encountered the same core conceptual territory — the self-contained vertical urban ecosystem — three times, each time with greater systemic complexity demanded by the brief and greater cognitive maturity brought by accumulated studio experience.

Importantly, this pattern holds at the cohort level, across three distinct groups of students, rather than tracking the same individuals longitudinally. This suggests that the progression observed reflects deliberate pedagogical design — specifically, the incremental modification of the brief — rather than individual maturation alone. The studio's recurring structure thus functions as an effective mechanism for institutionalizing cumulative learning within an elective studio context.

The Persistent Tension Between Imagination and Constructability

Despite the overall upward trajectory, structural feasibility remained the lowest-scoring criterion across all three cohorts. This finding resonates with Frampton's (1995) argument that tectonic integrity — the integration of material, constructive, and structural logic into the architectural proposition — represents a disciplinary commitment that cannot be achieved through conceptual or programmatic ambition alone.
The Year 3 data are particularly instructive in this regard: the simultaneous improvement in systems thinking and engineering integration scores alongside the continued underdevelopment of structural feasibility suggests that students can internalize systems logic at a diagrammatic level without necessarily developing the structural literacy required to translate those systems into constructible form. This distinction — between systems comprehension and tectonic competence — has not been clearly articulated in the existing literature on speculative design pedagogy and represents an original finding of this study. It implies that future studio iterations must address structural realism as a distinct disciplinary domain requiring dedicated pedagogical intervention, rather than assuming that general improvements in technical thinking will automatically extend to structural feasibility.

Systems-Based Thinking as a Transferable Competency

The marked improvement in systems thinking scores across cohorts, and the concurrent maintenance of high creative thinking scores in Year 3, challenges the common pedagogical assumption that technical and creative competencies exist in tension. The Year 3 results suggest that, when the studio brief is designed to frame engineering systems as creative material rather than as external constraints, students are capable of integrating technical complexity without sacrificing conceptual originality. This finding aligns with the broader pedagogical literature on design-integrated learning [27] and supports the proposition that environmental science, structural engineering, and social programming can be incorporated into a single design workflow without fragmenting the creative process.

This observation has direct implications for the broader debate about the balance between professional training and speculative education in architectural curricula. The Vertical City studio model suggests that speculative complexity and technical rigor are not mutually exclusive pedagogical goals, provided that the studio brief is carefully scaffolded to introduce each dimension of complexity at an appropriate moment in the design process.

Site Context as a Driver of Speculative Freedom

The shift from an urban site (Year 1) to a non-urban site (Years 2 and 3) had a measurable effect on creative thinking scores. This finding is consistent with the pedagogical concept of the "liberating constraint" [28]: by removing the immediate constraints of existing urban infrastructure, the non-urban site freed students to speculate beyond the boundaries of established typologies, while the geographic and ecological specificity of the Khon Kaen provincial context prevented the site from becoming a neutral or indeterminate tabula rasa.

However, it is worth noting that this creative expansion came at the expense of contextual grounding: Year 2 proposals, while conceptually ambitious, often engaged the site more schematically than the Year 1 proposals had engaged the urban context. The Year 3 brief's requirement for systemic integration partially addressed this issue by necessitating a more detailed engagement with site-specific environmental conditions (solar orientation, wind patterns, water availability) to support the design of distributed renewable energy and water management systems.

Limitations of the Current Pedagogical Model

Several limitations of the current studio model must be acknowledged. First, the absence of formal collaboration with engineering faculties means that students' engagement with structural and mechanical systems remained largely self-directed and, in consequence, often technically incomplete. Second, the reliance on architectural presentation softwares limited students' ability to test and validate performance claims against measurable simulation data. Third, the single-instructor design introduces the possibility of evaluative bias, which the inter-rater review protocol partially mitigates but does not fully eliminate.

6. CONCLUSION AND FUTURE DIRECTIONS

This three-year longitudinal pedagogical research project has examined the development of student competencies across four dimensions — creative thinking, systems thinking, engineering integration, and structural feasibility — within a recurring Vertical City design studio at Khon Kaen University. The study was conducted with 12 students per cohort, in a five-hour-per-week studio format, over three successive academic years.

The findings provide empirical support for three principal conclusions. First, iterative thematic studios designed according to a spiral curriculum logic are capable of fostering measurable, progressive improvements in students' capacity for systems thinking and engineering integration. Second, the tension between creative vision and constructive feasibility identified by Frampton (1995) is not resolved by brief modification alone; structural feasibility requires deliberate, focused disciplinary reinforcement that cannot be assumed to emerge organically from improvements in other technical dimensions. Third, in response to RQ3, the most significant pedagogical gaps in the current model are the absence of formal interdisciplinary collaboration with engineering faculties, the lack of digital performance simulation tools, and the insufficient depth of engagement with structural realism — all of which are addressable through the future directions proposed below.

These findings contribute to the literature on speculative design pedagogy in Southeast Asian architectural education by demonstrating that a regionally embedded, evidence-based studio model can produce measurable improvements in multidimensional design competency, while also identifying the specific pedagogical interventions required to address persistent gaps in structural literacy.

To build on these findings, future iterations of the Vertical City studio should pursue the following directions:

1) Formal Interdisciplinary Collaboration: Establishing structured collaboration with the Faculty of Engineering at KKU, incorporating joint reviews and co-taught technical workshops, to provide students with direct access to structural and mechanical engineering expertise.
2) Advanced Digital Performance Simulation: Integrating Building Information Modeling (BIM) and environmental performance simulation tools to enable students to validate energy, water, and structural performance claims against quantitative benchmarks.
3) Regenerative Systems Focus: Deepening the studio's engagement with ecological urbanism by framing the Vertical City explicitly as a regenerative rather than merely efficient system, with active ecological restoration as a design requirement.
4) Expanded Data Collection: Future research should incorporate structured student interviews, pre- and post-studio competency assessments, and comparison with a control cohort enrolled in a conventional large-scale building studio, to strengthen the evidentiary basis for the pedagogical claims advanced here.

Limitations and Future Research: This study is subject to limitations that constrain the generalizability of its findings. The single-site, single-instructor design prevents direct causal attribution of observed competency improvements to specific pedagogical interventions. The sample size (n = 12 per cohort) is sufficient for a longitudinal case study but too small to support statistical inference at a population level. Future research should replicate this studio model across multiple institutions and instructors, incorporate comparative cohort designs, and employ validated instruments for measuring design competency to enable broader generalization of the findings.

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Sociocultural inclusion of elder persons in public space, case of Khemisti garden and floral garden, in Algiers, ALGERIA.*

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Abstract: Sociocultural inclusion is a fundamental principle for sustainable and equitable urban development, aiming to ensure the participation of everyone in urban life regardless of age, origin, or status. Despite advances in urban planning, the meaningful inclusion of older people in public spaces remains a significant challenge. Due to reduced mobility and physical and social barriers, older people are often marginalized, limiting their access to services and social interaction. Public spaces play a vital role in promoting the integration of older people into urban life by offering accessible spaces for socialization, leisure activities, and inter-community connection. By fostering gatherings, civic engagement, and supporting physical and mental well-being, these spaces contribute to strengthening the social fabric and building an inclusive society for people of all ages. This study aims to provide answers to the issue of older people's participation in public spaces. Based on field studies of the Khemisti garden and flower garden in central Algiers, the study seeks to understand the elements that enable better inclusion of older people. An activity map based on field observations of activities and practices carried out by older people in this area has been prepared, and the results obtained have been used to understand the limitations faced by this age group. In response to these observations, various suggestions have been made to improve the participation of older people in public spaces. These suggestions include the application of universal design principles such as accessibility and comfort for all age groups, as well as the encouragement of intergenerational and social initiatives to strengthen social ties.

Keywords: Sociocultural inclusion; Elder persons; public space; Khemisti Garden and floral garden; Algiers; Algeria.

Cezayir'deki Khemisti Bahçesi ve Çiçek Bahçesi Örneğinde Yaşlı Bireylerin Kamusal Alana Sosyokültürel Katılımı

Özet: Sosyokültürel kapsayıcılık, yaş, köken veya durumlarından bağımsız olarak herkesin kentsel yaşama katılımını sağlamayı amaçlayan, sürdürülebilir ve adil kentsel gelişim için temel bir ilkedir. Kentsel planlamadaki ilerlemelere rağmen, yaşlıların kamusal alanlara anlamlı bir şekilde dahil edilmesi hâlâ önemli bir zorluk teşkil etmektedir. Hareket kabiliyetlerinin azalması ve fiziksel ve sosyal engeller nedeniyle yaşlılar sıklıkla marjinalleştirilmekte, bu da hizmetlere erişimlerini ve sosyal etkileşimlerini sınırlamaktadır. Kamusal alanlar, sosyalleşme, boş zaman etkinlikleri ve topluluklar arası bağlantı için erişilebilir mekanlar sunarak yaşlıların kentsel yaşama entegrasyonunu teşvik etmek açısından hayati bir rol oynar. Buluşmaları, sivil katılımı ve fiziksel ve zihinsel refahı destekleyerek bu alanlar, sosyal dokunun güçlendirilmesine ve her yaştan insan için kapsayıcı bir toplumun oluşturulmasına katkıda bulunur. Bu çalışmayla, yaşlıların kamusal alanlara katılımı konusuna yanıtlar sunulması amaçlanmaktadır. Çalışma,

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Cezayir merkezindeki Khemisti bahçesi ve çiçek bahçesi alan çalışmalarına dayanarak, yaşlıların daha iyi bir şekilde dahil edilmesini sağlayan unsurları anlamaya çalışmaktadır. Yaşlıların bu alanda gerçekleştirdikleri faaliyet ve uygulamalara ilişkin saha gözlemlerine dayalı bir faaliyet haritası hazırlanmış, elde edilen sonuçlar ile, bu yaş grubunun karşılaştığı kısıtlamaların anlaşılmasına çalışılmıştır. Bu gözlemlere yanıt olarak, yaşlıların kamusal alanlara katılımını iyileştirmek için çeşitli önerilerde bulunulmuştur. Bu öneriler arasında, her yaş grubu için erişilebilirlik ve konfor gibi evrensel tasarım ilkelerinin uygulanmasının yanı sıra, toplumsal bağları güçlendirmek amacıyla kuşaklar arası ve sosyal girişimlerin teşvik edilmesi yer almaktadır.

Anahtar kelimeler: Sosyokültürel katılım; Yaşlılar; kamusal alan; Khemisti Bahçesi ve çiçek bahçesi; Cezayir; Cezayir.

1.INTRODUCTION

“The city that does not take older people into account is a city that does not take into account its own history and its future. » [1], Demographic aging is emerging as one of the major societal transformations of the 21st century, revealing a complex but unavoidable challenge for contemporary urban planners. In this context, the inclusion of older people in public spaces and gardens is of crucial importance for the creation of truly sustainable and equitable cities. Across the world, aging citizens face persistent challenges in their quest to actively participate in urban life [2]. Public spaces, often designed without taking into account the specific needs of seniors, become areas where physical, social and cultural inaccessibility is frequently observed.

In Algeria, a country undergoing rapid social and demographic change. According to the National Statistics Office (ONS) newsletter, Algeria counted in 2019, 11 million people aged of 60 years old and over, out of a global population of 43 million inhabitants.

Persons aged of 65 years old and over, presents an annual growth rate of 3.1%. the rate is higher than that of the entire population of the country, which is around 2.5%. the population of this category is concretely present total of 2.684 million people, 1.324 million men and 1.360 million women [3].

The aging of the population poses a crucial question about the way in which public spaces and gardens are designed and used by consequence. The inclusion of older people in these spaces is becoming an essential issue for societies willing honors its elders and aspires to inclusive urbanity [4]. However, gaps remain, requiring critical assessment to better understand the national specificities of this phenomenon.
Older persons, due to various age-related factors such as reduced mobility, health problems and changing needs, may face significant obstacles when interacting with urban space. The design of these spaces must therefore evolve to anticipate and adequately respond to these challenges, in order to create environments where older people can not only survive, but also thrive. Our research and our conceptual framework allowed us to formulate our research question. So, the question we want to answer is:
“How does the design of public spaces take into account the needs of older people and how can we improve urban planning to make it better adapted and more welcoming and functional for this age category? ".

2.METHOD

Inclusion approach focuses on issues related to the accessibility of public spaces. It offers good practices in this area and is currently piloting the “City accessible to all” program [5]. This program aims to help urban stakeholders adopt a global approach to accessibility and take into account the needs of vulnerable users [6]. The applied method is firstly based on direct in site observations: Through an analysis grid, an observation of approximately 1 hour on a living space. User behaviors are observed (travel, activities, etc.), their profiles (gender, age group, alone or in a group, etc.) but also the characteristics of the place (spatial organization, amenities, etc.).

Sidewalk microphones: Open questions are asked of anonymous users encountered in public spaces. This tool of work consists of following a pedestrian who crosses a space taking exactly the same path as him, in order to study his path and his behavior within the environment and to understand his practices.

Simultaneously space analysis is operated, the layout of public places and spaces provides keys to understanding the issues and responding to the specific needs of each audience (a hearing-impaired person does not have the same needs as an elderly person, for example, in terms of accessibility). Ensuring accessibility for all involves allowing travel as well as information and orientation for everyone in the city and in public places. This approach represents an opportunity to improve the quality of use of public spaces, by promoting movement for all.

The public space observation methodology in destination of older persons, combined with the activity mapping, is a systematic and rigorous process aimed at collecting comprehensive data on interactions with activities held the urban environment. This approach combines direct field observation and activity mapping to provide a holistic understanding of the dynamics of public space.

The methodology is based on a structured observation grid which identifies in advance specific parameters such as physical accessibility, security, condition of the location, use of space, comfort and layout. In addition, the activity mapping method consists of visually mapping the activities of users in general and of elderly people in particular over time and in the different part of public space.

The activity mapping method provides a graphical representation of older adults' movements and activities in space. This approach offers dynamic visualization of behaviors, social interactions and help in identifying preferred activity areas.

Interactions with users, particularly Elder persons, enrich the methodology by providing qualitative insights into their specific experiences and needs. The data collected is analyzed in depth to identify trends, strengths and weaknesses in public space. The temporal and spatial dimensions provided by the activity mapping method are integrated to provide a comprehensive and nuanced understanding of how older persons interact with public space.

3. CASE OF STUDY

In order to evaluate the degree of elder people's inclusion in public spaces activities, the Khemisti and floral garden were taken as case study (figure 1). The Khemisti and the floral clock garden, used to be named the Gliéres garden during the French colonial period, is divided into 03 distinct parts, developed on a slopping field, the garden starts from a platform at 17 meter above the Mediterranean Sea level to reach the quote at 54 meter above the sea level. The configuration of the garden looks like an open-air theater open to the sea. The garden on the north-west limit is bordered by Colonel Amirouche boulevard (figure 2), at the south-east edge, is delimited by Cherif Saadan street (figure 2), the boulevard Mohamed Khemisti surround the garden from the east and west sides (figure 2). The immediate built environment of the garden is typically Haussmanian French style, where the ground floor of the building is reserved for commerce, the upper levels for housing, at the east side of the garden the large post office building momentously take place, in lower part we found Sofia Park. The garden is crossed by the two avenues, to know avenue Pasteur (figure 2), and avenue el Khettabi Physical attributes of garden A, situated between 17-meter altitude to 24 meters:

Close to the garden A we found a metro station (Tafourah-grande poste). The garden is accessible through 5 entrances concretely materialized by 7 crosswalks. On the sidewalk, there are two signs where the name of the garden is mentioned. In terms of urban furniture, the garden is equipped with 50 benches which can hold two to three persons, made of concrete and marble, near each grouping area we found hanging trash cans. In the first platform of this garden, there is a 10-meter diameter water large pool, in the third, there are rectangular pools with smaller dimensions. In the lower part of the garden there is a status of a footballer surrounded by water pools.

A small kiosk selling tobacco and newspapers take place on the south-eastern corner of the garden, a cafeteria and fast-food kiosk with a small table space are as well located in the garden. The vegetal covert of the garden is dominated by palm trees and Ficus retusa trees.

Physical attributes of garden B, situated between 24m altitude to 39 meters:
Access to metro station (Tafourah-grande poste) are also available from this part of the garden. 6 sidewalks facilitate the access to the garden which is materialized by 4 entrances. On the sidewalk on the northeast side there is a large advertising panel, and on the northwest side there are two tobacco sales kiosks. Inside the garden we notice that the garden is subdivided into two sub-spaces, one dedicated to the stairs leading to the underground gallery and the other one is dedicated for vegetation and rest.

In term of urban furniture, the garden has only 2 benches integrated into the central vegetation zone, we can see the treatment of the edges of the other vegetation zones. For water features, there is a water fountain with a diameter of 06 meter. This part of the garden is richer than the previous one in term of vegetation, Ficus trees form a vegetal cap, palm trees harmoniously adhere to the landscape silhouette, shrubs and plants draw and trace the limit of the garden.

Physical attributes of garden C, formally named the floral clock garden situated between 39-meter altitude to 48 meter above sea level:

The garden of the floral clock is built on a slope, it is fenced by bars, only accessible by two gate one from Pasteur Avenue the other gate on the upper part on the doctor Cherif Saadane street, on the west and east sides the garden is delimited by outstanding urban stairs. Near the garden on the sidewalk, there are both a stop for taxis buses. On the same sidewalk, there is a single wooden bench, a sign bearing the name of the garden, and two tobacco kiosks.

Inside the garden, we notice a total absence of urban furniture. Installation of a floral clock at the entrance to the garden surrounded by ramps, there is also a decorative arrangement, then a dominant monument take place just after 04 steps. This garden is also rich in terms of vegetation; the dominant type of trees is palm trees and shrubs and Ficus trees.

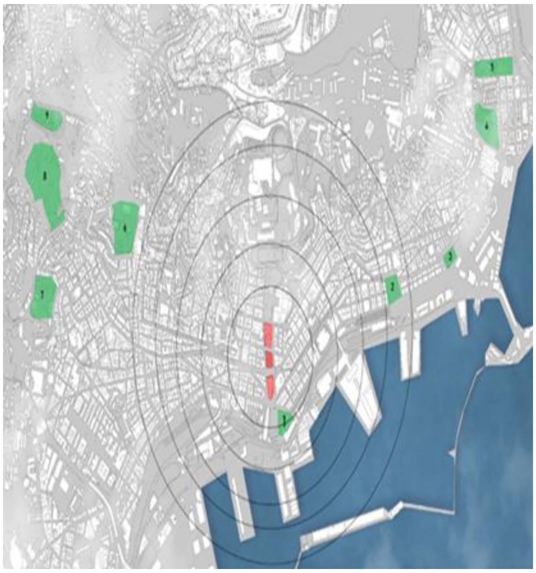

Figure 1. Situation of Khemisti garden

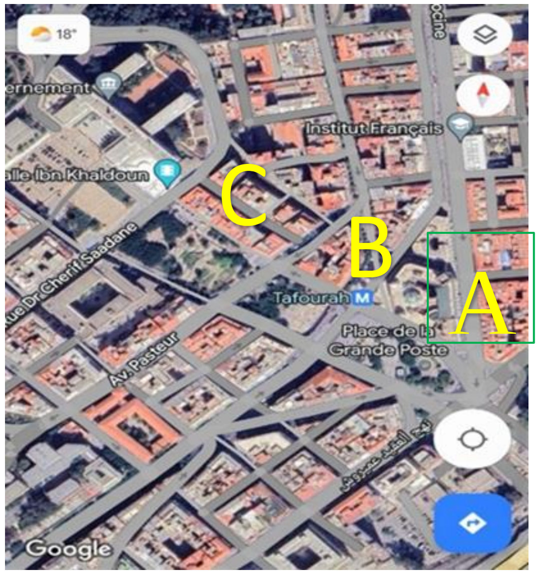

Figure 2. Map of Khemisti and floral clock Garden

<u>Chronomorphogical Development of Khemisti Garden</u>

In the period from 1841 to 1850, the city of Algiers was under an operation of construction of a new enclosure by gates among them, Isly gate was built on the land of the actual large post office, in 1860 with two porticos decorated with columns and crowned with entablatures, thirty years later the isly gate was demolished in 1897.

The current land of the Khemisti garden and its surroundings was called park of Isly or sometimes the square of Isly, it was a place of rest and family entertainment, with shades with balsamic smells, it was also a place for meetings, games and walks. In depth, the garden went as far as rue Barthezène (actually rue Dr. Saadan), after which it was a jumble of thick vegetation: various trees, thick bushes which climbed the slope to stop at Telemly. A setback wooden fence separated the park from a wide sidewalk lined with trees and benches where old ladies, peaceful retirees, came to rest and share things.

In the early 1900s, Isly Park suffered destruction, where a new village was established, the start of Boulevard Laferrière, with the gardens of Square La Ferrière (figure 3). Their declassification was carried out in two stages: the land in the lower part was the first to be released, those in the upper part were released in the 1920's [7].

In 1919, the upper part of the garden (currently the floral clock) was equipped with a stele called "the Guynemer stele", in honor of Guynemer, a French pilot who died during the Second World War.

In 1928, the Guy Nemer stele was replaced by the statute (the grand Pavois), a monument sculpted by Paul Landowski (the sculptor of the Chris statute in Rio de Janeiro) to commemorate the 10,000 Algerian soldiers who died for France during the 1st world War (Figure 4).

In 1978, on the eve of the African Games, M'hamed Issiakhem was asked to revamp this stele recalling the French colonial period. The famous plastic l artist locked the Pavois in a concrete sarcophagus. He adorns the facade of this monument with a sculpture: two raised fists, breaking the chains of the colonial yoke.

The garden was always the central place of urban dynamic, the flood of thousands of citizens passes by every day, the strategic situation that occupy the garden, between Amir Abdelkader neighborhood (used to be named Isly neighborhood during the colonial period) and Maurice Audin neighborhood, lets him to be an excellent indicator for Algerian society transformation. In the late of 80's, in 1988 the place was the scene of civil protest, in the 90's the garden received many works of rehabilitation in context of city beautification works, in 31 October 2011, Algiers first metro line was inaugurated covering a distance of 9.5 km between Hai El Badr and Tafforah la grande poste close to the garden.

Figure 3. les Gliéres garden (Khemisti actually) In 1900 [8]

Figure 4. Guy Nemer square (Khemisti actually) in 1928 [8]

4.RESULTS

The result of the observation table for the second part of the garden (from 24m altitude to 39 meter) indicates that: In terms of accessibility, this part of the garden has an advantage regarding the pedestrian crossings that surround it, which guarantees safe and comfortable access to the garden. The garden in his flat part with presence of plantation and trees and urban furniture attract more the older person, the other part of the garden is occupied by steps to access to the underground galleries remains an untransmissible area for older person, here we understand that the topography of the land is an essential criterion to ease older person accessibility.

The visual appearance of the garden may be qualified as an efficient and relatively well adapted to elderly people needs. The presence of luminous elements such as street lamps. The presence of a medium-sized water fountain, the nature and diversity of plantation, trees, palm trees and shrubs, Plus, the presence of pigeons over the entire surface of the space offers a climate of tranquility for elder people. In this part of the garden, we noticed the lacks maintenance in many ways, especially in terms of floor paving, which can represent a serious danger for elders, also in relation to the pollution of the water fountain. We noticed as well a good maintenance of trees and plantation.

The signage at garden level is almost inexistent (the absence of indicators), this made elderly person feel lost in the space by consequence leads to a feeling of insecurity. Therefor the use of space is poorly thought out to meet the of the elderly. We note that the activities offered by the garden for this age group are limited to relaxation, discussion and walking. Activities intended for older adults are poorly implemented; there is a lack of comfortable benches which are suitable for this age group (figure 5). There is even a lack of provision for normal benches. This part of the garden offers an average level of comfort; it is justified by the absence of elements which guarantee the physical comfort of the elderly. However, thermal comfort is guaranteed by the shade generated by the planted trees.

The following table is elaborated in context of activities observation grid, and obtained information serve to establish a significant preliminary diagnosis about the inclusion of older person in the garden case of study, for this purpose parameter assessment was arrested.

Table 1. Evaluation grid according to socio-cultural inclusion criteria

Parameter	Criteria	Indicator	Configuration	Accessibilty for elder Person	VG	G	M	W	Ast
Accessibility	Orientation and signage	Direction signs	Sign close to the garden, (place de la grande poste).	Medium size text, color contrast (black and white)				**x**	
		GPS location	availability of routes via GPS		**x**				
		Visual guides	The vegetation and la grande poste, the port			**x**			
	Accessibility to transport	Accessibility to transport station	Underground station (Tafourah, grande poste)	Presence of pedestrian crossing near the metro stations. (figure 5)		**x**			
		Ground signage	Signage for pedestrian crossing				**x**		
	Exterior pedestrian crossing	The signage	Information panel	Presence of 7 pedestrian crosswalk	**x**				
		Presence of speed bumps	/						**x**
	Accessibility to space	Presence of access ramps	/	no consideration for people with reduced mobility (presence of steps)					**x**
	proximity to public facilities	Commerce	Commerce located at the ground floor of buildings	Easy access for elder person, distance doesn't exceed 20 meters	**x**				
		Sanitary equipment	blood analysis laboratory				**x**		
		Administrative equipement	- Algérie ferries, la grande poste			**x**			
Aesthetic	Artificial appeal elements	Light elements	advertising board, lamp post of different shapes.	/ /	**x**				
		Presence of water	large pool of water 10-meter diameter, small pools 6-meter diameter		**x**				
	Natural appeal elements	The vegetation	Palm trees, ficus, shrubs		**x**				
		Bird feeding area	Located in the garden at 24 meter level					**x**	

Site status	Landscape maintenance	General aspect	good maintenance of trees (pruned)	/	**x**				
		Maintenance of installations	dirty water pool				**x**		
	Maintenance of facilities	Condition of floor covering	deteriorated	Presence of tactile devices near the steps		**x**			
		Waste management	trash cans	installation of trash cans near benches		**x**			
		State of benches	/	/		**x**			
	Topography	Ramp	présence of 3 urban platform	Absence of access ramps					**x**
Signage	Visible signage	Ground signage	Signage for pedestrian crossing	Medium size text, color contrast (white and red)			**x**		
		Information signage	road signs (traffic lights and signs)			**x**			
		Pictograms	/					**x**	
Land use and operated activities	Passive recreation	relax	Relaxation and rest area	Accessible for the elderly			**x**		
		Discussion	Grouping space				**x**		
		Contemplation of nature	Landscaping			**x**			
	Active recreation	reading	Relaxation area	Participation of seniors in activities (reading, walking, consuming			**x**		
		walking	Moving inside the garden			**x**			
		participation in temporary events	Cultural event				**x**		
		playing	Inside the garden					**x**	
		Consumption	Restauration				**x**		
Activities materialization [9]	Furniture and fittings for passive recreation.	Benches and seats	Benches made of concrete and marble	Arrangement of benches in different points in space		**x**			
		Benches with armrests	/						**x**
		Number of seats	Around a hundred seats		**x**				
	Furniture and fittings for active recreation.	Games areas and tables	/	/					**x**
		Performance spaces	Arrangements of stands on the sidewalk				**x**		
		Street libraries	/						**x**
		Kiosks	Two kiosks (tobacco and fast food)			**x**			
Layout and comfort	Physical comfort	Public toilets	/						**x**
		Access ramps and handrails	/						**x**
		Ergonomic benches	/						**x**
	Visual comfort	Presence of vegetation	planting the space with different plants and trees		**x**				
		La pollution	Uncleanliness of some part the garden, and				**x**		

			water pool						
		Environnement	view of the port, contemplation of architecture			x			
	Thermal comfort	Sunshine	Presence of sunny and shaded areas thanks to vegetation		x				
		Shaded areas				x			
	Acoustic comfort	Noise	Trafic					x	
Security	Lighting	Spot Lightning	Presence of street lamps arranged in a uniform way [10]		x				
		diffuse Lightning				x			
		Spot on the ground				x			
	Natural monitoring	intense shadow area	/			x			
		Clear visibility			x				
		visual obstacles						x	
	Surveillance system	cameras	/						x
		Security personnel							x
		Alarm system							x
Results					**12**				**-12**

Activity mapping:

After having achieved the observation assessment and producing evaluation tables, we pass to another stage of urban activities assessment, the operated work carried out in the space, consist on reporting and materializing activities held in group or individually, and specifying its nature and location exactly on the space. So the activity mapping process was operated on Saturday 11/25/2023 from 11 a.m. to 1 p.m., a sunny day 20°c. The results of this observation are synthesized in a map to better identify and understand each type of activity practiced by older persons. (figure 5)

On-site following to the observations on the garden A situated at 17-meter altitude, the results reveal that only 15.5% of the people present in the garden are elders. Among the 11 elder persons present in the first garden, 72.73% of them are resting and chatting (passive recreation), and 27.27% are sitting and reading (active recreation). Among the 11 elderly people observed, 5 of them are sitting alone (individual activity) (figure 6) and the others are grouped together (figure 7). the elders observed prefer sitting in sunny areas in front of water pools. Some of them prefer sit on the sidewalks at the limit of the garden.

The second garden situated at 24-meter altitude, the results reveal that 29.8% of the people present in the garden are elders. The rate is properly represented by 14 elderly person, all of them were resting and chatting which means that 100% of them are classified as passive recreation. The elders observed prefer have a rest in shaded areas facing the water fountain and sitting on the edges of the planting areas. The transition between the two situations photographed from a pedestrian's point of view reveals a co-variation of light, sound, temperature, and also kinetic factors.

Observations on site of the third garden situated at 39-meter altitude, that of the flower clock, reveal that this garden none of elder person were present in place and this is because of the land topography and the number of steps inside the garden.

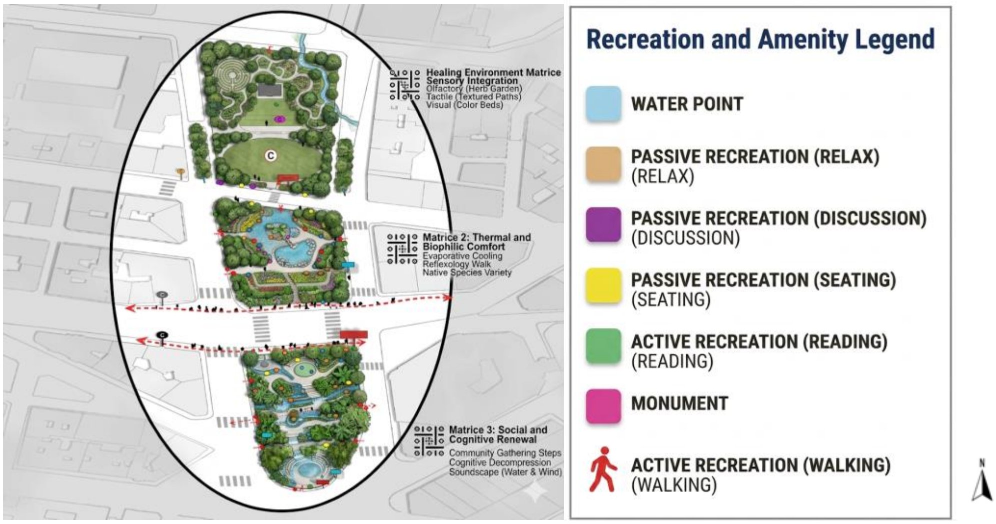

Figure 5. Activities mapping illustration

5. DISCUSSION

The crossing process between the evaluation grid of the 03 parts of the garden and their respective mapping activities allow us to understand why and how and which one stands out or responds more to the needs of the elderly in terms of accessibility, layout, security, comfort… According to the cross-result between the evaluation grid and field observation we see that the second part of the public space is the most frequented by this age group and this is thanks to:

• accessibility: despite the sloping topography, this space does not have steps to access it (presence of ramps).
• natural potential: Shaded areas, water spaces, and vegetation, these elements contribute to creating an aesthetic environment, offering pleasant rest areas.
• the intimacy of the space: we feel that this part of the garden is characterized by a certain degree of intimacy and comfort, visual, thermal and acoustic comfort due to the presence of grouped trees.

Even if this space remains the most frequented by seniors, the layout of the latter remains limited and insufficient, which results in the lack of normal benches with armrests, the absence of public toilets, games tables, etc.

Analysis of the small square and garden reveals a gap between the space's potential and its actual capacity to comfortably accommodate older adults.

Observed activities demonstrate a certain connection to these spaces, embedded in daily routines and activities. However, this attachment alone is insufficient to guarantee an adequate response to the needs of older adults. While the spaces are indeed used, they are not truly adapted in terms of comfort, accessibility, autonomy, and diversity of use. Older adults' appropriation of public space depends on their personal adaptability rather than on the design itself. Therefore, the presence of older adults in these spaces cannot be equated with genuine functional suitability. Rather, it reveals an available use and existing potential. For these spaces to become truly accessible, it is necessary to go beyond mere landscape quality or simply high usage, and to offer amenities that support usage, promote independence, and enhance daily comfort.

This includes considering postures and behaviors (sitting, standing, walking slowly, group gatherings).

The proposed recommendations aim to enhance the existing potential of public spaces through targeted interventions, developed based on the findings of the study.

They are structured around four complementary approaches, allowing action at different scales and across different dimensions of the space: The technical approach, which is the priority of the recommendations, encompasses interventions related to accessibility, safety, and user comfort to ensure independent use of the space by older adults.

The landscape approach aims to enhance existing potential in order to strengthen the sense of belonging.

The cultural and sporting approach seeks to diversify activities and encourage social interaction. The urban art approach contributes to the construction of an identity and a certain attachment to space.

Figure 6. Passive individual recreation

Figure 7. Passive group recreation

6.CONCLUSION

As part of this study on the exclusion of elderly people in public spaces, several observations were noted throughout the work process, in particular through careful observation methods. The analysis of social and spatial dynamics revealed major obstacles to the inclusion of older people in these environments, highlighting significant challenges to promote their full participation in urban life. Based on these findings, several recommendations can be put forward to improve the inclusion of older people in public spaces. Firstly, it is essential to integrate universal design principles into the design of urban infrastructure, ensuring that spaces are accessible, comfortable and suitable for all ages and abilities. Furthermore, particular attention must be paid to the lighting and security of public spaces.

In conclusion, this study explored in depth the problem of the exclusion of elderly people in public spaces, highlighting the multiple challenges that this population faces when participating in the social life of the city. The study demonstrated that inadequate amenities and non-inclusive infrastructure can limit the access and participation of older people, thereby compromising their quality of life.

The research process led to the creation of a reference guide for the design of public spaces specifically intended to meet the needs and concerns of older people. This guide aims to be a practical and innovative tool for urban planners, architects and urban planning managers, offering clear guidelines and recommendations for the design of inclusive, accessible and user-friendly public spaces.

Ultimately, this reference guide represents a significant contribution to the field of urban planning by proposing concrete solutions to mitigate the exclusion of older people in public spaces, thus supporting the overall objective of creating sustainable, accessible and inclusive urban environments for all citizens. It is hoped that this research will serve as a solid foundation for future initiatives aimed at improving the quality of life of older adults within our urban communities.

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Research Article

A Model Proposal for the Selection of Interior Covering and Insulation Products Produced from Waste Materials


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Abstract: The increasing amount of waste associated with industrialization and rising consumption contributes to air, water, and soil pollution, biodiversity loss, climate change, and serious human health problems, ultimately leading to a decline in quality of life. Furthermore, the inadequacy of landfill capacity and the presence of toxic waste disrupt ecosystem balance and accelerate the depletion of natural resources. In this context, recycling waste materials and incorporating them into building materials used in the construction industry is of critical importance for achieving sustainability goals. However, a review of the existing literature reveals that studies addressing interior finishing products produced from waste materials and their application remain limited. In response to increasingly pressing environmental challenges worldwide, this study proposes a systems-based model for selecting interior covering and insulation products produced from waste materials. The model developed within this framework is based on the use of agricultural and construction waste, which constitute a significant share in terms of both quantity and type, as covering and insulation materials among interior finishing products used in interior applications. The model is structured through a holistic approach that includes the analysis of the most suitable waste materials, their integration into the design stage based on analytical findings, and the implementation processes of the resulting materials. In particular, the evaluation of agricultural and construction waste as covering and insulation materials offers solutions aligned with green design principles by combining functionality and aesthetics. Based on data obtained from the literature, strategies that guide and facilitate the selection process have been identified, and economic advantages have been evaluated alongside environmental benefits. This study aims to promote the use of waste materials in the selection of interior covering and insulation products, raise awareness regarding their adoption within relevant industries, and provide a resource to guide designers in decision-making processes. Furthermore, it is expected to contribute to policies and regulations that encourage the use of waste materials in the construction industry. With the proposed model, it is anticipated that both environmental and economic benefits can be considered, that designers can be better informed during the interior design stage regarding the selection of interior covering and insulation products produced from waste materials based on appropriate criteria, and that environmental impacts can be reduced while improving resource management.

Keywords: Waste materials, İnterior covering products, interior insulation products, agricultural wastes, construction wastes, material selection model.

Atık Malzemelerden Üretilen İç Mekan Kaplama ve Yalıtım Ürünlerinin Seçimi İçin Bir Model Önerisi

Özet: Sanayileşme ve tüketim artışıyla birlikte artan atık miktarı, doğal kaynakların tükenmesine ve yaşam kalitesinin düşmesine neden olmaktadır. Bu bağlamda, atık malzemelerin geri dönüştürülerek yapı sektörüne entegre edilmesi, sürdürülebilirlik hedefleri açısından kritik bir öneme sahiptir. Ancak mevcut literatür incelendiğinde, iç mekân bitiş ürünleri kapsamında atık malzeme kullanımının oldukça sınırlı olduğu görülmektedir. Çalışmanın amacı, küresel bağlamda artan çevresel sorunların etkisi doğrultusunda, binalarda atık malzemelerden üretilebilecek iç mekân kaplama ve yalıtım ürünlerinin seçimine yönelik sistem yaklaşımıyla tasarlanmış bir model önerisi sunmaktadır. Bu kapsamda geliştirilen model önerisi, atık miktarı ve türleri incelendiğinde, yoğunluk arz eden tarımsal ve inşaat atıklarının iç mekân uygulamalarında, iç mekân bitiş ürünlerinden; kaplama ve yalıtım malzemesi olarak kullanımını esas almaktadır. Model, atık malzemelerin seçimi için analiz, tasarım aşamasına entegrasyonu ve uygulama aşamalarını içeren bütüncül bir yaklaşımla yapılandırılmıştır. Özellikle tarımsal ve inşaat atıkların kaplama ve yalıtım malzemesi olarak değerlendirilmesi, işlevsellik ve estetiği birleştirerek yeşil tasarım ilkeleriyle uyumlu çözümler sunmaktadır. Literatür taraması yoluyla elde edilen veriler doğrultusunda, seçimi yönlendirmeye ve kolaylaştırmaya yönelik stratejiler belirlenmiş; çevresel faydaların yanı sıra ekonomik avantajlar da değerlendirilmiştir. Çalışma ile iç mekân kaplama ve yalıtım ürünlerinin seçiminde atık malzemelerin kullanımının yaygınlaştırılması, ilgili sektörlerde atık malzeme kullanımının benimsenmesine yönelik farkındalık yaratacak ve karar aşamasında tasarımcılara yol gösterecek bir kaynak oluşturulması amaçlanmaktadır. Ayrıca, atık malzemelerin yapı sektöründe kullanımını teşvik eden politika ve düzenlemelerine katkı sağlayacağı düşünülmektedir. Bu doğrultuda geliştirilen model önerisiyle hem çevresel hem ekonomik faydaların gözetilebileceği, iç mekân tasarımı aşamasında tasarımcıların, uygun ölçütlere göre atık malzemeden dönüştürülmüş iç mekân kaplama ve yalıtım ürünlerinin seçimi konusunda bilinçlendirileceği ve çevresel etkilerin azaltılarak kaynak yönetiminin iyileştirilebileceği düşünülmektedir.

Anahtar kelimeler: Atık malzemeler, iç mekân kaplama ürünleri, iç mekân yalıtım ürünleri, tarımsal atıklar, inşaat atıkları, malzeme seçim modeli.

1.INTRODUCTION

Rapid population growth and the increase in construction activities driven by rising demand are among the primary causes of the depletion of natural resources. As of 2025, the world population stands at 8,218,187,542, while Türkiye's population is reported to be 87,643,318 [1]. The growing population and increasing demand for resources disrupt ecosystem balance by causing environmental problems such as water and air pollution. The escalation of these environmental issues has made the importance of sustainable architectural practices more evident. In this context, the use of building materials derived from waste in interior design contributes significantly to resource efficiency and environmental sustainability [2]. Worldwide, approximately 2.1 billion tons of municipal solid waste are generated each year, and in low-income countries only about 40% of this waste is properly disposed of. Waste management is directly related to sustainable development goals, and the global amount of waste is projected to reach 3.782 billion tons by 2050 [3]. These data highlight the importance of reducing resource consumption and developing robust waste management strategies, along with their consistent and effective implementation.

Population growth, rapid urbanization, and industrial development in Türkiye increase the amount of waste generated, thereby underscoring the need for appropriate disposal methods, production and consumption practices that generate less waste, and the implementation of effective environmental policies [4]. Waste refers to materials that have become unusable due to environmental, economic, or functional reasons but still possess the potential to be recycled or reused. Waste management is of critical importance in reducing environmental pollution and ensuring environmental sustainability. In the literature, waste types are classified in various ways and include categories such as glass, electronic, paper, radioactive, industrial, medical, construction, organic, inorganic, plastic, metal, chemical, healthcare, nuclear, composite, and oil waste [2, 5, 6].

When studies on waste generation and management are examined, waste quantities are observed to vary across categories, with construction waste and agricultural (organic) waste accounting for relatively higher proportions. According to 2020 data from the European Statistical Office, 37.1% of the total waste generated in European Union countries originates from construction activities, making the construction industry the largest waste-producing industry. Construction waste, composed of materials such as concrete, iron, glass, plastic, and domestic appliances, represents a major environmental concern due to both the intensive consumption of natural resources in their production and the large volumes of waste generated. On the other hand, according to the Municipal Waste Statistics Survey conducted by the Turkish Statistical Institute (TÜİK) in 2016, nationwide municipal waste data indicate that biological waste accounts for the largest share at 55.54% compared with other waste types. This situation highlights the importance of the sustainable management of agricultural waste with high recycling potential and emphasizes that the use of biological waste in next-generation material production and agricultural waste management processes can provide both environmental and economic benefits [7, 8, 9, 10, 11].

Çüçen and Altuncı (2022) state that recycled materials such as concrete, metal, and glass are primarily used in foundations, fillings, and structural systems, whereas their integration into interior design remains limited due to aesthetic criteria and health-related constraints. Similarly, in the study conducted by Akyıldız (2020), the contribution of recycled materials to architectural design was examined through ten building examples; the acquisition methods of these materials, their locations of use, and their roles in design were analyzed through diagrams. Although Akyıldız argues that waste-based materials can provide originality and environmental benefits in interior spaces, the study also emphasizes that their practical applications remain limited. The article in Yapı İnşaat Dergisi (2025) and Akyıldız (2020) further underline that recycling rates in interior design remain below 10%, mainly due to criteria such as aesthetics, health considerations, and user perception. These findings clearly demonstrate that the evaluation of waste-based materials as interior finishing products in interior design has not yet become widespread [7, 12, 10, 13, 14, 34].

Literature reviews indicate that waste materials are predominantly used in rough construction processes; however, despite the high volume of waste generated in the construction industry, their utilization as finishing products in interior design remains limited. The substantial quantities of construction- and agriculture-derived waste suggest that converting these materials into interior finishing elements—such as insulation and covering used in interior applications—can play an important role in reducing resource consumption and strengthening sustainable design principles. In this context, the study aims to encourage the integration of waste-based interior building materials into interior architectural design and to provide designers and practitioners with a systematic evaluation tool through a product selection model developed in line with material properties and functional advantages.

2.METHOD

The proposed model presents a systematic decision-making process for the selection of interior finishing products produced from waste materials and aims to contribute to the construction industry in line with sustainable design principles. In developing the model, covering and insulation products derived from various waste materials were first examined through a literature review, from which environmental, economic, and functional impact assessment criteria were identified. At this stage, a comprehensive literature review approach is adopted to map existing research on the use of waste materials and material selection in design studies. The aim is to identify the main research themes, methodological approaches, and gaps in the existing literature. Based on these criteria determined through a literature review, three main processes—analysis, design, and application—were defined. Each process is supported by stages of information collection, analysis, and evaluation, ensuring the applicability of the model from the early design phase to the post-implementation stage.

Developed using a systems approach, each stage is addressed in terms of systems, subsystems, and processes. Within the overall structure, inputs, processes, and outputs are defined, and the output of one subsystem is configured to serve as the input for the subsequent subsystem. In cases where problems arise at any step, the model allows a return to previous stages, thereby enhancing process flexibility. In this way, a feedback-based structure is established that supports designers' decision-making and guides material selection in accordance with spatial requirements and sustainability criteria. The framework is structured to ensure applicability across various stages of the interior design process. Accordingly, this study proposes a sustainability-oriented, feedback-based, and applicable product selection model that promotes the use of waste materials in the selection of interior covering and insulation products.

3.INTERIOR COVERING AND INSULATION PRODUCTS PRODUCED FROM WASTE MATERIALS

By revising recent studies found in the literature, a comprehensive review was conducted on the integration of waste materials into interior building materials. In this study, a literature review was conducted using the Scopus, Web of Science, and Dergipark databases and conference papers. Initially, a broad search was conducted using the keywords 'interior coating products', interior cladding products', 'interior covering products', 'waste material', and 'recycled material'. Then, to clarify and narrow the focus of the study, the types of waste used in the waste conversion process were identified as "construction waste" and "agricultural waste"; in this context, the research was limited to studies classifying these materials. Subsequently, a second phase of the search was structured using the keywords 'interior coating products', 'insulation products', 'covering materials', finishing products', and 'interior building materials' to narrow down the types of materials produced from waste materials.

The studies selected during this review process were chosen from sources that provided the most detailed data on waste materials and the properties of materials produced from these waste materials, to be used in the evaluation processes of the model steps. At this stage, studies providing comprehensive answers to the following questions raised during the screening were prioritized: where is the waste material sourced from, what is the waste material transformed into, in which sector is this newly produced material used, and what are the advantages and disadvantages identified in the use and subsequent stages of the material? This systematic approach contributed to the creation of a transparent and understandable dataset supporting the study's findings; it also ensured that the literature was used as a strategic source of information in developing the research model.

From each study, the advantages and disadvantages of the waste types used and the covering and insulation products produced from these wastes were evaluated in terms of parameters such as technical performance, environmental impact, and production process, thereby data regarding the material transformation processes were collected in a multidimensional manner.

In their study, Ata-Ali et al. (2021) compared recycled and non-recycled insulation materials under different climatic conditions in Spain using the life cycle assessment (LCA) method. Among the "recycled" materials analyzed are wastes obtained from the cork industry. These wastes refer to the recycled form of natural cork derived from the bark of the cork oak tree (Quercus suber), which, after processing, has been used for the first time as an insulation material. The study reports relatively low environmental impact and energy efficiency as advantages. Whereas lower performance in certain climatic regions compared to conventional materials is identified as a disadvantage [15].

In the study conducted by Güller (2001), forestry industry wastes such as fibers, sawdust, and woody particles were combined with various binders and converted into composite wood building materials. These composites were used in the production of building materials such as plywood, fiberboard, and Oriented Strand Board (OSB). The study reports reduced natural resource consumption and lower production costs as advantages. Whereas low resistance to moisture is identified as a disadvantage [16].

In the study conducted by Alici and Dalkılıç (2022), bio-based materials obtained from agricultural and marine-based wastes were converted into furniture, flooring, and surface covering building materials to be used in interior spaces. The study reports renewability, low environmental impact, and aesthetic diversity as advantages. Whereas limited durability and longevity compared to conventional products are identified as disadvantages [17].

In Li's (2016) study, which focuses on the use of renewable materials derived from textile and agricultural wastes to produce wall covering and decorative interior elements, the study reports aesthetic diversity, low environmental impact, and cultural compatibility as advantages. Whereas low fire resistance and moisture resistance are identified as disadvantages [18].

In their research, Guirguis et al. (2023) examined the use of sugarcane bagasse, a locally available agricultural waste in Egypt, in the production of fiberboard intended for covering applications. The resulting board was proposed as an interior covering material and was reported to provide thermal insulation properties as well as aesthetic contributions to interior spaces. The study indicates that the use of the developed material reduces energy consumption and carbon emissions. The study reports thermal insulation properties, aesthetic contribution, reduced energy consumption, and lower carbon emissions as advantages. Whereas no explicit disadvantages are reported [19].

In their study, Devi et al. (2023) presents a general evaluation of sustainable building materials. The study examines the use of waste such as recycled plastic, waste steel dust (ferrock), cork, bamboo, straw bales, and mycelium in the construction industry. They considered these materials as alternatives that can be used for covering, filling, or insulation purposes in walls, floors, and structural elements. The study reports low environmental impact, renewability, and energy efficiency as advantages. Whereas limitations in technical durability and fire safety are identified as disadvantages [20].

In the study conducted by Chen et al. (2024), the technological development of biomaterials used in the construction industry and their implications at the policy level were comprehensively examined. Materials such as mycelium, bio-concrete, natural fibers, and recycled composites were evaluated as options for façade covering, insulation, and interior furnishing elements. The study reports reduced CO_2 emissions, lower water absorption, and improved energy efficiency as advantages. Whereas lack of policy awareness and dependence on conventional materials are identified as disadvantages [21].

In their study, Bourbia, Kazeoui, and Belarbi (2023) compiled an overview of recent studies conducted on bio-based building materials. The study suggests that agricultural wastes such as alfa grass, straw, date palm, and cork can be used in the production of insulation and covering covering materials. The study reports low embodied energy these materials possess, their CO_2-neutral or negative characteristics, and high moisture buffering capacity as advantages. Whereas lack of data on long-term durability particularly of alfa grass, straw, and date palm and compliance with standards are identified as disadvantages [22].

In their study, La Gennusa et al. (2021) evaluated the thermal performance of nine different insulation materials produced from agricultural and industrial wastes. The study reports low environmental impact and high energy efficiency of these materials as advantages. Whereas the need for additional structural strength testing, particularly on wheat straw, rice husk, and corn cob is identified as a disadvantage [23].

The study conducted by Aydın İpekçi et al. (2017), discussed the recovery of building and demolition waste generated by the construction industry for use in the production of interior building materials and assessed its sustainability implications. The study investigated the use of recovered materials in production of building materials such as covering, partition elements, and insulation products, and evaluated their contributions to resource conservation, the reduction of environmental burden, and the improvement of economic efficiency. An exemplary case study conducted specifically examined the use of surface building materials produced from recycled concrete and wood wastes in interior spaces. The findings indicate that although the technical performance of these materials was found to be adequate, users who prioritize aesthetic criteria—such as aesthetic variety, visual diversity, discernible material texture, and overall design coherence—tend to approach these materials with reservation. This situation was associated particularly with the expectations for visual quality in interior design to be high. The study reports resource conservation reduced environmental burden, and economic efficiency as advantages. Whereas lack of certification and limited aesthetic acceptance are identified as disadvantages [24].

In the study conducted by Yalçınkaya, Ş. and Karadeniz, İ. (2022), the reuse of waste materials in architectural design was evaluated through ten building examples. The acquisition methods of the materials, their application areas, and their roles in the design process were analyzed through diagrams. The study reports the potential for creative design and a wide range of applications as advantages. Whereas insufficient compliance with technical standards is identified as a disadvantage [25].

In their study, Lisowski and Glinicki (2023) examined the usage potential of insulation materials produced from biomass wastes in the construction industry. In the study, materials with low thermal conductivity (<0.100 W/m·K) were comparatively evaluated in terms of their environmental impact, production costs, and technical performance. The study notes low carbon footprint of bio-based materials and their contribution to energy savings as advantage. Whereas, low resistance to moisture of some biomass-derived materials, particularly wood shavings and wood residues, straw and wheat stalks, cotton and textile wastes, and rice husk, and their fast biological degradation are identified as their disadvantages [26].

In the study conducted by Marín-Calvo et al. (2023), insulation panels were produced using recycled paper and rice husk, and the resulting building materials were tested according to ASTM standards. The study notes low thermal conductivity (0.04 W/m·K) of these materials and adequate mechanical durability they offer as their advantage. Whereas, difficulties in achieving homogeneity during production are identified as their disadvantages [27].

In the study conducted by Ertaş and Mıhlayanlar (2025), products such as new glass panels, glass wool, and expanded glass aggregate were produced from glass wastes. As an advantage, it was reported that adding 10% glass cullet to the glass production process reduces energy consumption by approximately 2.5–3%, and that each 1 ton of glass cullet used saves about 1.2 tons of raw materials. Whereas, lower compressive strength these newly produced expanded glass aggregates exhibited compared to the conventional aggregates, and their increased water absorption capacity due to their higher porosity were noted as their disadvantageous features that require careful consideration in terms of durability when used under external environmental conditions [28].

In the experimental study conducted by Özbek (2022), brick waste—one of the most common by-products of construction and demolition waste—was used to produce a new composite acoustic material, with clay added as a binder and rice husk waste incorporated to provide porosity. The study reports that applying this material as a finishing layer on interior wall surfaces yields favorable results in projects where increased overall sound absorption is desired. The main advantage of the material is its high sound absorption coefficient. In addition, because the material is elastic before firing, it allows reflective panels to be produced in different shapes. As a disadvantage, it is noted that the effect of different firing temperatures on the sound absorption performance of the material could not be determined with certainty. Furthermore, it was observed that increasing the thickness of the samples is more effective in improving the sound absorption coefficient, particularly at low frequencies [29].

In the study by Liuzzi et al. (2023), paper pulp was first produced by processing locally sourced office paper waste. Biomass aggregates—including sawdust powder, coffee grounds, and fava bean residues—were subsequently incorporated into the pulp mixture, from which bio-based thermal insulating building materials were produced. The study reports that these materials exhibit low thermal conductivity and can therefore be used as thermal insulation panels, while their acoustic properties also allow their application as sound insulation panels installed on interior walls and suspended ceilings. As an advantage, it is reported that all tested samples exhibited sufficiently low thermal conductivity to be classified as thermal insulators. In particular, the mixture containing sawdust powder demonstrated the best insulation performance as per the study. As a disadvantage, differences in acoustic behavior were observed between the upper and lower surfaces of the samples due to shrinkage occurring during the production and drying processes. The fibrous structure of the mixture containing sawdust powder contributed to superior insulation performance by enabling the material to develop a more porous final matrix [30].

In the study conducted by Sezgin and Aytar Sever (2022), new materials produced using recycled wood and paper wastes were examined. The study reports acoustic insulation, energy efficiency, humidity regulation, and antibacterial properties as advantages. Whereas the need for further research on durability is identified as a disadvantage [31].

In the study conducted by Sair et al. (2019), an environmentally friendly composite material was produced from a mixture of gypsum, cork fibers, and waste cardboard. The aim of the study was to develop ecological thermal insulation materials capable of meeting economic, ecological, and mechanical requirements by limiting heat losses in buildings. The primary advantage of the newly produced material is the significant improvement in thermal insulation capacity—up to 300%—compared to pure gypsum. With the addition of waste cardboard to the mixture, the mechanical properties of the material were observed to improve, as the cardboard waste helps fill the voids between cork particles. As a disadvantage, it was noted that due to the hydrophilic nature and high porosity of plant fibers, the material exhibited greater water absorption than pure gypsum, indicating that this property must be carefully controlled. The study concludes that the developed material is suitable for building thermal insulation applications. [32].

In the study conducted by Barreca and Fichera (2013), the use of olive pits as an additive in lime–cement mortar was examined. The aim of the study was to determine whether the incorporation of olive pits could contribute positively to improving the thermal insulation properties of the mortar and enhancing its thermos-physical characteristics. The results showed that the addition of olive pits reduced the thermal conductivity of the mortar. The study also reports that as the density of the material increases, its thermal conductivity increases, whereas the specific heat capacity exhibits an inverse relationship with density. [33].

Based on the data obtained from the reviewed studies, Table 1 systematically presents the potential of different types of waste materials to be transformed into interior building products. It is observed that agricultural and construction wastes can be used particularly as insulation, covering, covering and partition elements on interior surfaces such as walls, ceilings, and floors.

Table 1. Interior Covering and Insulation Products Produced Form Waste Materials [*15-33*]

LITERATURE REVIEW CONDUCTED WITHIN THE SCOPE OF THE STUDY						
AUTHORS	**YEAR**	**WASTE TYPE**	**NEW MATERIAL PRODUCED**	**INTERIOR APPLICATION AREA**	**ADVANTAGES**	**DISADVANTAGES**
Ata-Ali, N., Penadés-Plà, V., Martínez-Muñoz, D., & Yepes, V.	2021	Recycled cork waste	Insulation materials	Wall and ceiling insulation	Low environmental impact, energy efficiency	Weak performance in certain climates
Güller, B.	2001	Fibers, sawdust, woody particles	Wood composites	Wall and floor covering	Reduced natural resource consumption, low production cost	Adverse environmental impact of binders, low moisture resistance
Alici, N., & Dalkılıç, B.	2022	Agricultural and marine-based wastes	Bio-based furniture, flooring, surface covering	Furniture, flooring, surface covering	Renewability, low environmental impact, aesthetic diversity	Limited durability and longevity
Li, J.	2016	Textile and agricultural wastes	Wall cladding, decorative components	Wall cladding, decorative components for the interior	Aesthetic diversity, low environmental impact, cultural compatibility	Low fire and moisture resistance
Guirguis, M. N., Farahat, Z., & Micheal, A.	2023	Sugarcane bagasse	Fiberboard	Wall covering	Reduced heat loss, aesthetic contribution, low energy consumption	Not specified
Devi, M., Saini, N., Bhardwaj, I., & Kataria, R.	2023	Plastic, steel dust, cork, bamboo, straw, mycelium	Wall systems, floor systems, insulation layers, structural components	Walls, floors, insulation, structural components for the interior	Low environmental impact, renewability, energy efficiency	Limited technical durability and fire safety
Chen, L., Zhang, Y., Chen, Z., Dong, Y., Jiang, Y., Hua, J., Liu, Y., Osman, A. I., Farghali, M., Huang, L., Rooney, D. W., & Yap, P. S.	2024	Mycelium, bioconcrete, natural fibers, composites	Facade covering, insulation, interior furnishing materials	Facade covering, insulation, interior furnishing	CO_2 emission reduction, low water absorption, energy efficiency	Lack of policy awareness, dependence on conventional materials
Bourbia, S., Kazeoui, H., & Belarbi, R.	2023	Alfa grass, straw, date palm, cork	Insulation and covering materials	Covering, wall and ceiling insulation	Low embodied energy, CO_2-neutrality, high moisture buffering capacity	Lack of data on long-term durability and compliance with standards
La Gennusa, M., Marino, C., Nucara, A., Panzera, M. F., & Pietrafesa, M.	2021	Agricultural and industrial wastes	Insulation materials	Wall and ceiling insulation	Low environmental impact, high energy efficiency	Additional tests required to determine accurate structural strength
Aydın İpekçi, C., Coşkun, N., & Tikansak Karadayı, T.	2017	Concrete and wood construction wastes	Coveringg, partition panels, and insulation materials	Covering, partition and insulation panels	Resource conservation, reduced environmental burden, economic efficiency	Lack of aesthetic acceptance, insufficient certification data
Yalçınkaya, Ş., & Karadeniz, İ.	2022	Various waste materials	Building materials (various types)	Wall panels, partitions, decorative components for the interior	Enables creative design applications; wide range of uses	Lack of compliance with technical standards
Lisowski, P., & Glinicki, M. A.	2023	Biomass wastes	Insulation materials	Wall and ceiling insulation	Low carbon footprint, energy savings	Low resistance to moisture and biological degradation
Marín-Calvo, N., González-Serrud, S., & James-Rivas, A.	2023	Recycled newspaper, rice husk	Thermal insulation panels	Suspended ceilings, partitions, doors, furniture, attics, walls and floors	Low thermal conductivity, sustainability, low carbon footprint, low embodied energy, high compressive durability, moisture control	Long drying time, risk of mold formation in highly humid environments, need for additional chemical treatment for flame resistance
Ertaş, G., & Mıhlayanlar, E.	2025	Glass wastes (construction/demolition waste)	Glass panels, glass aggregate, glass mosaic	Thermal and acoustic insulation, decorative surface cladding	Energy savings and conservation of natural resources	Insufficient collection and sorting infrastructure
Özbek, U.	2022	Rice husk	Composite acoustic materials	Finishing layer on wall surfaces	High sound absorption performance	Sporadic nonlinear influence of parameters on acoustic results
Liuzzi, S., Rubino, C., Martellotta, F., & Stefanizzi, P.	2023	Sawdust, coffee grounds, fava bean residues	Thermal and acoustic insulation materials for walls and ceilings	Walls, ceilings, acoustic panels	Efficient thermal insulation	Acoustic behavior differences between upper and lower surfaces of the material
Sezgin, S., & Aytar Sever, İ.	2022	Waste wood, timber offcuts, paper/newspaper	Recycled wood, wood terrazzo	Wall covering	High acoustic performance, moisture regulation, energy efficiency, antibacterial properties, high durability	Low mechanical durability
Sair, S., Mandili, B., Taqi, M., & El Bouari, A.	2019	Cork fiber, waste cardboard	Composite panels	Thermal and acoustic insulation	Efficient thermal insulation, high sound absorption	High water absorption, weak mechanical resistance
Barreca, F., & Fichera, C.	2013	Cork granules	Cement/lime mortar with cork granule additive	Thermal insulation	Efficient thermal insulation	Not specified

As shown in the table, the advantages of waste-based products include a low carbon footprint, energy efficiency, reduced consumption of natural resources, the use of local resources, aesthetic diversity, and cost-effectiveness. Particularly favorable performance has been observed in criteria such as sound and thermal insulation, impact absorption, lightness, and ease of installation. However, several technical and perceptual limitations are also identified, including moisture and fire resistance, long-term mechanical performance, micro-plastic emissions, aesthetic acceptance, and compliance with standards. These findings suggest that waste-based materials can be considered a sustainable alternative in interior design; however, they also demonstrate that multidimensional criteria—such as technical validation, user perception, and regulatory compliance—must be addressed in an integrated manner to enable their widespread adoption.

4. A SELECTION MODEL FOR INTERIOR COVERING AND INSULATION PRODUCTS PRODUCED FROM WASTE MATERIALS

The “Selection Model for Interior Covering and Insulation Products Produced from Waste Materials” was developed using a systems approach to evaluate waste-based building materials in interior environments from a holistic perspective, considering environmental, economic, and design dimensions. Initially, an extensive literature review was conducted to identify the criteria and evaluation approaches employed in the reviewed studies. Consequently, the data derived from the literature were assessed based on their contribution to the stages of the model, and those deemed to be limited in their application suitability were excluded.

The selected data were organized within the main structure of the model under the relationships of “Inputs,” “Process,” and “Outputs,” thereby forming the decision-making stages of the model (Figure 1). In the “Inputs” stage, the objective is to promote efficient resource utilization, reduce raw material consumption, and increase the use of waste materials through appropriate material selection based on their reuse in interior covering and covering applications. Accordingly, the defined goals include: classifying the types of waste predominantly generated by the construction industry; determining which types of waste materials can be integrated into specific interior finishing products; transforming the identified waste materials into new interior finishing products; and encouraging the selection and adoption of these products in interior design applications. The resources required to achieve these objectives include actors such as designers, interior architects, architects, material engineers, and users; as well as legislation, standards, and certifications; new materials derived from waste materials; literature and patent data; product information available in the market; qualified workforce; technology and experience; supply and logistics resources; and financial resources.

In the “Process” stage, the designer follows the “Analysis,” “Design,” and “Implementation” action steps defined in the model and proceeds toward selecting interior covering and insulation products produced from waste materials in line with the established objective and goals. Within this stage, the “Analysis” process comprises user requirement analyses, functionality analyses, and application area analyses. The “Design” process includes the determination of the needs program, the configuration of spatial relationships, preliminary design activities, material selection and main decisions, and approved final design. In the “Implementation” process, the creation of the implementation project according to the approved final design, quantity take-off and cost estimation, implementation process planning, and execution are carried out. Within this process, production planning is not included; the focus is on material selection and on defining application decisions specific to the selected material.

In the “Outputs” stage, the outputs of the model are defined in terms of environmental, economic, and implementation-oriented gains. Accordingly, the expected outputs are structured as follows: under environmental benefits, reduction of environmental pollution and resource consumption; under economic efficiency, cost savings through reduced need for new product production and lower material costs; under waste valorization, reduction of waste quantity and alleviation of disposal burden; and under dissemination potential, promotion of waste material use in interior covering products, along with increased industry awareness and a broader range of application examples. These outputs contribute to demonstrating the applicability of the model and its contribution to sustainability goals.

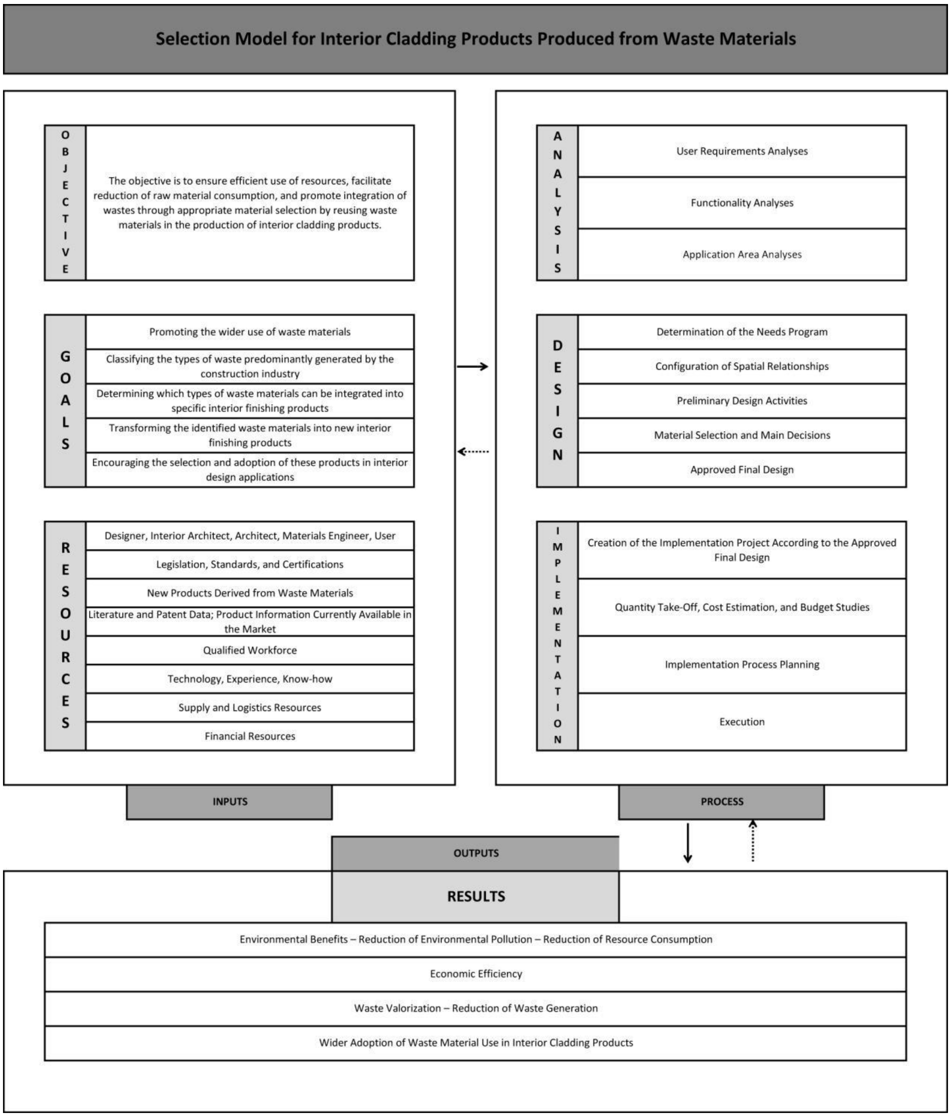

Figure 1. Selection Model for Interior Covering and Insulation Products Produced from Waste Materials (developed by the author).

This comprehensive selection model not only provides designers with a technical decision-making tool but also enables a holistic evaluation of factors such as user requirements, environmental impact, and production conditions. In this way, the model offers a guiding framework for designers and indirectly facilitates users' access to more sustainable, functional, and environmentally responsive products.

Systems and Subsystems of the Model

The “Inputs” stage of the model is structured to define the initial conditions and key decision drivers that shape its conceptual framework. At this stage, a sustainability-oriented objective is established to promote the selection and use of waste-based materials. Accordingly, the goals and resources required to achieve this objective are systematically identified. These inputs should not be treated merely as data sources; rather, they function as strategic drivers that shape the direction of the decision-making process. In this way, the operation of the model is guided, and a holistic decision-making framework is established. This stage provides the necessary data and resources to support the proper and systematic functioning of the “Analysis,” “Design,” and “Implementation” systems.

As the first step of the “Process” stage, the “Analysis” system provides a multidimensional evaluation framework for the selection of waste-based interior covering and insulation materials. The User Requirement Analyses subsystem enables the assessment of human-centered data such as ergonomic comfort, health impacts, user profiles, and usage feedback. Within the Functionality Analyses subsystem, physical, mechanical, and chemical properties, together with relevant sustainability and environmental factors, are examined to determine material performance and environmental impact. These analyses play a critical role, particularly in the comparison of waste-based materials with conventional products. The Application Area Analyses subsystem, in turn, enables the evaluation of factors such as supply chain feasibility, climatic compatibility, regulatory compliance, and space-specific requirements. This structure functions as a robust evaluation tool for decision-makers, supporting the assessment of technical accuracy, user satisfaction, and environmental efficiency.

The “Design” system guides material selection and spatial decision-making based on the findings obtained from the analysis stage. Within the Determination of the Needs Program subsystem, spatial requirements, material properties, and application-specific requirements are defined. Within the Configuration of Spatial Relationships subsystem, functional organization, user behavior, and comfort conditions are evaluated, and user-oriented design scenarios are developed. In the Preliminary Design Activities subsystem, design alternatives are evaluated in terms of aesthetic considerations, economic feasibility, and certification compliance. Within the Material Selection and Main Decisions subsystem, building materials produced from agricultural and construction waste are evaluated in terms of their physical, chemical, mechanical, and technical properties, insulation performance, and compatibility with spatial identity. These decisions address multiple requirements, including load-bearing capacity, resistance to wear, durability, compliance with safety standards, and sound and thermal insulation performance. Through the Approved Final Design subsystem, all these inputs are translated into final design decisions. This system offers a holistic design approach in terms of sustainability, user well-being, and technical performance

The “Implementation” system consists of processes that enable the selected material to be technically and operationally implemented within the interior environment. Within the Creation of the Implementation Project According to the Approved Final Design subsystem, aspects such as application methods, techniques, application areas, and related requirements are defined. Within the Quantity Take-Off, Cost Estimation, and Budget Studies subsystem, material quantity calculations, labor planning, unit price analyses, alternative comparisons, logistics costs, and raw material–product price comparisons are carried out, contributing to economic efficiency. Within the Implementation Process Planning subsystem, procedures such as surface preparation, equipment selection, technical specifications, scheduling, quality control, finishing processes, protective applications, and occupational health and safety measures are addressed. The Execution subsystem ensures that the material is properly applied within the space in accordance with application type (insulation, painting, cladding, covering, coating), application area (walls, ceilings, floors), and application method (on-site or prefabrication), thereby maintaining performance continuity.

The “Outputs” stage of the model defines the environmental, economic, and industry-specific gains generated through the process. Environmental benefits, economic efficiency, the reintegration of waste into reuse streams, and the broader adoption potential of waste-based materials constitute the principal outcomes of the model.

5. FINDINGS

The “Selection Model for Interior Covering and Insulation Products Produced from Waste Materials” developed in this study addresses the use of waste-based materials in interior finishing products through a multidimensional evaluation framework. The criteria and assessments derived from the literature were organized in alignment with the process–action–selection structure of the model, and the analysis was conducted based on criteria with the greatest influence on material performance and decision-making. Accordingly, the findings presented in Tables 2 and 3 constitute a structured evaluation framework that supports designers in their decision-making processes.

Table 2. Integrated Criteria for Waste-Based Product Selection (developed by the author).

VARIOUS IMPACT ASSESSMENT CRITERIA FOR INTERIOR COVERING AND INSULATION PRODUCTS PRODUCED FROM WASTE MATERIALS	
1	EFFECT OF BINDING AGENTS IN PRODUCED MATERIALS ON HUMAN HEALTH
2	EFFECT OF RAW MATERIALS ON PRODUCTION COST
3	FEASIBILITY OF MAINTAINING COLOR CONSISTENCY IN PRODUCED MATERIALS
4	IMPACT OF TIME-RELATED INDIRECT COSTS DURING THE LOGISTICS STAGE
5	IMPACT OF PRODUCED MATERIALS ON CARBON FOOTPRINT
6	BIOLOGICAL DEGRADATION RESISTANCE OF PRODUCED MATERIALS
7	WASTE GAS EMISSIONS FROM PRODUCED MATERIALS
8	CONTRIBUTION OF PRODUCED MATERIALS TO WASTE REDUCTION
9	SUPPLY CONTINUITY OF MATERIALS USED IN PRODUCTION
10	IMPACT OF ADDITIVES IN PRODUCED MATERIALS ON VOC EMISSIONS
11	TOXICITY EFFECT OF ADDITIVES IN PRODUCED MATERIALS
12	IMPACT OF ADDITIVES USED IN PRODUCED MATERIALS ON INDOOR AIR QUALITY
13	FLAME SPREAD RESISTANCE OF PRODUCED MATERIALS
14	SURFACE HARDNESS AND ABRASION RESISTANCE OF MATERIALS
15	UV RESISTANCE OF MATERIALS

Table 2 presents 15 core criteria integrated into the process–action–selection structure of the model developed for the selection of waste-based building materials. These criteria were specifically defined to reflect the characteristics of waste-based material production processes. Each criterion is associated with the content structure of the selection stage and formulated to enable its integration into the model’s decision-making system.

The criteria were developed based on the literature data presented in Table 1, with the aim of evaluating the properties of products derived from waste materials as reported in each study. Their integration into the model provides guidance for designers in achieving design objectives during the selection stage and offers systematic support for making informed product choices grounded in environmental and health considerations.

This evaluation system enables a comparative assessment of the literature data across the 15 core criteria. Each study was systematically analyzed in terms of waste type, intended use of the newly produced material, interior application area, and corresponding criteria (Table 3).

Table 3. Multi-Criteria Evaluation of Waste-Based Interior Covering and Insulation Materials Based on Literature Review (This table was created by the author based on the information in Tables 15–31).

NEW MATERIAL	INTERIOR APPLICATION AREA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Insulation materials	Wall and ceiling insulation	✗	?	?	?	✓	?	✓	✓	✓	?	✓	✓	?	?	?
Wood composites	Wall and floor covering	?	✓	?	?	?	✓	?	✓	✓	?	?	?	✓	?	?
Bio-based furniture, flooring, surface covering	Furniture, flooring, surface covering	✓	✓	✓	✓	✓	✗	✓	✓	✓	?	✓	✓	?	?	?
Wall covering, decorative components	Wall covering, decorative components for the interior	✓	✓	✓	✓	?	?	?	?	✓	?	✓	?	✓	✓	?
Fiberboard	Wall covering	?	✓	✓	?	✓	?	✓	✓	✓	?	✓	✓	?	✓	?
Wall systems, floor systems, insulation layers, structural	Walls, floors, insulation, structural components for the interior	✗	✓	?	✗	✓	✓	✓	✓	?	✗	✗	✗	✓	✓	✓
Facade covering, insulation, interior furnishing materials	Facade covering, insulation, interior furnishing	✗	✗	?	✗	✓	✗	✓	✓	✓	✗	✗	✓	✗	?	✓
Insulation and covering materials	Covering, wall and ceiling insulation	✗	✓	?	✓	✓	✗	✓	✓	✓	?	?	✓	✗	✗	?
Insulation materials	Wall and ceiling insulation	✓	✓	?	✓	✓	?	✓	✓	✓	?	✓	✓	?	✗	?
Covering, partition panels, and insulation materials	Covering, partition and insulation panels	✗	✓	?	✗	✓	?	?	✓	✓	?	✗	?	?	✗	?
Building materials (various types)	Wall panels, partitions, decorative components for the interior	?	✓	?	✓	✓	?	?	✓	✓	?	?	✓	?	✓	✓
Insulation materials	Wall and ceiling insulation	✓	✓	?	?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	?
Thermal insulation panels	Suspended ceilings, partitions, doors, furniture, attics, walls and	?	✓	?	✗	✓	✓	?	✓	✓	?	?	✓	?	✓	?
Glass panels, glass aggregate, glass mosaic	Thermal and acoustic insulation, decorative surface covering	?	✓	?	✗	✓	✓	✓	✓	✓	✓	✓	✓	?	?	✓
Composite acoustic materials	Finishing layer on wall surfaces	✓	✓	?	?	✓	✓	?	✓	✓	?	✓	✓	✓	?	?
Thermal and acoustic insulation materials for walls and cielings	Walls, ceilings, acoustic panels	✓	✓	?	✓	✓	?	✓	✓	✓	✓	✓	✓	✓	?	?
Recycled wood, wood terrazzo	Wall covering	✓	✓	✗	?	✓	?	?	✓	?	?	✓	✓	?	✗	?
Composite panels	Thermal and acoustic insulation	?	✓	?	?	✓	?	?	✓	?	?	?	✓	?	✗	?
Cement/lime mortar with cork granule additive	Thermal insulation	?	?	?	?	?	?	?	✓	?	?	?	?	?	?	?

✓	?	✗
POSITIVE	UNKNOWN NOT ANALYZED	NEGATIVE

The data compiled from the literature review provide detailed information on criteria such as energy use in production processes, carbon footprint, toxic content, and material integration, thereby offering technical validation and a substantive reference base for designers. For users, these data support informed decision-making by providing insight into the scientific background and environmental impacts of the products. The analyses presented in Table 3 demonstrate how the 15 core criteria integrated into the selection stage of the "Selection Model for Interior Covering and Insulation Products Produced from Waste Materials" operate at both the application and literature levels. For designers, this evaluation system enables a multidimensional assessment of technical suitability, environmental impact, sustainability, and health-related risks during the product selection process. For users, it establishes a basis for informed product choices, particularly with regard to the health impacts of the materials used.

6.CONCLUSION

Increasing industrialization and consumption patterns in our world today have led to a significant rise in waste generation, resulting in the depletion of natural resources and posing a threat to environmental sustainability. Due to its high resource consumption and adverse environmental impact, the construction industry is considered one of the priority areas for the implementation of sustainability policies. In this context, transforming waste materials into building products and integrating them into interior design processes is deemed to offer significant environmental and economic benefits. A review of the existing literature indicates that waste materials are more commonly used in their unprocessed form in building envelopes and rough construction processes. However, waste-based interior covering and insulation products—which process different types of waste materials and incorporate them into their production—are often overlooked and remain underutilized in design practice, as there is no systematic decision-making framework to guide designers in selecting appropriate products for specific applications.

To address this gap, the study proposes a model structured through a systems approach that enables the evaluation of waste materials in the selection of interior covering and insulation products. The model does not limit the use of waste materials to the selection stage alone; rather, it introduces a holistic framework encompassing design, implementation, post-application control, and documentation processes. Accordingly, the study demonstrates that agricultural and construction waste can be effectively utilized as covering, cladding and insulation materials, offering solutions capable of meeting both aesthetic and functional requirements. The model enables designers to simultaneously assess technical, environmental, economic, and user-oriented criteria, thereby supporting a more systematic and traceable selection of waste-based materials for interior surfaces. Furthermore, the model is projected to facilitate the integration of waste materials into interior building material production processes in alignment with incentive policies and to serve as a strategic tool for reducing adverse environmental impacts.

In conclusion, the proposed model is expected to contribute to the broader selection and adoption of interior finishing products produced from waste materials, while upholding environmental and economic benefits, improving resource management, and promoting the practical implementation of sustainable design. In this way, the use of new building materials derived from waste is anticipated to be encouraged through designer-driven processes that indirectly engage end users. In this respect, the model can be regarded not only as a selection tool but also as a guiding framework in terms of environmental responsibility and design ethics.

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A Discussion on Temporal and Ephemeral Architecture

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Abstract: This paper discusses that ephemeral architecture cannot simply be associated with temporal architecture, which refers to short-lived structures, such as pavilions, exhibition spaces, and installations. In this context, the paper aims to redefine the ephemeral architecture of the twenty first century, where architectural objects are created as images using digital technologies and, most recently, artificial intelligence. It employs the method of conceptual analysis to discuss the shift from object to image in architecture. By this method, the paper reveals that image-objects now dominate the field of architecture in which objects are mostly replaced by images. There are also other replacements between space and screen, material and immaterial, physical and non-physical, appearance and disappearance. Image-objects refer to the new materiality in architecture. They are created as immaterial structures that appear and disappear within the blink of an eye. We usually experience structures through images shared on digital and social media, for only a few seconds. This is why they are described as ephemeral structures in the paper. The paper discusses conceptual shifts from object to image to distinguish temporal and ephemeral by relating the former to the physically constructed objects for events and exhibitions, and the latter to the non-physically created images for projecting onto buildings' surfaces. These ephemeral images do not even need a physical surface or structure, since they can be created and experienced without bodily presence. Therefore, the paper redefines ephemeral architecture as the design of image-objects, emphasizing the instantaneous impact of images in the twenty first century architecture. This redefinition is intended to clarify the confusion arising from the use of 'temporal' and 'ephemeral' as synonymous terms in architectural theory and design.

Keywords: Temporary, ephemeral, image, image-object, ephemeral architecture.

Geçici ve Uçucu Mimari Üzerine Bir Tartışma

Özet: Bu makale, uçucu mimarinin sadece pavilyonlar, sergi alanları ve enstalasyonlar gibi kısa ömürlü nesnelerle ilişkilendirilemeyeceğini tartışmaktadır. Bu bağlamda, makale nesnelerin dijital teknolojilerle ve son zamanlarda yapay zeka teknolojileri sayesinde hızla ve kolaylıkla oluşturulan imgelerine odaklanarak yirmi birinci yüzyılın uçucu mimarisini yeniden tanımlamayı amaçlamaktadır. Makale, mimaride nesneden imgeye doğru yaşanan değişimi tartışmak için kavramsal analiz yöntemini kullanmaktadır. Bu yöntemle, nesnelerin imgelerle yer değiştirdiği mimarlık ortamına imge-nesnelerin hakim olduğunu ortaya koymaktadır. Ayrıca mekan ve ekran, maddesel ve maddesel olmayan, fiziksel ve fiziksel olmayan, görünme ve kaybolma arasında yaşanan yer değişimlerini de ele almaktadır. İmge-nesneler, mimaride yeni maddesellikle ilişkili olarak tartışılır. Bunlar, maddesel olmayan oluşumlardır ve göz açıp kapayıncaya kadar ortaya çıkar ve kaybolurlar. Bu oluşumları çoğunlukla dijital ve sosyal medyada paylaşılan görüntüler aracılığıyla ve birkaç saniye boyunca deneyimleriz. Bu nedenle makalede imge-nesneler geçici oluşumlar olarak tanımlanmaktadır. Makale, nesneden imgeye doğru yaşanan kavramsal değişimleri tartışırken, geçici ve uçucu olanı, ilkini etkinlikler ve sergiler için fiziksel olarak inşa edilen nesnelerle, ikincisini ise binaların yüzeylerine yansıtılan fiziksel olmayan imgelerle ilişkilendirerek birbirinden ayırmaktadır. Hatta bu uçucu imgeler, fiziksel bir yüzeye veya binaya ihtiyaç duymamakta; çünkü bedensel varlıkları olmadan ve bedensel olarak deneyimlenmeye ihtiyaç duymadan var olmaktadır. Bu nedenle makale, uçucu mimariyi imge-nesnelerin tasarımı olarak yeniden tanımlamış, yirmi birinci yüzyılın uçucu mimarisinde imgelerin anlık etkileri olduğunu vurgulamıştır. Yeniden tanımlama, mimarlığın kuram ve tasarım alanlarında 'geçici' ve 'uçucu' terimlerinin eşanlamlı olarak kullanılmasından kaynaklanan karışıklığı gidermek için yapılmıştır.

Anahtar kelimeler: Geçici, uçucu, imge, imge-nesne uçucu mimari.

1.INTRODUCTION

Marshall Berman's quote, 'All that is solid melts into air.', refers to the ever-changing social, cultural and technological circumstances that emerged with modernism at the beginning of the twentieth century [1]. However, the quote seems even more relevant to describe the specific atmosphere of the twenty-first century, in which everything is in a constant state of flux, including architectural norms and principles. One of them that has survived for centuries is that architecture should be permanent and last as long as possible. Accordingly, architects have designed rigid, static, permanent and monumental structures that have functioned for many years. However, architecture is not permanent, but temporary in its nature. Throughout history, people have built various spaces and structures without disciplinary knowledge. These spaces were mostly inhabited, but they had a short lifespan because nomadic living was dominant. Before the Agricultural Revolution, people tended to construct temporary structures to protect themselves from the worldly conditions. They used local, natural materials such as wood and stone for these structures and reconstructed them in the event of natural disasters, animal attacks, displacement and other expected or unexpected circumstances. Apart from their shapes, these temporary spaces and structures could be heavy or light, dense or not, and made of various materials. Nomadic culture led people to embrace temporary architecture. After the Agricultural Revolution, there was a shift in architecture from unsettled to settled living. People began to settle down and sustain their lives in built environments. This paved the way for a further shift towards permanent structures. Site-specific conditions played a crucial role in the design of these structures, ensuring they were firmly rooted in the site and would last for years.

Following the Industrial Revolution, the emergence of modernism highlighted the dichotomy between temporariness and permanence. Modern architects sought to liberate the discipline of architecture from its historical norms and principles. Consequently, they designed buildings with pilotis to cut their relationship with the site and environment. They used industrial materials such as concrete, steel and glass to make buildings look lightweight and transparent, in contrast to the solid, heavy and monumental structures of the pre-modern world. This modern structural approach, encompassing lightness, transparency, and transience, anticipates contemporary image-based architectural productions. Although modern architects embraced flexibility, dynamism, mobility and transparency to establish a new relationship between buildings and their environments, they usually produced permanent structures. But the normative principles of architecture have changed dramatically in modern times, leading architects to focus on producing inflatable, adaptable, changeable and moveable structures with new shapes and materials, such as balloons, blobs and clouds, which were considered more relevant design solutions for an unpredictable world in the second half of the twentieth century. These were labelled as temporary structures in architectural history. In the discursive environment of this paper, they are also evaluated as 'temporal' rather than 'ephemeral'. Whether short-lived or not, these structures were seen as designs with the ability to adapt to the century's new realities and dynamics, such as the increased mobility promoted by advances in transportation technology. The advent of cars, planes and high-speed trains has transformed the design of architectural spaces and structures within the re-emerging nomadic culture of the last century. In a world defined by speed and displacement, temporary architecture is most associated with pavilions, installations and flexible, inflatable and movable structures. These are usually described as ephemeral structures in architecture. However, the paper aims to redefine 'ephemeral architecture' not by simply associating it with short-lived structures such as pavilions or installations. It employs the method of conceptual analysis to distinguish the terms 'temporal' and 'ephemeral'. This analysis encompasses a variety of structures, including primitive sheds, exhibition spaces, balloons and containers. It also includes structures that function as screens rather than spaces. The paper emphasizes the need for the redefinition of ephemeral architecture in the twenty-first century — an era characterized by the Digital Revolution and advances in information and communication technology, including the Internet, digital media, social media, and, most recently, artificial intelligence. Previous definitions of ephemeral architecture are insufficient because they are limited to objects that are both temporary and physically constructed. The paper argues that these definitions should be expanded to include ephemeral, non-physical images. In this context, ephemerality refers to an accelerated temporality based on digital images as non-physical structures. New digital technologies and new media enable architectural structures to be ephemeral in terms of their shapes, spaces, materials, meanings and messages. Ephemeral structures have ephemeral meanings for people who mostly experience them through screens rather than bodily presence. Therefore, the paper suggests that 'space' is being replaced by 'screen' in contemporary architecture. Similarly, there is a replacement between 'object' and 'image', as we experience images rather than objects and are surrounded by digital images. These images appear and disappear within seconds. Their appearance and disappearance change our spatial perception and how we experience space. The paper discusses ephemeral spaces and structures as 'image-objects', emphasizing that they exist independently of an object or structure. They are also referred to as 'objectless objects' throughout the paper. The paper's original contribution to architectural theory and design is its conceptual analysis of ephemeral architecture, which highlights the term 'image-object' as an 'objectless object'. In this respect, it also highlights conceptual shifts from 'object' to 'image', 'space' to 'screen', 'appearance' to 'disappearance', and 'material' to 'immaterial'. Through this analysis, the paper redefines ephemeral architecture as the design of an ever-changing building image with new media technologies. Ephemerality blurs the boundaries between the disciplines of art, design, media, and architecture. Architects design structures as image-objects, independent of site-specific conditions, adopting an approach similar to that of a media artist. This paves the way for architects to position their designs within an interdisciplinary context and embrace ephemeral architecture even without designing a physical structure. When architecture is no longer bound to a specific site or structure, it is liberated from its fundamental constraints, and the image becomes the new material. By focusing on this new immateriality, the paper distinguishes between ephemeral and temporal, relating ephemeral architecture to designing images, rather than objects, in contemporary architecture.

2. TEMPORARY ARCHITECTURE

The most common examples of temporary architecture are pavilions, installations and exhibition spaces, which are built for a specific time or event. These structures are usually lightweight and moveable and are not intended to have a permanent presence. They often create a popular destination for people to gather, socialize and experience. They revitalize not only social and cultural life, but also economic life by attracting tourists to the built environment. Temporary structures have played a significant role in the history of architecture through their appearance and subsequent disappearance. The history of temporary structures stretches from primitive huts, tents, and sheds in pre-modern times to non-primitive exhibition halls and spaces such as the Crystal Palace (1851), the Barcelona Pavilion (1929) and the Serpentine Pavilion (2000–…). Whether primitive or not, any structure that exists for a limited time is usually considered an example of temporary architecture. But these structures can sometimes become permanent, or vice versa. Lifespan-based definitions can limit our understanding of temporariness. In architecture, however, temporary is commonly seen as the opposite of permanent. Nevertheless, it can be difficult to define what constitutes a temporary or permanent structure.

Philip Jodidio uses the example of the Eiffel Tower to highlight the blurred boundaries between temporary and permanent structures. The tower was originally constructed as a temporary structure for the 1889 World's Fair and was intended to be dismantled after the event. But this never happened, and the tower has become one of the most popular landmarks in Paris. This example illustrates that permanence can be interpreted through the lens of cultural and representational aspects rather than material aspects of the structure. Jodidio refers to this phenomenon as 'temporal permanence' [2]. Cate Hill states that many buildings intended to be temporary have become permanent features of cities. He also cites the Eiffel Tower in Paris as an example. Additionally, he mentions the Serpentine Pavilions, which are dismantled and transformed into beachside restaurants, private garden follies, and marquees for theme parks after the events at their original site in Hyde Park, London [3]. In her seminal text Architectureproduction, Beatriz Colomina recounts the fascinating story of the Barcelona Pavilion, designed by Mies van der Rohe and constructed as a temporary pavilion in the 1920s. But it had a significant media impact, and it was rebuilt as a permanent structure in the 1950s [4]. It is therefore better not to draw strict lines between the terms 'temporary' and 'permanent' in architecture.

On the other hand, the term 'temporary architecture' has always had a specific meaning. It usually refers to a structure whose lifespan is defined not only by its short-lived purpose within a site and community, but also by the spectacle of its planned construction and deconstruction [5]. Temporary architecture is now synonymous with shipping containers, street food, music festivals and pop-ups. While these structures, situations and events appear and disappear quickly, they are designed to become embedded in a community, public space or set of ideas [3]. Thus, Aaron Betsky suggests that architecture is really going pop. According to him, obsession with eternity is ridiculous, and we should learn to live in and for the moment [6]. While pop-up architecture may have a limited function in society, it sends a broader message to architecture. But there is still a common idea that architecture should be timeless. It should rise above the vagueness of current fashion and style. It should embody permanent values. Architecture should accept the rhythms of everyday life but not be defined by them. It should last as long as possible and then become a beautiful ruin. In other words, architecture should be monumental.

However, architecture does not need to be monumental to conveying a message, creating an effect, or providing a worthwhile experience. Temporary and non-monumental buildings may also influence cities and societies, and people may be interested in exploring their interior and exterior spaces. As Hill discusses, temporary structures create spaces for experimentation, interaction and engagement [3]. These structures may be designed for specific biennales, festivals and commissions, or they may be self-initiated, do-it-yourself buildings and platforms that exemplify collective and participatory designs. Anyway, they usually provide creative spatial and structural solutions that challenge the status quo of permanent architecture.

For Jodidio, architecture is already temporary in its nature [2]. This depends on the quality of its construction and a range of other factors, from location to the vagaries of the climate. If architecture is inevitably temporary to some extent and modern lifestyles are becoming increasingly nomadic, architects should embrace this and design buildings for the present moment without considering the future. Agnieszka Mańkowska and Artur Zaguła state that the temporary nature of architecture is evidenced by the materials used, the mobility of the elements or entire structures, and designers' conscious decisions relating to achieving a particular temporary effect [7]. Indeed, temporary structures are usually designed to have an impact in their built environment. The term 'contemporary' signifies to be 'temporary'. This is why modern architects in the early twentieth century aimed to replace existing architectural principles such as permanence, monumentality, and the symbolic imagery of buildings with temporality, non-monumentality, and the everyday appearance of buildings, in line with the emphasis on contemporaneity. But they paradoxically designed buildings that looked like modern monuments and permanent structures.

In the second half of the twentieth century, designers mostly embraced pop culture, and popular and nomadic architecture. This was because earlier advances in material and construction technology, such as concrete, steel and glass, were moving towards inflatable, mobile, flexible and lightweight structures. The 1960s were a period of significant social, cultural, and political transformations that impacted all creative fields, including architecture. It was a time when a new generation of architects emerged within the counterculture of architecture. Notably, inflatable and moveable structures liberated architectural space from the notion that architecture should be solid, static and permanent [8]. However, architecture in the twentieth century was primarily static, despite the dynamism and speed of the era. Architects, designers, and architectural groups and collectives criticized static architecture, offering dynamic designs as an alternative. One of the most notable examples of these alternatives was the utopic and dynamic designs of Archigram, which envisioned the principles of mobile and flexible architecture. These architectural designs challenged the concept of permanence with temporariness.

In the twenty first century, temporariness has become a 'trending topic', alongside the 'pop-up' culture emerging worldwide. Architecture is adapting to this relatively new situation, as building lifespans are dramatically decreasing and natural resources are at critical levels. In this context, temporary structures are considered as possible solutions [9]. But these are not the only reasons for the growing interest in temporary architecture. One of the main reasons is creating an instant effect with temporary structures. Apart from temporality, 'instantaneity' is a term that is emerging in twenty first century architecture. This term fits perfectly with the contemporary world, where our attention is reduced to just three or five seconds when viewing an image, regardless of what it represents. It is now widely accepted that images should have a shocking, instant effect to capture people's attention. Accordingly, the paper focuses on the shift from temporal to ephemeral, referring to the instant effect created by the image of an architectural object, rather than the object itself. Instantaneity points out to this effect, eliminating the need to construct an actual structure as the object. This relates to the ephemerality, rather than the temporality, of images in contemporary architecture. Mańkowska and Zaguła suggest that the temporary architecture of the twenty first century differs from the previous examples of non-permanent architecture, in that it is primarily intended to shock, surprise, provoke and fuel consumerism [7]. We experience temporary architecture by being there in person or by seeing images of it through digital technologies. The essence of temporary architecture is to shock and consume, as well as to provide space for specific events or public gatherings. One example of such a structure is the Blur Building, which was designed for the 2002 Swiss Expo. Its foggy structure shocked people and changed the way of describing the notions of form and matter. As Anastasia Karandiniou states, architecture encompasses not only the solid, material elements of space, but also the invisible, immaterial, and intangible. In this respect, he underlines the re-emergence of the notion of ephemeral in contemporary culture and architecture. For him, ephemeral architecture is related to the evolution of digital technology and media, as well as to the new ways of thinking about space and everyday situations that new media enable [10].

Although many architects, designers, critics and theorists of art and architecture use 'temporal' and 'ephemeral' as synonymous terms, the paper distinguishes between them by focusing on the shift from temporal to ephemeral in contemporary architecture. This does not mean that architects no longer design temporary structures. Instead, the paper highlights temporal and ephemeral structures, which are designed to align with the evolving dynamics and realities of digital culture. In the digital era, ephemeral structures do not need to be experienced physically. They are usually designed with new materials as images. They do not necessarily have to be built as a space or structure. Due to the nature of their images, they can be foggy, blurred, fluid, dynamic, or transient structures that do not require physical existence. This is why 'ephemeral' cannot simply be associated with 'temporal', as ephemeral refers to the design of an image, rather than an object. But the terms 'temporal' and 'ephemeral' are still used interchangeably. The paper argues that the term 'ephemeral' describes images that create a new type of immateriality in architecture.

3. EPHEMERAL ARCHITECTURE

In architecture, ephemerality is defined by both the material and immaterial aspects of a structure. It is defined by the use of fluid and transformable materials, as well as materials that change in terms of their shape and qualities, such as density, color, and transparency. Ephemerality is also defined by its relationship with the immaterial, such as specific elements of a structure like sound and smell. However, it is important to distinguish ephemerality from temporality because ephemeral architecture consists of non-physical, immaterial structures. Architects cannot easily work with the immaterial, such as time, movement, sound and smell, or the other aspects of the ephemeral experience of space and structure. But new media makes it possible for architects to conceptualize space through these immaterial aspects [10].

In this context, 'ephemeral' is typically associated with 'immaterial' in the discipline of architecture. This further blur the disciplinary boundaries between art and architecture, as artists are often involved in the design of ephemeral structures. New media technologies, particularly artificial intelligence, allow us to design these structures as objects with ephemeral images and meanings in architecture. These can be either 'objects' or 'objectless objects', characterized by fluid, transformable images as new materials. At this point, ephemeral architecture distinguishes itself from temporary architecture. Ephemeral architecture is well-suited to the context of the twenty first century, which is characterized by constant flux and evolving needs, demands, desires, and experiences in creative fields. Image-based creations shift the focus from objects to images and from structures to spectacles. Consequently, there is now a common tendency to view architecture as a discipline that creates spectacular images regardless of people's actual needs.

The effective use of new media technologies by artists, designers and architects leads us to question what creativity is. They push disciplinary boundaries, making it difficult to categorize an object as either artwork or architecture. When an object is created using new media, its image and its image effect are usually ephemeral. For example, in 2025, Anadol projected images created by artificial intelligence onto the Guggenheim Museum in Bilbao. He transformed the building's recognizable appearance by using the images as new materials. Previously, in 1995, artists Christo and Jeanne-Claude wrapped another popular and recognizable building, the Reichstag in Berlin, in fabric, not images. They also altered the building's appearance, but in a tangible way. Therefore, the paper argues that, unlike the temporary Reichstag installation, the Guggenheim was an ephemeral projection. This is because the Guggenheim images constantly change as they are projected onto the building's surfaces. The images don't even require a surface or structure. Apart from their temporal or ephemeral aspects, these artworks introduce a new ontological perspective to architecture by questioning the existence of buildings as objects through the use of tangible (e.g., fabric) and intangible (e.g., images) materials.

Due to the rapid evolution of technology, interdisciplinary approaches have become necessary in architecture, as in many other fields [11]. In particular, the blurring of the boundaries between the fields of art and architecture has encouraged architects to use and experiment with new materials in their designs. Of course, architecture is not just about designing images. Its main purpose is to create spaces that people can use and benefit from. In this era, however, images of spaces are even more important than the spaces themselves because we use these images to define ourselves on digital and social media. We convey messages and create new identities through the images we share on social media. As Marshall McLuhan states, 'the medium is the message' [12]. When architecture is the medium, the question remains: what message do we wish to convey through it? In the digital era, architecture's message seems to rest entirely on how it is created as both an object and an experience [5]. Interestingly, spatial experiences can also become ephemeral, as new media makes it possible to experience space through screens and images. Images are fleeting, and so is our experience of space. These instant experiences epitomize the ephemerality of twenty first century architecture. Thus, 'ephemeral' differs from 'temporal' in that it refers to instantaneity rather than temporality in architecture.

Brian D. Chappel defines ephemeral architecture as a category of buildings designed to be distinguished by their impermanence and physical removal from the site. He notes that, while architects have described certain works as ephemeral, they have never done so in a consistent manner. But we live in an era of constant change and uncertainty. Cling to static perceptions of the world does not allow for a quick response to an ever-evolving set of circumstances. And navigating this world requires flexibility and freedom. Therefore, Chappel believes that architects should attempt to envision buildings through the lens of ephemerality [13]. In this respect, Juan Alberto Almirón Cuentas and David Hugo Bernedo Moreira discuss that in a world where cities face constant challenges of development, densification, and change, the flexibility and adaptability of temporary architecture offer an innovative response to these demands [14]. As it is temporary by nature, this form of architecture allows experimentation with new ideas, forms, and functions, without the long-term commitments associated with permanent constructions. Dea Aulia Widyaevan also discusses that the term 'ephemeral' defines something as temporary, interchangeable, and adaptive. According to him, architecture no longer needs to be monumental or eternal. It should be designed to adapt to uncertain conditions [15]. Nonetheless, the terms 'ephemeral' and 'temporal' are used synonymously in these discussions. These terms are discussed in relation to others, such as flexibility, changeability, responsiveness, and adaptability. However, in contemporary architecture, ephemerality does not necessarily correspond to the adaptability or flexibility of temporary structures. At the beginning of the 2000s, the common approach was to define and discuss 'ephemeral architecture' as 'temporal architecture'. But this definition is insufficient in the context of the 2010s and 2020s. This is due to the impact that digital and social media have had on architectural perception and production. While temporary architecture is still recognized as designing lightweight, demountable, flexible, adaptable and moveable structures, ephemeral architecture is not associated with the structural, but rather the non-structural — for example, fleeting images. Thus, the paper suggests that there is a replacement between 'object' and 'image', 'structural' and 'non-structural', 'material' and 'immaterial', 'appearance' and 'disappearance', 'tangible' and 'intangible' in architecture.

As Àlex Sánchez Vidiella states, ephemeral architecture plays an important role in our society because it gives imaginative responses capable of energizing places, exciting and inspiring at the same time as offering opportunities to shine in an industry that is currently devoid of excitement and inspiration [16]. Nonetheless, ephemeral structures are associated with temporary structures built to last for a specific period until they fulfil their function. Temporary structures can sometimes meet some needs that permanent structures do not, for various reasons. This is why ephemeral architecture establishes a temporary spatial framework for artistic events such as exhibitions and installations [17]. Indeed, these structures enable us to explore new construction methods and materials and push the boundaries of architecture [18]. But 'ephemeral' and 'temporal' have different meanings in contemporary architecture. As the paper emphasizes, 'temporal' refers to the design of short-lived structures, while 'ephemeral' relates to the creation of non-fixed, fluid, and fleeting images of structures. Ephemeral structures can be temporal, appearing for a specific time or event and then disappearing. However, these structures cannot simply be defined as temporal in twenty first century architecture, which is mostly experienced through images created by artificial intelligence.

Due to artificial intelligence, building images are now created through a process called hallucination, which evokes the hallucinatory nature of images. Neil Leach refers to these image-creation processes as hallucinations [19]. They result in the immaterialization of architecture, whereby architectural objects are created as images, eliminating the necessity for physical construction. Nevertheless, Antoine Picon discusses that architecture is supposed to be the most material of all the arts [20]. Materiality designates the material dimension of a phenomenon, thing, object or system in relation to human thought and practice. Architecture is especially attuned to its visible and tangible aspects, which fall within the realm of the senses. This is why materiality is worth discussing in architecture. But twenty first century architecture seems to focus on immaterial and intangible aspects by creating images with artificial intelligence. Although it is still a highly visual practice, its visuality has a new meaning that does not require physical contact or bodily experience. This is what we call new materiality. For Lars Spuybroek, materiality refers to the physical nature of an object. In architecture, however, there are two aspects of materiality [21]. One relates to the corporeality of the body, and the other relates to the building's tectonics and technology. In this context, the paper discusses the shift from the material to the immaterial, which currently relies on the use of artificial intelligence technology.

Ephemeral architecture uses computer and digital technology, and now artificial intelligence technology, to create image-objects that blur the distinctions between 'image' and 'object', 'material' and 'immaterial', and 'appearance' and 'disappearance'. Ephemerality refers to structures that appear and disappear within the blink of an eye. This can be observed when viewing their images on a digital screen, on a building's exterior, or through any other structure. It recalls Virilio's theory of the aesthetics of disappearance, in which the screen replaces space or space hides behind the screen and disappears [22]. The paper discusses this through the lens of ephemeral architecture. It emphasizes that ephemeral refers to the shifts from 'object' to 'image' and 'space' to 'screen' in architecture.

4. THE CONCEPTUAL ANALYSIS: REDEFINING EPHEMERAL ARCHITECTURE

The paper conducts a conceptual analysis to reveal shifts between concepts, such as the shift from object to image. These shifts are exemplified through a variety of temporal and ephemeral spaces and structures. Examples of temporal permanence include the Eiffel Tower and the Barcelona Pavilion because they still exist although they were designed as temporary structures for specific international events and exhibitions. Others are examples of the Reichstag and the Guggenheim, the former of which is wrapped in fabric and the latter in images. Both buildings feature artistic additions that alter their appearance. The paper, however, discusses the Reichstag as a temporal installation and the Guggenheim as an ephemeral projection. The Guggenheim is rebuilt with images projected onto its surfaces, but the images do not need the building to exist. They create a constantly changing appearance for the building. The Reichstag, on the other hand, creates a static appearance that differs from the Guggenheim's new dynamic images. The paper also uses the Blur Building as an example to emphasize the differences between temporal and ephemeral architecture. The Blur Building has a foggy appearance that changes according to weather conditions. This is an example of temporal architecture, as the building is characterized by fog as a new material that can be experienced through bodily presence. Therefore, it does not exemplify immateriality related to ephemeral architecture. The paper discusses ephemeral architecture through the immateriality of images, which are not bound to bodily experience.

Examples in architectural history, such as primitive sheds, exhibition spaces, and containers, are described as temporal structures. Balloons, blobs, and clouds, which are built with new materials and technologies, are temporal structures as well. These structures present new aesthetics with their inflatable, mobile, and moveable designs, but they are still material and tangible. As discussed throughout the paper, the shift from temporal to ephemeral occurs when designing intangible and immaterial objects, such as images, in architecture. In this respect, the paper explores image-objects as examples of ephemeral architecture. These include the Guggenheim wrapped in images and the Sphere. The Sphere, in particular, exemplifies the ephemerality of architecture due to its constantly changing images, which transform the physical structure into a showcase of a non-physical spectacle. This spectacle-over-structure state fits the building site in Las Vegas, as the city itself is already a showcase for people. Thanks to digital and artificial technologies, architects can easily and quickly design images without actually building them. Although the Sphere is a built structure, it is characterized by its dynamic digital images in contemporary architecture. These images differ greatly from those exemplifying paper architecture, such as the utopic city designs of Archigram. The architects of Archigram imagined and designed on paper using their own human intelligence. Of course, architects still use their intelligence and senses today, but artificial intelligence seems to characterize designs as images rather than objects. This highlights the shift in architecture from objects to images. In this context, the paper uses image-objects created with Stable Diffusion, a popular artificial intelligence platform, to illustrate ephemeral structures. Accordingly, the paper redefines ephemeral architecture as designing image-objects within an ever-changing, dynamic context. This emphasizes the instantaneous impact of images on twenty-first-century architecture (Figure 1 and 2).

Figure 1. The conceptual framework of temporal and ephemeral architecture, illustrated by examples of designs, buildings and installations (Created by the author.)

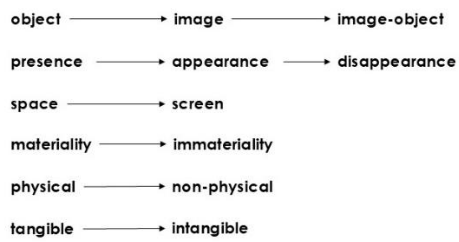

Figure 2. The conceptual shifts followed the shift from temporal to ephemeral in contemporary architecture (Created by the author.)

5. CONCLUSION

In the twenty first century, everything is in a constant state of flux, primarily due to information and communication technologies such as digital and social media and, most recently, artificial intelligence. These technologies allow us to produce, share and consume images in a matter of seconds. As Jean Baudrillard states, we are distracted by images. In fact, these are reproductions of images that he refers to as simulations [23]. They flow all around us through new media technologies. They create impressions of people, cities, spaces, events, art, design, culture and nature. We are impressed and inspired by these images. However, it is usually challenging to grasp them as they are ephemeral images. The images and the objects they represent are both perceived instantly and can therefore be defined as ephemeral, regardless of whether they are temporary or permanent. Ephemerality refers to the instantaneous nature of images and their image effects in contemporary architecture. Therefore, the paper discusses that ephemeral architecture cannot be reduced to the design of lightweight, mobile, flexible, transformable, adaptable, or demountable structures, all of which are related to temporary architecture. Instead, ephemeral architecture creates an image effect using digital technologies, new media and artificial intelligence. While temporary architecture is bound to a physical structure, ephemeral architecture can exist either physically or non-physically. Temporary architecture is usually experienced in person, whereas ephemeral architecture is typically experienced through images displayed on screens or building surfaces that act as screens.

Today, we perceive architecture and the world through the ephemerality of images displayed on screens. As McLuhan suggests, media changes the way we perceive the world [12]. It changes our everyday routines, tastes, desires, behaviors, clothing, buildings, and cities [24]. We are constantly exposed to images, particularly through new digital and social media technologies. The shocking nature of these images reinforces our daily state of distraction. Walter Benjamin discusses that buildings are truly experienced in a state of distraction rather than in a tourist-like state of concentration. He defines distraction as a condition that shapes our everyday experience of architecture. Concentration, on the other hand, leads to buildings being seen only as objects, separated from everyday life. This dichotomy between distraction and concentration remains relevant today, as distraction is often used negatively to describe people's experience of architecture and other art forms, such as film and photography, when they are distracted [25]. We are now in a state of distraction due to the constant bombardment of images on our computers, phones and screens of other smart devices. It is new media that has made us the distracted people we are today. Lev Manovich defines new media as the internet, websites, computer multimedia, and virtual reality [26]. We are distracted by these technologies. But, in this digital era, the term 'distraction' does not have the same meaning as in Benjamin's theory. In the twenty first century, distraction has paradoxically come to mean the concentration described in that theory, which refers to a tourist gaze and experimentation. We usually experience architecture through the lens of the tourist, taking pictures in front of buildings, posting them on social media, and creating memories.

That is why everything we see is a spectacle. As Guy Debord famously stated, the reality has been substituted by the spectacle [27]. The way we experience architecture is changing due to people's tendency to share every aspect of their daily lives online. Consequently, architectural objects such as buildings, spaces and structures seem to be replaced by images of architecture. Instead of experiencing the object itself, we experience an image of it. We use images to experience and share architectural spaces, consuming them without seeing them. Our memories of spaces are formed from images of these spaces seen through screens. Memories have also become as ephemeral as images. In this respect, the paper redefines ephemeral architecture as not simply temporal architecture — usually described as designing a short-lived structure — but as creating a flowing image of a structure without necessarily building it. This redefinition is intended to eliminate the confusion arising from the use of 'temporal' and 'ephemeral' as synonymous terms in the fields of architectural theory and design. The terms are used in these fields interchangeably, but the paper points out a key distinction between ephemeral and temporal. The term ephemeral has gained a new meaning with the rise of digital technology. It now refers to the design of digital images that are dynamic and instantaneous, capturing attention for at least a few seconds. These images then flow away or are replaced by others, ensuring that our attention remains focused on the screen. At this point, it is evident that 'ephemeral architecture' is more closely related to 'media architecture' than to 'temporary architecture'. Images created by digital and social media, as well as artificial intelligence, are the new materials of ephemeral architecture.

The paper argues through conceptual analysis that ephemeral architecture has its own specific framework, which includes the concepts of 'image', 'screen', 'immateriality', 'intangible' and 'non-physicality'. This framework suggests that people can experience ephemeral architecture even if it is not materially or physically constructed. It can be constituted only by images and experienced through them, either with or without bodily presence. Due to its transient nature, 'ephemeral architecture' is also related to 'screen architecture', as both refer to the instantaneous appearance and disappearance of images on screens. The paper discusses that ephemerality liberates architecture from the constraints of site, space and structure. Architecture now allows space and structure to be created as images that appear and disappear instantly in various sites and environments. This blurs the boundaries between art and architecture by imagining architectural objects as artworks, or mediaworks, that are expected to create an instant image effect, regardless of their site-specific conditions. These have become not only siteless but also objectless objects of architecture. The concept of ephemeral architecture may be challenging to fully comprehend, but it is evident that ephemeral structures enable site-specific constraints and conditions to be challenged. Artificial intelligence has increasingly led to the creation of siteless and objectless objects, or 'image-objects', which have become the real examples of ephemeral architecture. In this respect, ephemeral architecture also refers to the blurring of the boundaries between 'the real' and 'the artificial'. This implies that 'the new reality of objects', that is discussed as 'ephemerality' throughout the paper, is now created by digital technologies and artificial intelligence in contemporary architecture.

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Recurring Seismic Damage in Repeatedly Restored Historic Masonry: A Damage Classification-Based Evaluation of Malatya Teze Mosque[*]

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Abstract: This study aims to evaluate earthquake-induced damage in historic masonry structures that have undergone repeated restoration interventions through a damage classification–based approach, using the Teze Mosque in Malatya as a case study. The structure, which has been repaired multiple times over different periods, was damaged and restored again following the earthquakes of 1893, 1964, 2020, and 2023. The research was conducted in two stages. In the first stage, a damage classification approach was developed based on commonly observed in-plane and out-of-plane behaviors, connection deficiencies, and material deterioration in unreinforced masonry structures. This approach is grounded in internationally recognized references such as FEMA 306 and EMS-98 and is further supported by the element-level analytical method proposed by Vlachakis et al. (2020). In the second stage, archival data were used to examine the damage patterns the structure experienced during past earthquakes, and the recurrence and evolution of these damages over time were analyzed. The findings indicate that restoration interventions carried out after previous earthquakes did not improve the structural performance of the building in subsequent seismic events; on the contrary, in some cases, the intervened areas became more vulnerable to damage. One of the most significant findings of the study is the identification of the phenomenon in which restored sections become the first parts to fail. The analyses revealed that certain areas subjected to previous restoration interventions experienced earlier and more severe damage during subsequent earthquakes compared to the original parts of the structure. The main causes of damage include differences in rigidity arising from double-walled construction systems, inadequate structural connections, the use of weak bonding materials, and soil conditions.

Keywords: Earthquake damage, unreinforced masonry, damage classification, structural performance, restoration interventions.

Tekrarlanan Restorasyon Müdahaleleri Sonrasında Tarihi Yığma Yapılarda Yinelenen Deprem Hasarları: Malatya Teze Camii’nin Hasar Sınıflandırmasına Dayalı Bir Değerlendirmesi

Özet: Bu çalışma, tekrarlayan restorasyon müdahalelerine maruz kalmış tarihî yığma yapıların deprem kaynaklı hasarlarını, hasar sınıflandırmasına dayalı bir yaklaşımla değerlendirmeyi amaçlamakta olup, Malatya’daki Teze Camii örnek olay olarak ele alınmıştır. Farklı dönemlerde birden fazla kez onarım görmüş olan yapı, 1893, 1964, 2020 ve 2023 depremlerinin ardından hasar almış ve yeniden restore edilmiştir. Araştırma iki aşamada yürütülmüştür. İlk aşamada, donatısız yığma yapılarda yaygın olarak gözlenen düzlem içi ve düzlem dışı davranışlar, bağlantı yetersizlikleri ve malzeme bozulmaları temel alınarak bir hasar sınıflandırma yaklaşımı geliştirilmiştir. Bu yaklaşım, FEMA 306 ve EMS-98 gibi uluslararası kabul görmüş referanslara dayanmakta olup, ayrıca Vlachakis ve arkadaşları (2020) tarafından önerilen eleman düzeyindeki analitik yöntemle desteklenmiştir. İkinci aşamada ise, yapının geçmiş depremlerde maruz kaldığı hasar örüntüleri arşiv verileri kullanılarak incelenmiş, bu hasarların zaman

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içerisindeki tekrarlanma ve gelişim süreçleri analiz edilmiştir. Bulgular, önceki depremler sonrasında gerçekleştirilen restorasyon müdahalelerinin yapının sonraki sismik olaylardaki yapısal performansını iyileştirmediğini; aksine bazı durumlarda müdahale edilen bölgelerin hasara karşı daha kırılgan hâle geldiğini göstermektedir. Çalışmanın en önemli bulgularından biri, "restore edilen bölümlerin ilk hasar gören bölümler hâline gelmesi" olgusunun ortaya konulmasıdır. Analizler, önceki restorasyon müdahalelerine maruz kalan belirli bölgelerin, yapının özgün kısımlarına kıyasla sonraki depremlerde daha erken ve daha şiddetli hasar gördüğünü ortaya koymuştur. Hasarın başlıca nedenleri arasında çift cidarlı duvar sistemlerinden kaynaklanan rijitlik farklılıkları, yetersiz yapısal bağlantılar, zayıf bağlayıcı malzeme kullanımı ve zemin koşulları yer almaktadır.

Anahtar kelimeler: Deprem hasarı, donatısız yığma yapılar, hasar sınıflandırması, yapısal performans, restorasyon müdahaleleri.

1.INTRODUCTION

When looking at the earthquake hazard map of Europe, countries with a coastline along the Mediterranean Sea, especially Turkey, Greece, Albania, and Croatia, are situated in a major seismic zone. In the past three years, these countries in the region have experienced loss of life and property due to the impact of earthquakes. Turkey is located on several major fault lines, including the North Anatolian Fault (NAF), the East Anatolian Fault (EAF), the Northeast Anatolian Fault (NEAF), and the West Anatolian Fault (WAF). The EAF is one of the world's most active earthquake faults with the shortest return periods. Over the last decade, this fault has been responsible for several major and destructive earthquakes that caused significant loss of life and extensive structural damage. The latest devastating earthquake on this fault occurred in Turkey on February 6, 2023, at 04:17 local time, with a magnitude of 7.7 Mw, and its epicenter was in Pazarcık (Kahramanmaraş) on the East Anatolian Fault. Shortly after this earthquake, approximately 9 hours later at 13:24 local time, another major earthquake with a magnitude of 7.6 Mw hit the Elbistan-Ekinözü region, also in Kahramanmaraş province. These earthquakes caused extensive destruction and significant damages in nearby provinces as well. Malatya, being one of the cities near the earthquake epicenters, was one of the places where significant destruction was observed.

Both modern and historical buildings in the city center suffered considerable damage. One of the most severely affected historic buildings was the structure known as the Teze Camii.The historic Teze Camii, with its social presence in the city center, is considered one of the symbols of Malatya throughout history. Despite undergoing various damages in numerous earthquakes, the structure has been subjected to restoration after each earthquake. However, it is observed that the damages escalate with each subsequent earthquake. Upon reviewing archival records, no studies documenting the types of damages the building suffered after earthquakes were found. Yet, the damages caused by earthquakes in various years present a significant opportunity, especially for understanding the static and material behavior of historical structures, as historical buildings have different characteristics compared to modern constructions, and predicting their seismic response is not a straightforward task. Accurate documentation of damages in historical buildings after earthquakes can provide valuable information for future risk assessments. The types, intensities, and distributions of damages can be analyzed. This helps to identify which parts of the structures are more vulnerable and require strengthening. Consequently, this information guides restoration efforts.

By understanding the types and extent of damages, suitable strengthening methods can be implemented, making the structures more resilient and less susceptible to damage in future earthquakes. In summary, documenting the damages in the historic Teze Camii is a crucial step in mitigating potential damages in future earthquakes. These records can be utilized in various fields, such as risk assessment, strengthening projects, inspection, control, education, and raising awareness, all of which contribute to minimizing post-earthquake damages. The absence of any damage documentation for the historical building in archival records indicates that lessons were not learned from previous earthquakes, despite the damages increasing with each subsequent event. However, examining and documenting the damages the building experienced during earthquakes can contribute to preventing future damages and ensuring the building's sustainability.

The literature emphasizes the following lessons learned from damage assessment and documentation studies in stone buildings: Vlachakis et al. (2017) [6], in the aftermath of the Lesvos Earthquake (Greece), identified that the general damages in stone buildings were primarily due to the inadequacy of structural connections and the weakening of the mortar, which is the construction material, as a result of various factors. One significant factor contributing to earthquake damages was the use of different materials between the double-layered walls in the construction technique of these buildings. Çağlar et al. (2020) [7], in their damage studies in Elâzığ and Malatya (Turkey), found that the reasons for damages in stone buildings were structural and material flaws. Post-earthquake research conducted in various parts of the world consistently highlights that earthquake damages in stone masonry buildings are generally caused by factors such as varying rigidities between double-layered walls, insufficient connections, and material incompatibilities [8-15]. Italy stands as a noteworthy example of lessons learned after earthquakes. The devastating earthquakes that struck Italy in the 1970s and 1980s led to a thorough reevaluation of the effectiveness and compatibility of the restoration techniques previously adopted. As a result of the earthquake events, the performance of previous strengthening techniques was tested, and measures for retrofitting were renewed. Consequently, some previously adopted techniques were restricted or even banned [16-19].

Historical buildings undergo multiple repairs across different periods. However, a review of the literature shows that the reasons why past interventions fail to prevent recurring damage have not been examined in a thorough and systematic manner. Therefore, there is a need for studies that not only describe earthquake-induced damages but also evaluate their underlying causes together with the performance of previous interventions. The purpose of this study is to (I) examine the damages incurred by the structure after earthquakes and present the damage models affecting the stone building, (II) identify the weaknesses and factors leading to damages, and (III) determine why previous post-earthquake repairs failed and emphasize preventive factors. To achieve these objectives, archival research and field studies were conducted.

The main contribution of this research is to demonstrate the “restored parts fail first” phenomenon in repeatedly restored historic masonry structures. The analyses revealed that certain areas subjected to previous restoration interventions experienced earlier and more severe damage during subsequent earthquakes compared to the original parts of the structure. Through a tailored damage classification framework adapted from FEMA 306[40], EMS-98[41] and Vlachakis et al. (2020) [43] along with systematic archival analysis, this study shows that previous restoration interventions not only failed to improve the structural seismic performance but, in many cases, increased the vulnerability of the repaired section.

1.1.CASE STUDY

1.1.1.THE GEOLOGY AND TECTONICS OF THE AREA

There are three major strike-slip faults in the world. Two of these strike-slip faults pass through Turkey. These are the East Anatolian Fault (EAF) and the North Anatolian Fault (NAF), and the third one is the San Andreas Fault. The East Anatolian Fault Zone (EAF) is a deformation belt that starts from Karlıova in Eastern Anatolia and extends towards Antakya with a width of 4-25 km and a length of 580 km. It has been moving for the past 2 million years, causing a lateral displacement of 15 km to date. The slip rate is approximately 8 mm per year. According to historical records, along the EAF, numerous earthquakes with magnitudes ranging from 6.7 to 7.8 have occurred in the mentioned sections, resulting in severe damages [20].

The East Anatolian Fault Line passes approximately 23 km south of Malatya in a straight line. Due to its proximity to the East Anatolian Fault Zone and being located on a fault line close to this zone, Malatya city and its surrounding areas are among the high-risk earthquake zones in Turkey. The city center of Malatya is situated within the first-degree earthquake zone. All the earthquakes that occur in Malatya and its vicinity have a tectonic origin. These earthquakes are associated with the Hazar-Sincik, Çelikhan-Gölbaşı, and Sürgü faults. The Malatya Fault was first identified by Aktimur in 1979, who named it "Malatya Fault" based on aerial photographs [21-23].

The subject of the research, Malatya city, and its surrounding area are located in the Upper Euphrates Region of the East Anatolian Region, south of the basin with the same name. The southern part of the low plateau characteristic Malatya basin is surrounded by the Malatya Mountains, which are extensions of the Southeastern Taurus Mountains, with an average elevation of 2500 meters. The highest point with an elevation of 2545 meters is the Şillan Hill on Mount Beydağı. To the west and north of the basin, there are areas that can generally be considered as high plateau areas, with some structural features but mostly characterized by erosion surfaces as high plateaus. Malatya city has developed in the piedmont plain, which is covered with alluviums sloping gently and regularly from the Beydağları Mountains towards the basin, thickening gradually in the west and northwest directions. The potential damage effect of a possible earthquake depends on local ground conditions, such as variations in the soil properties, vibration characteristics, settlement, groundwater level, and liquefaction susceptibility. The majority of Malatya city center is built on alluvial deposits [24] (see Fig. 1).

1.1.2.HİSTORY AND ARCHİTECTURAL FEATURES OF TEZE CAMİ

The historical landmark, also known as Teze Cami among the locals, was originally built as "Hacı Yusuf Efendi Camii" in 1843. It suffered damage during the Great Malatya Fire in 1889 but was reconstructed with the support of the Ottoman Sultan Abdulhamid II. Over the years, the New Mosque (Teze Cami) has faced numerous earthquakes. It experienced damage during the earthquake of March 3, 1893. In 1913, it underwent repairs, but on June 14, 1964, it was once again damaged by another earthquake. The mosque's dome and walls were restored, and in 2005, it went through a significant restoration process due to another earthquake. Following the Elazig earthquake on January 24, 2020, the dome suffered severe damage, but it was repaired and reopened for worship. However, during the Kahramanmaras earthquake on February 6, 2023, the mosque was almost completely destroyed [26].

Malatya Teze Cami reflects the characteristics of Ottoman architecture with its square plan and a large dome covering the prayer hall supported by four pillars. The entire mosque is constructed from carved stone and consists of a central dome and a prayer hall with five rooms. The last mahfil (gallery) of the mosque is located on an area of 1,500 square meters, with a plan of 24.50 meters by 24.50 meters, and it is 4 meters wide with arcades. The central dome of the mosque is supported by four piers and covered with a suspended central dome, resting on four thick columns and reinforced with barrel vaults and smaller corner domes on each side. The side wings are covered with a central dome and half domes, with smaller similar domes on the corners. The main entrance, providing access to the main prayer hall, is a stone-carved door adorned with geometric and floral motifs. The narthex is 4 meters wide and covered with arcades. Additionally, two round-bodied, two minarets with two balconies each and made of stone materials were added on both sides of the last gallery. In terms of facade architecture, the eastern wall features two windows. The western facade is blind, forming two dome silhouettes in succession with upper coverings. In the middle section of the southern facade, there is a mihrab (prayer niche) within a half-dome, located symmetrically as the central axis of the facade. The mosque and minarets exhibit unique architectural features, which can be the subject of separate research. The minaret's conical capstone, in some earthquakes, has fallen and was replaced with a new one [27].

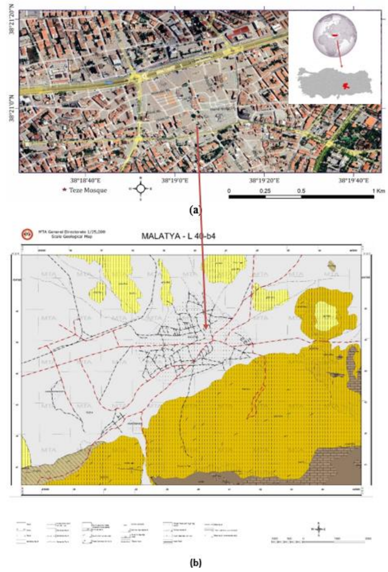


Figure 1. Location of Malatya Teze Mosque (a) and Geological Map (b) [25].

2.METHOD

The research was conducted in two stages: a literature review and archival-based office work. In the first stage, a semi-quantitative damage classification and severity assessment matrix was developed to systematically evaluate the earthquake-induced damages observed in the mosque. The proposed framework is based on typical seismic damage mechanisms commonly encountered in unreinforced masonry (URM) structures, including in-plane and out-of-plane behaviors, connection deficiencies, material deterioration, structural discontinuities, and foundation-related failures. The classification system was primarily developed by adapting the damage types and collapse mechanisms defined in internationally recognized references, particularly FEMA 306 [40] and EMS-98 [41], such as foundation settlement, in-plane and out-of-plane wall failures, roof–wall separation, overturningmechanisms, and connection failures. Furthermore, the element-level structural damage assessment methodology proposed by Vlachakis et al. (2020)[42] following the 2017 Lesvos earthquake provided important analytical guidance for identifying recurring damage patterns and evaluating damage evolution over time. The collected information was adapted to the specific structural, material, and architectural characteristics of historic stone mosques, resulting in a tailored damage classification matrix for these structures. In addition to damage identification, the framework incorporates a measurable damage severity scoring system and a "main cause" evaluation column in order to establish a more systematic and comparative analytical methodology. Unlike conventional descriptive approaches, this semi-quantitative framework enables the comparative assessment of recurring damage patterns observed in different earthquake periods.

The damage severity scoring system was defined as follows:

- 0 = No observed damage
- 1 = Slight damage

- 2 = Moderate damage
- 3 = Severe damage
- 4 = Partial collapse / critical structural failure

In addition, the "Main Cause" column was introduced to identify the dominant structural or material-related factors associated with each damage type, including weak soil conditions, rigidity incompatibilities, inadequate retrofit interventions, weak structural connections, seismic shear stress, and structural instability. Damage severity values and dominant damage causes were assigned through the systematic evaluation of archival photographs, historical documents, restoration reports, post-earthquake visual records, and comparative damage observations. This approach enabled the identification of recurring structural weaknesses and the interpretation of damage evolution over approximately 130 years. Particular attention was given to the recurring vulnerability of previously restored sections. The analyses revealed that some areas subjected to earlier restoration interventions experienced earlier and more severe damage during subsequent earthquakes compared to the original structural components. This phenomenon, defined in this study as "restored parts fail first," constituted one of the principal analytical findings of the research. The developed assessment matrix therefore serves as a practical analytical tool for evaluating post-earthquake damage in historic stone mosques located in different geographical regions (Table 1).

In the second stage, a detailed archival investigation was carried out to analyze the historical earthquake damages sustained by the building. For this purpose, the earthquakes affecting the structure in different years and the corresponding post-earthquake damages were systematically examined. Various archival sources, including newspapers, historical reports, restoration documents, books, magazines, and digital archives, were reviewed. The damage patterns identified for the earthquakes of 1893, 1964, 2020, and 2023 were comparatively evaluated and transferred into the damage classification matrix presented in Table 1. The resulting data were interpreted together with representative historical and post-earthquake photographs. In addition, schematic drawings, comparative damage diagrams, and damage evolution timelines were prepared to facilitate the visualization, comparison, and systematic interpretation of recurring damage mechanisms over time.

Table 1. Damage Classification and Severity Matrix of Teze Mosque) [40,41,42]

Damage Code	**Components**	**Definition**	**1893**	**1964**	**2020**	**2023**	**Main Cause**
(1)	Foundation	Settlement of the foundation soil	2	2	3	3	Weak soil conditions
(2)	Walls	Crumbling or loss of stone walls	0	1	0	0	Material deterioration
		Deterioration of cladding material, especially in double-walled stone structures	0	0	0	2	Rigidity incompatibility in double-leaf walls
		Damage occurring between vertical walls due to different material usage, inadequate connections, previous insufficient retrofit interventions, or lack of maintenance	0	0	2	2	Weak structural connections and inadequate retrofit interventions
		In-plane sliding cracks in the main body of the wall	0	2	0	0	Seismic shear stress

		Shear cracks in the main body of the wall	0	2	0	0	Repeated seismic loading
		Toppling of the entire wall or a part of it out of its plane	0	0	0	4	Out-of-plane instability and connection deficiency
(3)	Columns	In-plane shear cracks in the wall's main body	0	0	0	0	No observed damage
		In-plane torsional or shear cracks	0	0	0	0	No observed damage
		Toppling or collapse	0	0	0	0	No observed damage
(4)	Slabs	Spalling or loss of stone veneer	1	1	0	0	Surface material deterioration
(5)	Dome	Damage occurring at the roof corners or top of the main wall	2	2	3	3	Roof-wall separation and structural discontinuity
		Shear damage between the roof and walls, especially due to previous inadequate strengthening interventions or lack of maintenance	0	0	2	3	Inadequate strengthening interventions
		Roof collapse or settlement of roof elements	0	0	2	3	Structural instability
(6)	Minarets	In-plane sliding cracks	0	2	0	0	Seismic vibration effects
		In-plane torsion or shear cracks	0	2	0	0	Torsional seismic behavior
		Deterioration or loss of stones in stone walls	0	2	0	2	Material weathering and seismic action
		Toppling	2	0	0	4	Slender structural behavior and instability
(7)	Auxiliary Elements (Arch, Decorations, Chimney, Cornices, etc.)	Loss or displacement of auxiliary elements	0	2	2	2	Weak anchorage and vibration effects
		Shear cracks on auxiliary elements	0	0	2	2	Stress concentration during earthquakes

Note: As shown in Table 1, the proposed damage classification and severity scoring system is based on typical seismic damage mechanisms observed in unreinforced masonry (URM) structures. The framework was adapted from FEMA 306 (1998) , EMS-98 (1998), and Vlachakis et al. (2020) [40,41,42] according to the specific structural, material, and architectural characteristics of historic stone mosques. Damage severity values were assigned through archival photograph analysis, historical documentation, and post-earthquake observations using a semi-quantitative evaluation approach.

3.RESULTS

In this section, the damage models and contributing factors observed during the severe earthquakes listed in Table 1 are explained in detail with schematic drawings and photographs.

3.1.THE 3RD OF MARCH 1893 EARTHQUAKE

The earthquake that occurred on 3rd March 1893 took place in the Çelikhan-Gölbaşı segment and had a significant impact over a large area. The earthquake was felt from Aleppo to Sivas and Yozgat, but its most devastating effects were observed in the center of Malatya province. The 1893 earthquake stands out as the most intense and destructive earthquake ever recorded in the region in terms of damage and losses. Due to coinciding with the period of the decline of the Ottoman Empire, there is not much detailed archive available about this major earthquake.

During the 1893 earthquake, the minaret of Malatya Teze Camii suffered a collapse above the balcony level. When the New Mosque (Yeni Cami) was constructed, the minaret was intentionally left unfinished as a memorial to remember the effects of the earthquake. The General Secretary and Historian of Malatya City Council, Abdulkadir Artan, provided some information about the history of the New Mosque and the disasters it experienced, stating the following during a verbal interview: "The minaret with no upper part above the balcony, left by Hocazade Hacı Yusuf Efendi, is a monument of the earthquake. Because you can see the horror of the 1893 earthquake by looking at that minaret" [28] (see Fig. 2).

Figure 2. The original state of the structure and the restoration after the 1893 earthquake, where the minaret was left unfinished as a reminder of the earthquake [28].

3.2.14TH OF JUNE 1964 EARTHQUAKE

On June 14, 1964, a 6.0 magnitude earthquake struck Malatya on a Sunday at approximately 3:15 PM. During this earthquake, the Malatya Teze Cami experienced several damages, including cracks in the dome and some walls. Some of the stones serving as the base for the minarets' finials, acting as a supporting element for the dome, fell off. Due to the historical context of the event, there is not much detailed archival information available regarding the aftermath of this significant earthquake, which coincided with the decline of the Ottoman Empire.

Following the earthquake, the Vakıflar Genel Müdürlüğü (General Directorate of Foundations) undertook restoration efforts to repair the damaged parts of the cami. The upper parts of the window frames were removed, and the damaged areas were repaired. The lead roofing of the cami was replaced, cracks were filled, and the interior plastering was renewed. In addition, the intermediate dome stones were removed, and larger finials were installed on the minarets, giving them a new shape. The frames of the intermediate upper windows were also removed. Furthermore, in response to continuous public demands, the Vakıflar Genel Müdürlüğü carried out a second auction to ornate the interior of the cami, adding decorative elements to the dome and inscriptions on it [29] (see Fig. 3).

Figure 3. Damage and restoration of Malatya Teze Mosque after the 1964 earthquake [29]

3.3.THE 24TH OF JANUARY 2020 ELAZIĞ-MALATYA EARTHQUAKE

The earthquake that occurred on January 24, 2020, centered in Sivrice with a magnitude of 6.8, caused significant damage to the mosque. The main dome partially collapsed, and walls exhibited shear cracks, while the minaret domes experienced crumbling. Based on the available images from the archives, it is believed that the causes of the observed damages are as follows [30].

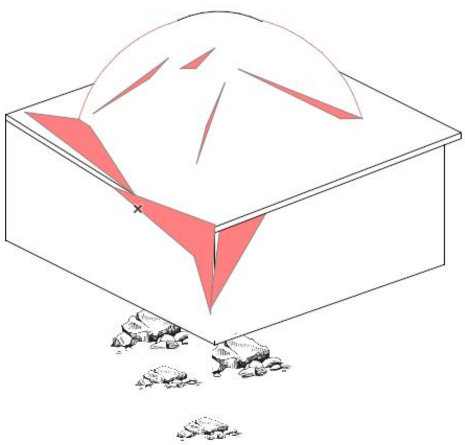


Figure 4. Damage caused by the 24th January 2020 Elâzığ- Malatya earthquake - Schematic drawing of the damage (Damage at the corners of the roof or on the main wall, Roof element displacement, Shear cracks on arches) (Developed by the author, 2026)

The shear cracks observed in the walls occur when the tensile stress at the center of the walls reaches its tensile capacity. This mode of damage is more brittle and appears as cross X-shaped cracks on the wall, particularly in large stone walls. Figure 5 shows example cases of damage patterns resulting from the tensile stress reaching its capacity at the center of the walls (see Figure 5).

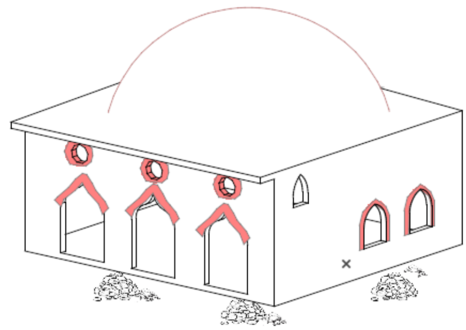


Figure 5. Schematic drawing of the damage (Damage occurring between vertical walls due to different material usage, insufficient connections, previous inadequate reinforcement interventions, or lack of maintenance, Crumbling or loss on corbels) (Developed by the author, 2026)

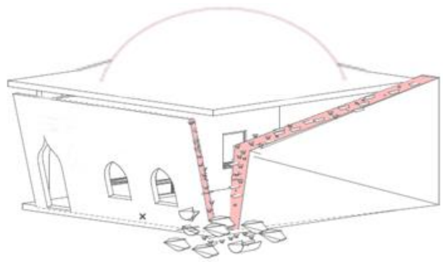
After the earthquake, strengthening works were carried out on the damaged mosque. During these works, the main dome and other damaged domes were completely removed and replaced. Additionally, buttresses were added to the east and west side walls to reinforce the structure. The interior walls of the mosque were also strengthened, and reinforcement was done on the foundation. In newspaper reports after the 2020 earthquake, it was mentioned that the parts of the mosque that were previously restored were the first to collapse. It was stated by various experts that the added buttresses on the east and west walls collapsed, the newly constructed dome completely collapsed, and the restoration efforts proved ineffective and even worsened the damage [30].

3.4.THE EARTHQUAKE CENTERED IN KAHRAMANMARAŞ ON FEBRUARY 6, 2023

After being reopened for worship in 2023 following the 2020 Elâzığ-Malatya earthquake, the structure suffered severe damage again during the 7.7 and 7.6 magnitude earthquakes centered in Kahramanmaraş on February 6. The four minarets, dome, and walls of the building were affected. The dislodging of stones from the walls was prominently observed on the building [30].

The structure has double-walled construction, with the outer and inner wall layers made of different materials. The outer wall layer consists of perfectly cut stones, chosen for their richness and solidity, while the rest of the structure was constructed with rubble stones. This resulted in different rigidity for the two layers during the earthquake. The earthquake forces exerted more impact on the outer wall layer, while the inner wall layer, being more flexible, was less affected. The irregular and non-monolithic nature of the stone walls, coupled with negligible tensile strength and high mass, led to the early occurrence of local failure mechanisms during seismic events.

These local mechanisms were not mitigated through proper construction details and structural connections, leading to partial collapse. The connections between the outer and inner wall layers in the double-walled construction also played a significant role in the partial collapse of the walls. The walls were built using weak binding materials like lime mortar and earth mortar. Earth mortar was mainly used in the inner part of the wall layer and its low binding properties, low compressive strength, and sensitivity to moisture resulted in further weakening of the wall element's rigidity. Additionally, the adverse effects of atmospheric conditions (such as temperature and rainfall) caused deformations in the mortar and joints over time, leading to cracks in the structure during earthquakes. The low-strength properties of the mortar, the use of earth as filling material, and inadequate wall connections contributed to the weakening of the walls and facilitated separations during the earthquake (see Figure 6).



(a)

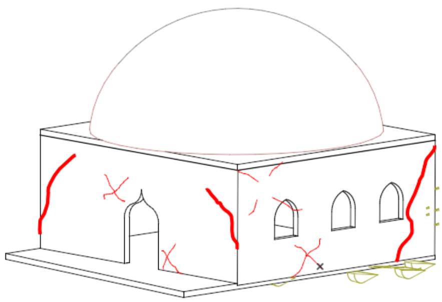
(b)

Figure 6. a) Schematic drawing of the damage (Developed by the author, 2026) (b) Images illustrating the vulnerability created by the joining of different types of materials, such as cut stone and rubble stone, used in double-walled construction, in the presence of earth mortar (The images used in this study were obtained from the following source: AA Haber[30] , Malatyahaber. (2023)[31] and Busabah Malatya (2023) [33].

Another finding is the weak mortar connection in the structure. Mortar material is a crucial component that holds the stone blocks together. It fills the gaps between the stone blocks, providing structural integrity, flexibility, and resilience to the building. During an earthquake, the distribution of horizontal and vertical forces in the structure is significantly influenced by the quality of the mortar. The load-bearing characteristics of the walls depend on factors such as the type of stones used, the quality of the mortar, and the connection details, all of which affect the behavior of the walls during an earthquake.

The emptying of mortar in the masonry of stone structures has several negative effects during earthquakes. It weakens the connections between stone blocks, rendering the structure less resistant to seismic forces, making it more susceptible to collapse or damage. In cases where the mortar is missing or weak, the displacement and sliding of stone blocks during an earthquake are more likely, resulting in structural deformation and cracks in the building. Insufficient strength of connection elements also makes the structure more vulnerable. If the connections are too weak or missing altogether, partial wall displacements and collapses can occur during an earthquake, subjecting the walls to significant loads.

During field inspections, it was observed that natural factors over the years have led to the weakening and erosion of the mortar in the structure. The problem of wall displacement due to weak mortar connections was prevalent in the examined building. The emptying of mortar has compromised the structural integrity of the stone masonry, reducing its resistance to shaking motions, resulting in more extensive damage to the building (see Figure 7) [34].

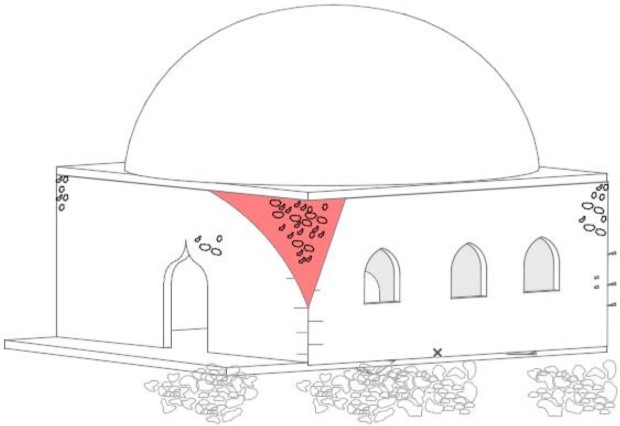


(a)

(b)

Figure 7. a) Schematic drawing of the damage (Developed by the author, 2026) b) Shear cracks in the main body of the wall due to the weakness of the mortar (The images used in this study were obtained from the following source: AA Haber (n.d.)[31]

The lack of horizontal bonding stones in the wall joints of the structure resulted in the detachment of walls and separation of stone surfaces. Adequate bonding capacity is essential in rubble masonry structures, typically achieved through corner stones. Various studies [35-37] emphasize that horizontal bonding stones in stone constructions provide horizontal sliding planes, distribute energy, and enhance the durability of stone walls, thus improving earthquake performance of the buildings. This technique reinforces the horizontal connections between walls, helping to bind the leaves of a wall together and prevent disintegration. The section below illustrates damages caused by the absence of corner connections in the structure (see Figure 8).

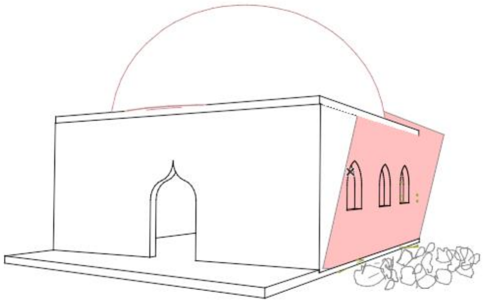


(a)

(b)

Figure 8. a) Schematic drawing of the damage (Developed by the author, 2026) b) Typical multi-story wall sections with missing horizontal bonded stones and inadequate corner stone connections (The images used in this study were obtained from the following source: AA Haber (n.d.) [31]

The toppling of walls in the corners of the structure is also prevalent in the building. When buildings lack "box-like behavior," meaning that structural elements are not interconnected with unified lateral diagrams, bending occurs in the inertia forces of walls perpendicular to the earthquake effect. Under such effects, the capacity of stone walls significantly decreases, leading to the collapse of many walls in events similar to the Turkey earthquake. Long walls or walls without adequate lateral support undergo vertical, one-way bending. Particularly in the structure, two-way bending is observed, especially in the upper parts of facades with inadequate connection to the roof (see Figure 9).

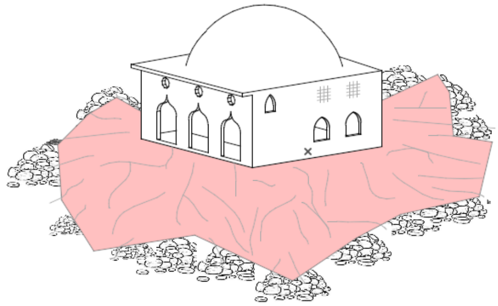


(a)

(b)

Figure 9. a) Schematic drawing of the damage (Developed by the author, 2026) b) Toppling of the entire wall or a portion of it out of the plane (The images used in this study were obtained from the following source: Habername. (2023, March 7)[32]

The foundation on which the stone walls of the structure rely is an important component that provides support to the building. The foundations and ground conditions of stone structures are significant factors that affect the durability of the buildings. An inadequate or low-quality foundation can lead to the collapse and settlement of the upper parts of the walls during earthquakes [4]. Based on archival research regarding the site where the mosque is located, it is reported that the area was known to have weak ground conditions when the mosque was constructed. The 1894 Mamuret-ül-Aziz Salname [38] provides the following information about the foundation: "During the excavation of the mosque's foundation, a substantial amount of water emerged, and juniper trees were used to prevent waterlogging. After the workers drove the piles into the ground, they filled the hole created with a paste-like substance known as 'log'. This suggests that the characteristics of the ground and foundation of the structure may have influenced the potential wall collapses during the earthquake. Further investigation is needed to understand the site conditions, groundwater level, and adequacy of the building's foundation (see Figure 10).



(a)

(b)

Figure 10. a) Schematic drawing of the damage (Developed by the author, 2026) b) Damage images attributed to ground-related issues (The images used in this study were obtained from the following source: Busabah Malatya (2023) [33]

4.DISCUSSION

Over the past 20 years, several earthquakes in Turkey have caused significant loss of life and property. This article explains the geological and geotechnical aspects of the region and the performance of the structure due to earthquakes based on on-site assessments. Through various archival research and field studies, the damages occurred in the Malatya Teze Mosque after the earthquakes in 1893, 1964, 2020, and 2023 have been identified, tabulated, compared, and analyzed. The study reveals enlightening observations about the seismic behavior of the structure after each earthquake. The findings indicate that the repair and restoration efforts carried out after each earthquake did not improve the structural performance for the subsequent earthquake. On the contrary, it was observed that the restored areas were the first ones to suffer damage in the following seismic events. After the earthquakes in 1893, 1964, 2020, and 2023, one of the fundamental causes of the collapse and destruction is attributed to the insufficient support walls and later added buttresses that failed to carry the weight of the dome. As a result, the roof detached from the walls, leading to toppling and collapse. The findings of the study provide evidence that the same damages occur after each earthquake due to these reasons, indicating that the effectiveness of restoration interventions is not thoroughly examined by experts. The factors identified as generally causing damage in the structure after severe earthquakes, excluding aftershocks, include different rigidities caused by double-layered walls, inadequate connections, the use of weak bonding materials, the combination of weak and low-strength materials, and the properties of the ground.

According to observations, almost all the deficiencies encountered in the examinations after earthquakes in our country were also observed in this earthquake region. The material strength of the constructed mortar structures was found to be insufficient, and at the same time, it was observed that the structural elements were not well locked at the connection points of the mortar structures. Çağlar et al. (2020) [7] determined in their damage studies in Elâzığ and Malatya that the reasons for the damage in stone structures were structural and material defects. Teze Cami also showed the occurrence of the same type of damage after each earthquake, and this study has similar results. Similarly, Vlachakis et al. (2017) [6] identified the cause of stone structure damages in the Lesvos Earthquake (Greece) as the inadequacy of structural connections and the weakening of mortar, the construction material, due to various factors. These findings are consistent with our study findings. One significant factor contributing to the formation of earthquake damage in structures is the use of different materials between the double-layered walls present in the construction technique. The study results are similar to research findings conducted in various locations around the world after earthquakes, indicating that the general causes of damage in stone structures after earthquakes in Turkey are mainly due to the different rigidities caused by double-layered walls, inadequate connections, the use of weak bonding materials, and the combination of weak and low-strength materials [8-15]. As a result, it has been determined that the effects of earthquakes on Teze Mosque are related to the construction technique, seismic behavior, mismatched materials, inadequate connection elements, and weak mortar. Additionally, geotechnical factors such as soil conditions need to be considered.

5.CONCLUSION

One of the most significant findings of this study is that sections subjected to previous restoration interventions became the most vulnerable parts of the structure during subsequent earthquakes. Comparative analyses revealed that damage initiated earlier and progressed more severely in previously restored wall junctions, roof–wall connections, and minaret elements compared to the original structural fabric. This finding indicates that restoration practices focused solely on repairing visible damage are insufficient for ensuring the long-term seismic resilience of historic masonry structures.

Based on the findings of this research, the following conclusions and lessons can be drawn:

(I) Malatya is located in the impact zone of the East Anatolian Fault (EAF), one of the most active faults in the world. Therefore, improving foundation stability and considering local soil conditions are essential before any restoration work. A detailed geotechnical investigation should be conducted prior to restoration, and appropriate ground improvement techniques — such as epoxy grouting or soil consolidation — should be implemented to enhance the foundation's performance.

(II) The stone walls of the Teze Mosque are highly susceptible to damage mechanisms such as partial collapse, settlement, and out-of-plane overturning during earthquakes. These damages are primarily caused by insufficient connections between structural elements, the double-leaf wall system with differing rigidities, and the use of weak bonding mortars (lime and earth mortar). The absence of adequate cornerstones and through-stones further contributes to wall separation and disintegration. To mitigate these issues, proper structural connections, compatible materials, and enhanced wall interlocking details should be employed in future interventions.

(III) Long-term environmental effects have significantly weakened and eroded the mortar in the masonry over time. Before any restoration, a detailed characterization of the existing mortar is necessary to understand its mechanical properties and compatibility with new materials. This step is crucial for achieving durable and seismically compatible repairs.

The phenomenon defined in this study as "restored parts fail first" clearly shows that post-earthquake interventions in historic masonry structures should move beyond mere damage repair toward a comprehensive, performance-based conservation approach that prioritizes material compatibility, structural integrity, and long-term seismic behavior.

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