# Decoding Urban Déjà Vu: Developing a Visual Assessment Matrix for Urban Legibility

Mahmoud Yousef M. Ghoneem

**Abstract**

Repetitive and standardized urban fabrics in multiple cities have produced indistinct spatial experiences, leading to perceptual confusion and weakened imageability. Such environments arise from planning paradigms that prioritize functional efficiency and regulatory uniformity over human perception and spatial identity, resulting in façades that appear interchangeable and spaces that evoke a sense of **Urban Déjà Vu** (a perceptual-cognitive state where distinct places evoke a similar visual familiarity). This research develops and empirically validates the Visual Assessment Matrix (VAM), an integrative perceptual assessment framework that captures the circular relationship between visual, cognitive, and affective dimensions of urban experience. The framework operationalizes its variables into a Perceptual Clarity Index (PCI) with calibrated weighting factors, enabling a quantitative evaluation of perceptual coherence in contemporary urban environments. Findings confirm that excessive visual repetition reduces imageability, intensifies cognitive disorientation, and weakens affective attachment, revealing a consistent causal chain: visual monotony → weak imageability → disorientation → detachment. The validated VAM exhibits high reliability and practical relevance as both a diagnostic and design-planning tool, allowing practitioners to identify perceptually fragile zones and to guide evidence-based interventions toward greater visual diversity, spatial legibility, and emotional coherence. Ultimately, the study bridges perceptual theory and design praxis, reframing urban identity not as aesthetic uniformity but as a measurable condition of perceptual clarity and human-centered spatial well-being.

**Keywords**

Urban déjà vu · Urban morphology · Imageability · Cognitive mapping · Perceptual clarity · Urban legibility · Spatial identity · Perceptual clarity index (PCI)

## 1 Introduction

### 1.1 Background

Urban environments are fundamentally perceptual systems that shape how people see, remember, and emotionally experience space. Yet the acceleration of globalized construction models and codified zoning standards has produced cities of growing visual monotony and perceptual uniformity. These patterns are evident in repetitive façades, uniform building heights, and modular blocks that prioritize technical efficiency while neglecting sensory and emotional diversity. Within such settings, distinctiveness fades and places become cognitively interchangeable. This visual sameness gradually erodes spatial identity and leads to perceptual fatigue and moments of uncertainty akin to psychological déjà vu.

This research conceptualizes the condition as Urban Déjà Vu: a perceptual–cognitive state in which different urban environments feel oddly familiar despite first-time encounters (Bryan, 2003). It emerges from the combined effects of visual monotony and perceptual uniformity, which suppress perceptual variety, inhibit mental mapping, and weaken spatial memory (resulting in perceptual fragmentation that blurs the boundaries between places). Historically, Lynch (1960) defined *imageability* as the city's capacity to evoke a clear mental image through paths, edges, districts,

M. Y. M. Ghoneem (✉)
Department of Architecture, Faculty of Fine Arts, Capital University, Cairo, Egypt
e-mail: Mahmoud.Yousef@f-arts.helwan.edu.eg

Department of Architecture and Building Science, King Saud University, Riyadh, Saudi Arabia

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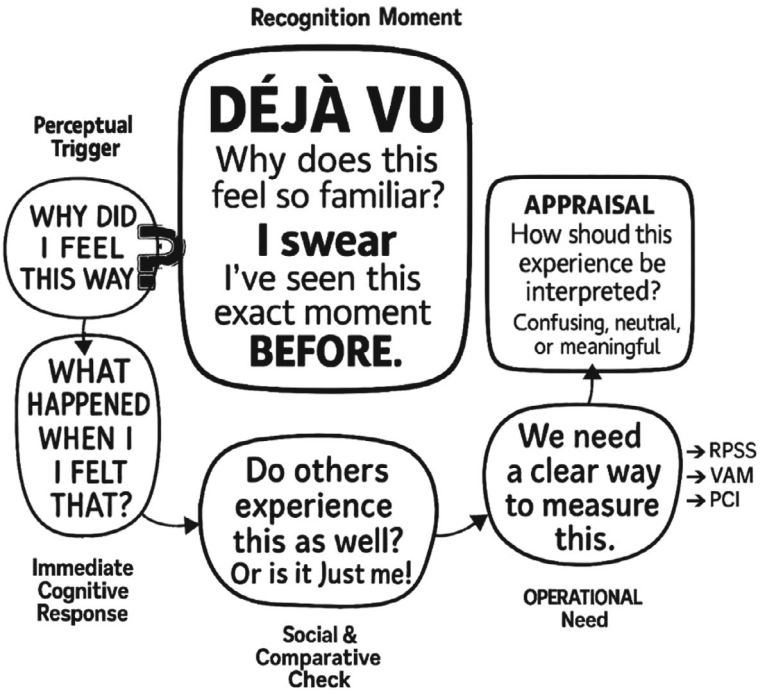



**Fig. 1** Conceptual pathway of the urban déjà vu experience. *Source* Author's own elaboration (2025)

nodes, and landmarks. While Cullen (1961) emphasized *serial vision*, the sequential drama of movement essential to engagement. Later work operationalized these insights: Nasar (1998) linked visual clarity to affect; Ewing and Handy (2009) validated measurable design qualities; Kaplan and Kaplan (1989) bridged preference with cognitive effort; and Gehl (2011) foregrounded human scale.

Advances in perception science and digital analysis further shifted the field toward data-driven evaluation: Rosenholtz et al. (2007) quantified visual clutter as cognitive load; Meenar et al. (2022) tested imageability with AI/digital mapping; and Passini (1996), Montello (2005) modeled wayfinding as a measurable cognitive process. Building on this progression, the present study adapts proven perceptual metrics and behavioral insights into a unified Visual Assessment Matrix (VAM) that integrates classical imageability and serial vision with modern measures of visual clutter and affective response. The VAM provides a replicable tool to diagnose perceptual weakness and promote environments that support perceptual clarity, orientation, and emotional attachment. Figure 1 maps the perceptual trigger, cognitive recognition, social comparison, and evaluative stages that together form the experiential structure of urban déjà vu.

## 1.2 Problem Statement

Across various cities, many urban districts suffer from a high degree of visual uniformity in their built environment, manifested in repetitive façades, consistent building heights, and rigid block configurations.

This condition was not identified solely through literature review but was strongly reinforced by a set of collective perceptual experiences observed during fieldwork and informal surveys across multiple contemporary cities. Many respondents consistently reported a recurring sense of spatial familiarity and visual sameness, where different urban districts appeared perceptually identical despite their physical distance.

This pronounced morphological standardization directly contributes to what can be described as perceptual fragmentation (a condition in which users struggle to distinguish between spaces and to form memorable mental images of their surroundings). In such environments, individuals often experience a spatial sensation akin to urban déjà vu, where the city feels familiar yet unidentifiable. Over time, this perceptual ambiguity weakens both spatial legibility and identity, eroding the cognitive and emotional connection between people and their urban environments.

Despite the long-standing theoretical contributions of Lynch (1960) and Gordon Cullen (1961), who emphasized imageability and serial vision as the foundation of urban perception, contemporary urban design practice continues to lack operational tools that measure how visually repetitive environments influence human perception and orientation.

Existing evaluation systems remain largely descriptive, qualitative, or limited to aesthetic judgment, without providing quantifiable indicators that link visual form to perceptual clarity, cognitive mapping, and affective attach-

ment. As a result, planners and designers frequently address visual monotony as an aesthetic issue rather than a perceptual and cognitive problem, leading to urban spaces that are formally organized but experientially indistinct.

This research responds to that gap by formulating and empirically validating a **Visual Assessment Matrix (VAM)** capable of diagnosing perceptual weaknesses in visually standardized urban environments and guiding design interventions that enhance imageability, spatial legibility, and emotional coherence.

## 1.3 Research Gap

Despite significant advances in urban perception theory, several key gaps persist:

- **First**, existing studies lack operational tools that quantify perceptual clarity through integrated visual, cognitive, and affective dimensions.
- **Second**, methodological frameworks remain limited in their ability to link perceptual diagnosis to design strategies in a replicable, data-driven way.
- **Third**, there is an absence of multi-level perceptual systems that combine rapid human-based screening (**RPSS**) with detailed analytical evaluation (VAM).

By addressing these deficiencies, this study transforms perceptual theory into a validated, evidence-based framework for diagnosing, measuring, and enhancing human experience in the built environment.

## 1.4 Research Aim

This study aims to examine how visual repetition and perceptual uniformity influence human perception, cognitive orientation, and emotional attachment, and to develop an operational framework for diagnosing and improving perceptual clarity and urban identity.

## 1.5 Research Objectives

1. Analyze how visual monotony and perceptual uniformity in urban environments contribute to perceptual fragmentation, cognitive disorientation, and weakened spatial identity, while identifying their underlying urban and planning causes.
2. Integrate classical perceptual theories (imageability (Lynch) and serial vision (Cullen)) with behavioral, spatial, and AI-based visual analytics to construct a multi-dimensional perceptual framework.
3. Critically evaluate the applicability and limitations of classical urban cognition models within contemporary contexts of morphological standardization.
4. Develop and validate the Visual Assessment Matrix (VAM) that combines visual, cognitive, and affective indicators through both field-based testing and statistical reliability analysis (e.g., CFA, Cronbach's $\alpha$).
5. Formulate evidence-based design strategies that enhance imageability, reduce perceptual disorientation, and strengthen urban legibility and emotional attachment.
6. Provide a transferable decision-support framework for planners and policymakers to evaluate perceptual quality and guide human-centered urban interventions.

## 1.6 Research Questions

1. How do visual monotony and perceptual uniformity in standardized urban environments affect perceptual clarity, cognitive orientation, and the sense of spatial identity?
2. Which visual and cognitive indicators can most effectively measure perceptual clarity and spatial orientation within these environments?
3. How can the proposed framework (VAM + RPSS) assist urban planners and policymakers in diagnosing, monitoring, and enhancing perceptual quality across diverse urban contexts?
4. How can evidence-based design and planning strategies derived from the VAM enhance perceptual clarity, urban legibility, and emotional attachment to place?

## 1.7 Significance of the Study

The term "**Urban Déjà Vu**"—adapted from the psychological notion "déjà vu"—describes a spatial experience in which urban environments appear strangely familiar and interchangeable despite being encountered for the first time (Bryan, 2003). This perceptual condition stems from repetitive façades, uniform building heights, and rigid block configurations that erode distinctiveness and fragment spatial cognition. As a result, users experience perceptual confusion, weakened imageability, and diminished spatial identity.

Despite extensive theoretical development in urban perception, many contemporary environments continue to exhibit visual monotony and perceptual uniformity (signaling a persistent disconnection between perceptual theory and applied urban design). While Lynch's imageability and Cullen's serial vision established the conceptual foundations for understanding legibility, few studies have operationalized these principles into validated, field-applicable instruments.

The present research bridges this gap by reframing legibility and identity as human-centered perceptual perfor-

mances rather than static formal attributes. It develops an integrated two-tier assessment system (the Rapid Perceptual Screening Sheet (RPSS) and the Visual Assessment Matrix (VAM)) that connects rapid field diagnosis with in-depth analytical evaluation. By incorporating AI-assisted visual analytics, behavioral mapping, and affective appraisal, the study provides a comprehensive and transferable framework for diagnosing perceptual weakness and guiding evidence-based design interventions. The VAM thus contributes to contemporary urbanism by positioning perceptual clarity, orientation, and emotional attachment as measurable dimensions of urban quality.

### 1.8 Research Contribution

This study contributes conceptually, methodologically, and practically to the emerging field of perceptual urbanism.

**Conceptually**, it introduces Urban Déjà Vu as a perceptual and cognitive condition arising from visual repetition and perceptual uniformity, reframing legibility and identity as human-centered perceptual performances rather than formal traits.

**Methodologically**, it develops and validates a two-tier analytical framework (the Rapid Perceptual Screening Sheet (RPSS) and the Visual Assessment Matrix (VAM)) that quantifies perceptual clarity and identifies cognitive and affective weaknesses within urban environments.

**Empirically**, it establishes a composite Perceptual Clarity Index (PCI) that validates the causal sequence linking visual monotony → weak imageability → cognitive disorientation → affective detachment.

**Practically**, the study offers an evidence-based design and planning toolkit that guides perceptual diagnosis and intervention, framing perceptual well-being as a measurable dimension of urban quality.

## 2 Literature Review

### 2.1 Classical Foundations of Urban Perception

The conceptual foundations of urban perceptual theory were established through Lynch's (1960) *The Image of the City* and Cullen's (1961) *The Concise Townscape*, which together defined how the built environment shapes human spatial cognition and visual experience.

Lynch introduced imageability as the capacity of urban form to evoke a clear and memorable mental image through identifiable spatial elements (paths, edges, districts, nodes, and landmarks). His empirical research in Boston, Los Angeles, and Jersey City revealed that legible environments enable orientation, enhance memory, and build emotional attachment, whereas monotonous settings produce cognitive disorientation and spatial anxiety.

Cullen's notion of serial vision complemented Lynch's analytical framework with an experiential one, emphasizing the dynamic rhythm of urban experience through contrast, sequence, and perspective change. He viewed the city as a composition of orchestrated scenes that stimulate sensory engagement and emotional resonance.

Together, their contributions repositioned urban design as a perceptual art (concerned not only with spatial order but with how people see, remember, and emotionally inhabit their surroundings).

Contemporary reinterpretations have adapted these classical theories to emerging digital and behavioral paradigms. Meenar et al. (2022) revisited Lynch's framework using GIS, digital mapping, and AI-based visual sensing to explore how urban environments are cognitively processed in the digital age. Their results confirmed the continued validity of Lynch's five elements but underscored the need to adapt them to new patterns of digital mobility and perception. This continuity between classic perceptual theory and computational tools provides the epistemological foundation for the present study's Visual Assessment Matrix (VAM), which operationalizes imageability and serial vision into measurable perceptual indicators.

### 2.2 Advancing Theoretical and Empirical Dimensions of Urban Perception

Following the classical period, perception research broadened to include psychological, behavioral, and methodological dimensions. Nasar (1998) reconceptualized the city image as an evaluative image, asserting that perception is inherently emotional and subjective. His studies demonstrated that visual attributes (color, texture, and rhythm) directly influence feelings of comfort, safety, and preference, embedding affective response within the physical reading of urban space.

Similarly, Kaplan and Kaplan (1989) proposed the Preference Framework, identifying four dimensions (coherence, complexity, legibility, and mystery) that define human environmental preference. They revealed that cognition seeks a balance between clarity and stimulation. This Principle connects directly to Lynch's notion of legibility while offering measurable parameters for perceptual comfort.

Roger Trancik's (1986) Finding Lost Space extended this discourse by highlighting the perceptual and social implications of undefined or fragmented urban spaces, coining lost space to describe environments devoid of visual or social meaning.

Methodologically, Ewing and Handy (2009) made a pivotal contribution by translating aesthetic and perceptual qualities into quantifiable design dimensions (imageability, enclosure, human scale, transparency, and complexity) validated across multiple cities. Their structured approach represented a decisive shift from theoretical description to field-based measurement.

Concurrently, Gehl (2011) reaffirmed the centrality of human scale and visual accessibility, linking perceptual legibility to pedestrian comfort and social vitality. His observations demonstrated that perceptually coherent environments are also socially successful. Together, these studies transformed perception research from conceptual speculation into a testable behavioral science, laying the empirical basis for perceptual urbanism.

## 2.3 Cognitive Mapping and Wayfinding Behavior

Advancements in environmental psychology reframed perception as a process of cognitive mapping. Golledge (1999), Passini (1996), and Montello (2005) conceptualized wayfinding as a dynamic process integrating perception, spatial memory, and decision-making. They argued that orientation depends not only on visibility but also on the coherence, hierarchy, and recognizability of spatial structure.

Environments with repetitive morphologies, poor landmarks, and ambiguous sequences impair navigational cognition and weaken spatial confidence.

Al-Hathloul (1996) demonstrated this empirically in Riyadh, using Lynch's five elements to evaluate the city's imageability. His findings highlighted weak landmarks, indistinct nodes, and excessive repetition as major factors reducing cognitive clarity and sense of place.

These insights reaffirm that legibility and imageability are not visual phenomena alone but cognitive processes deeply tied to spatial memory and decision logic. Such local evidence underscores the necessity for structured assessment models (like the VAM) to quantify perceptual weakness within contemporary urban fabrics.

## 2.4 Visual Clutter, Perceptual Load, and Spatial Coherence

Recent research has examined the negative dimensions of perception (visual overload and cognitive fatigue). Rosenholtz et al. (2007) developed a computational model of visual clutter, defining it as an excess of disorganized visual information that overloads cognitive capacity and diminishes recognition efficiency.

Wolfe and Horowitz (2017) further identified five perceptual factors (density, contrast, grouping, texture, and similarity) that influence visual search and attention in complex environments. Excessive repetition and uniformity, therefore, can be as cognitively stressful as chaos, producing what this study describes as perceptual uniformity.

Empirical work by Stamps (2000) and Güney et al. (2012) demonstrated similar outcomes: large-scale developments and high-rise clusters, when poorly integrated, fragment skyline rhythm and generate perceptual discomfort. These insights reinforce the need for evaluative frameworks capable of balancing visual richness with coherence (a balance directly embedded in the VAM's domains and the Perceptual Clarity Index (PCI)).

## 2.5 Emotional and Affective Dimensions of Place

Parallel to visual and cognitive analysis, the emotional experience of place has gained prominence as an essential layer of perception. Proshansky et al. (1983) introduced the notion of place identity as the emotional component of environmental interaction, linking spatial attachment to self-concept.

Nasar (1998) and Kaplan and Kaplan (1989) demonstrated that affective responses (comfort, safety, and preference) stem from perceptual coherence and balanced complexity.

Gehl (2011) reinforced this relationship behaviorally, showing that human comfort in public space is grounded in perceptual clarity at eye level.

Together, these studies frame the affective dimension as integral to perceptual performance, forming the emotional layer of the VAM model. The convergence of affective, visual, and cognitive research marks a shift toward perceptual performance as a holistic design metric.

## 2.6 Contextual and Applied Perspectives in Urban Perceptual Studies

Applied studies have increasingly sought to institutionalize perceptual assessment within urban design governance. Danese et al. (2009) demonstrated the role of Visual Impact Assessment (VIA) as a strategic tool for simulating and mitigating visual distortions using GIS-based 3D modeling.

Carmona (2021) offered a comprehensive multi-dimensional model (morphological, perceptual, social, visual, and managerial) identifying the perceptual dimension as vital to public-space quality.

In the Saudi context, Al-Hathloul (1996) critically reviewed Riyadh's grid-based expansion, arguing that while functionally efficient, it lacked visual coherence and cultural

identity, leading to urban repetition and weak place recognition. This critique aligns directly with the conceptual premise of Urban Déjà Vu in the present research.

Similarly, Stamps (2000) and Rapoport (2016) emphasized the importance of contextual calibration when applying Lynch's imageability model in cities with non-organic growth patterns such as those in the Gulf region. These empirical insights strengthen the necessity for localized tools like the VAM, which integrate perceptual theory into applied urban analysis.

### 2.7 Comparative Review of Existing Perceptual and Visual Assessment Tools

A wide range of frameworks has been developed to evaluate perceptual and visual quality across urban and landscape contexts. Institutional models such as the Visual Impact Assessment (VIA) under the U.S. NEPA guidelines and the Guidelines for Landscape and Visual Impact Assessment (Landscape Institute & IEMA, 2013) in the United Kingdom established standardized procedures for describing visual change and landscape sensitivity. However, these models remain primarily aesthetic and expert-oriented, offering limited insight into the everyday perceptual experience of urban users.

Within urban design research, more human-centered frameworks emerged. Ewing and Handy's (2009) Urban Design Qualities Index quantified five perceptual attributes (imageability, enclosure, human scale, transparency, and complexity) linking physical form to experiential response. Gehl's (2011) criteria for public-space quality extended this approach to include comfort, safety, and social interaction, emphasizing the perceptual conditions that support human-scale urban life. Both frameworks advanced perception research from descriptive theory to field-based evaluation but remained partial in their ability to address cognitive mapping or affective attachment.

Parallel analytical approaches expanded the quantitative assessment of perception. Rosenholtz et al. (2007) developed a computational Visual Clutter Model measuring perceptual load and information density, while Space Syntax Visibility Graph Analysis (Hillier & Hanson, 1984; Turner, 2001) modeled spatial legibility and inter-visibility patterns within urban form. Psychophysical methods such as the Scenic Beauty Estimation (SBE) (Daniel & Boster, 1976) further captured aesthetic preference through aggregated observer ratings. While these tools offered increasingly measurable perspectives, each isolated a single layer of perception (visual, cognitive, or affective) without acknowledging their interdependence in shaping the holistic urban experience.

Collectively, these frameworks demonstrate both the richness and fragmentation of perceptual assessment methodologies. They provide valuable insights into particular dimensions of human perception yet fall short of delivering an integrated and measurable structure that connects sensory perception, spatial cognition, and emotional response within a unified evaluative paradigm. This conceptual gap underscores the need for a comprehensive framework capable of diagnosing perceptual clarity as an interconnected human-centered construct.

### 2.8 Urban Experience as an Integrative Perceptual Paradigm

Building upon the preceding theoretical and empirical developments, this research situates urban experience as the integrative paradigm through which the visual, cognitive, and affective dimensions of perception converge. Rather than treating perception as a static visual act, the urban experience encompasses the continuous sensory, cognitive, and emotional interaction between people and their environments (mediated by movement, speed, and scale).

Gehl (2011) underscores the salience of pedestrian-scale perception in fostering comfort and social vitality; Kaplan and Kaplan (1989) and Nasar (1998) illustrate how perceptual coherence and balanced complexity generate emotional satisfaction and environmental preference, while Appleyard et al. (1964) demonstrate the sensitivity of perception to mode and velocity, revealing how walking and vehicular perspectives construct distinct visual narratives of the same urban form.

Within this synthesis, urban experience functions as an operational lens in the Visual Assessment Matrix (VAM), guiding the integration of visual, cognitive, and affective indicators into a unified perceptual framework. The concept thus reframes perception as a dynamic and human-centered process. In sum, this synthesis reframes perception as a dynamic, human-centered process that evaluates urban quality through clarity, orientation, and emotional resonance.

## 3 Conceptual Framework and Definitions

The reviewed literature reveals both the richness and the fragmentation of perceptual assessment. Existing frameworks often isolate individual domains (visual, cognitive, or affective) without capturing their interdependence in shaping the full urban experience. Building upon these complementary insights (while addressing their methodological gaps), this study introduces the Visual Assessment Matrix (VAM) as an integrative conceptual framework that unites sensory, spatial-cognitive, and emotional dimensions into one coherent structure. Through its composite indicator, the Perceptual Clarity Index (PCI), the framework transforms fragmented theoret-

ical insights into a measurable system providing a diagnostic basis for evaluating and enhancing perceptual performance in contemporary urban environments.

Within this conceptual structure, the Perceptual Clarity Index (PCI) is conceived as a composite construct that operates across multiple spatial scales. It synthesizes localized perceptual cues and broader experiential patterns, with its full operational logic elaborated subsequently in the methodological framework.

### 3.1 Visual and Cognitive Dimensions of Urban Perception

Urban perception unfolds across two interdependent layers: the **visual**, which organizes the immediate sensory field, and the **cognitive**, which transforms this field into a coherent mental structure. The visual layer encompasses what the eye registers at first encounter (color, texture, proportion, façade rhythm, and spatial contrasts). This configuration represents the **visual image**, a rapid optical snapshot that precedes deeper spatial understanding (Rosenholtz et al., 2007).

By contrast, the **mental image** develops through repeated exposure; the recognition of salient elements; and the hierarchical arrangement of paths, nodes, and landmarks (Lynch, 1960; Golledge, 1999). It constitutes the deeper cognitive representation that supports navigation, recall, and decision-making. Between these two layers lies the **visual impression**, the immediate affective evaluation of a scene (how it feels aesthetically and emotionally rather than how it is structured (Nasar, 1998)). In visually homogeneous environments, this triad becomes unbalanced: the visual image may remain clear, yet the mental image weakens, producing places that appear familiar but indistinguishable (a fundamental mechanism underpinning the *Urban Déjà Vu* condition).

These conceptual distinctions clarify why sensory order does not automatically translate into cognitive clarity. They also help differentiate between two forms of perceptual breakdown. **Visual disorientation** arises from sensory overload (clutter, signage saturation, or chaotic visual fields that limit attentional focus (Wolfe & Horowitz, 2017)). **Perceptual disorientation**, however, emerges from cognitive underload: excessive uniformity, repetition, or insufficient differentiation, even in visually tidy environments (Nasar, 1998). While the former impedes the ability to *see*, the latter compromises the ability to *know*, to form, update, or retrieve a coherent mental map.

Recognizing this duality between sensory perception and cognitive interpretation reveals why environments that appear visually controlled may nonetheless feel cognitively unstable. When urban form lacks anchors, hierarchy, or narrative progression, it undermines spatial clarity, weakens recall, and diminishes users' emotional connection to place (ultimately constraining the legibility and experiential quality of the built environment).

### 3.2 Visual Monotony and Perceptual Uniformity

The conventional term "visual homogeneity" inadequately describes the perceptual challenges of contemporary cities. Homogeneity can connote harmony and order, whereas the issue under investigation is repetition without distinction—a condition better articulated through the dual concepts of visual monotony and perceptual uniformity.

- Visual monotony occurs when façades, materials, modules, and skyline profiles recur excessively, inducing aesthetic and perceptual fatigue.
- Perceptual uniformity occurs when such monotony translates into near-identical mental impressions, making it difficult to differentiate one place from another.

Together, these conditions form the perceptual basis of Urban Déjà Vu (a situation in which the city feels familiar but indistinct, repetitive yet disorienting). Rather than creating comfort through order, visual monotony and perceptual uniformity undermine the city's narrative diversity, erasing the subtle variations that help users anchor meaning and memory within the urban landscape.

### 3.3 Typological and Morphological Roots of Urban Déjà Vu

Urban Déjà Vu does not emerge from isolated or incidental impressions; rather, it reflects a deeper morphological and typological condition embedded within the spatial logic of contemporary urban districts. As illustrated in Figs. 2 and 3, configurational and morphological sameness across different urban contexts produces converging perceptual impressions, reinforcing the spatial uniformity that underlies the urban déjà vu phenomenon. Field observations and interviews conducted across multiple neighborhoods consistently revealed a recurring perceptual confusion (a shared sense that different districts, though geographically distant, conveyed the same visual and spatial impression). This collective response points to a systemic phenomenon in which morphological sameness gradually weakens spatial distinction and erodes imageability.

At the core of this phenomenon are three mutually reinforcing logics of repetition (morphological, functional, and configurational) each contributing to perceptual uniformity in a distinct way.

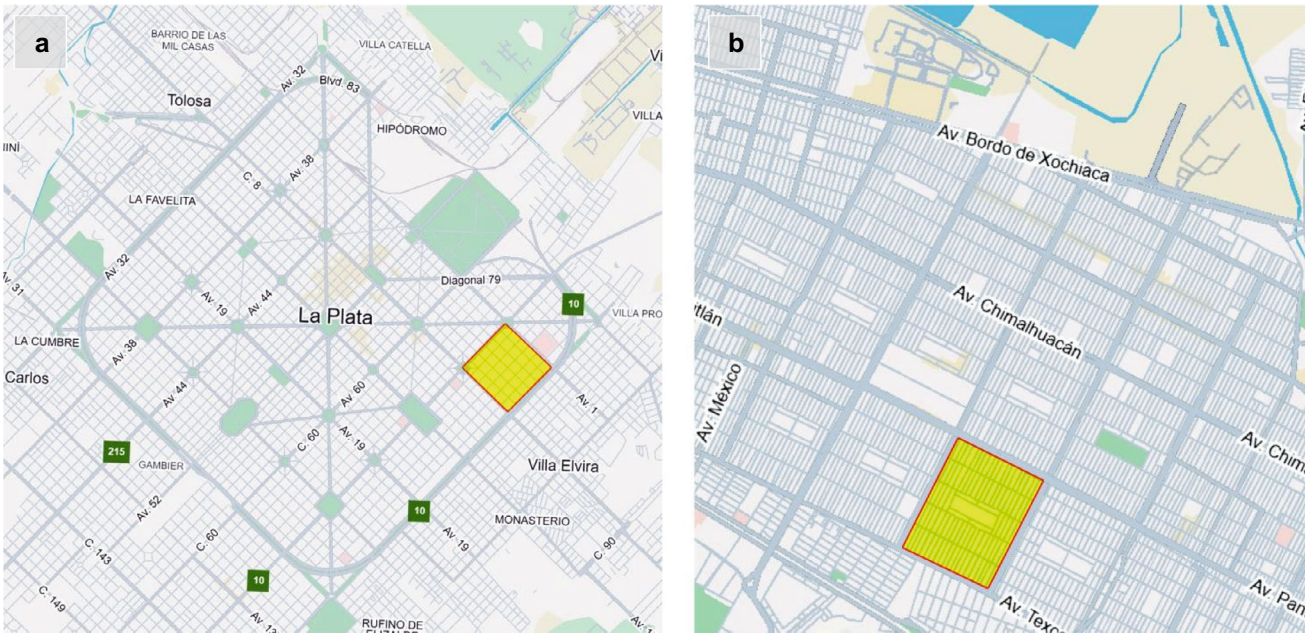



**Fig. 2** Configurational repetition across two global grid cities. **a** La Plata, Argentina: a formally planned diagonal–orthogonal grid where repeated block geometry produces high structural predictability. **b** Ecatepec, state of Mexico: a dense rectilinear grid exhibiting uniform block modules and limited configurational differentiation. *Source* Google Earth (2024), processed, compiled, and annotated by the researcher

- **Morphological Repetition**: This repetition manifests in the physical fabric of the city: recurring building heights, replicated façade proportions, repeated material palettes, and duplicated color tones. It extends to finer architectural details such as window rhythm, shadow lines, and textural treatments, producing a continuous field of visual sameness. Such homogenization suppresses perceptual contrast and blurs spatial memory. Notably, this pattern does not arise from well-executed regulatory frameworks; it typically emerges in environments where design codes are either absent, superficial, or applied without sensitivity to contextual variation. Effective design regulations maintain calibrated diversity that strengthens perceptual clarity rather than diminishing it.
- **Functional Repetition**: Functional repetition occurs when neighborhoods replicate the same cluster of essential land uses (commercial strips, community facilities, schools, and mosques) in nearly identical spatial arrangements. While functionally efficient, this uniform replication causes users to experience similar behavioral patterns regardless of location. Over time, movement scripts become predictable, diminishing neighborhood uniqueness and weakening emotional attachment.
- **Configurational or Structural Repetition**: This form of repetition is embedded within the underlying street network and its spatial syntax. Whether shaped by grid, radial, or looped layouts, districts often reproduce similar alignments, turning angles, and nodal terminations. These repeated sequences generate parallel perceptual rhythms and recurring kinetic experiences (what can be described as kinetic déjà vu, in which the unfolding of space during movement mirrors previous experiences even in entirely different locations). Here, perceptual confusion arises not from visual clutter but from excessive structural predictability.

These three layers rarely operate in isolation. Rather, they interact to form multi-sensory conditions of perceptual uniformity, where visual, functional, and structural repetition converge to diminish differentiation, reduce cognitive clarity, and induce perceptual fatigue. The issue lies not in repetition per se, but in the absence of distinctive perceptual markers (variations in form, color, materiality, or spatial hierarchy that help users construct cognitive maps and sustain place identity).

Understanding Urban Déjà Vu as a phenomenon rooted in typological and morphological repetition provides the theoretical foundation for a systematic evaluative approach. This conceptual grounding directly informs the development of the Visual Assessment Matrix (VAM) and its composite indicator, the Perceptual Clarity Index (PCI)—tools designed to translate perceptual theory into measurable urban design intelligence.




**Fig. 3** Multi-scale morphological repetition in mass-produced housing environments, Ixtapaluca, Mexico. This composite panel shows how multi-scale morphological repetition generates a visually undifferentiated environment. The resulting perceptual sameness contributes directly to spatial confusion and the emergence of Urban Déjà Vu. **a** Macro-scale district repetition. **b** Meso-scale block uniformity. **c** Large-area housing expansion. **d** Parcel-level modular repetition. **e** Street-level façade monotony. *Source* Google Earth (2024), multi-scale morphological interpretation and visual composition by the author

### 3.4 Imageability, Mental Mapping, and Perceptual Fragmentation

The cognitive map develops through a sequential perceptual–cognitive process in which raw sensory input is gradually transformed into an organized spatial schema. This process unfolds through several stages: initial sensory registration of edges, textures, colors, and silhouettes; recognition of salient elements, such as landmarks or junctions; spatial association, where these elements form relational patterns; reinforcement through repetition, which stabilizes memory; and finally interpretive attribution and operational deployment, whereby meaning, familiarity, and navigational utility consolidate into a coherent mental representation (Lynch, 1960; Montello, 2005; Passini, 1996).

When the middle stages (recognition, association, and reinforcement) are weakened due to morphological repetition or excessive similarity, the cognitive map loses distinctiveness. Urban environments become cognitively interchangeable, leading to reduced spatial differentiation and perceptual fragmentation.

According to Lynch's (1960) formulation of imageability, the clarity of the cognitive map depends on identifiable urban elements (paths, edges, districts, nodes, and landmarks) that anchor memory and facilitate spatial reasoning. When these elements lose contrast, the mapping process deteriorates. Cullen's (1961) concept of serial vision reinforces this by emphasizing the role of sequential variation and visual rhythm in sustaining perceptual engagement. Where this rhythm collapses, users experience a form of perceptual fragmentation marked by disrupted continuity and weakened experiential narrative.

The erosion of sequential differentiation and the fading of spatial anchors undermine both orientation and emotional resonance. Over time, these conditions may manifest as placelessness, a psychological state characterized by diminished attachment, experiential fatigue, and a weakened sense of spatial identity (Nasar, 1998; Relph, 1976).

### 3.5 Causes and Consequences of Cognitive Disorientation

While Sect. 3.3 examined the urban-form mechanisms that generate morphological, functional, and configurational repetition, the present section addresses how these patterns are processed cognitively and how they translate into perceptual breakdowns and emotional detachment. Cognitive disorientation does not result from repetition alone; it emerges when the perceptual environment lacks the contrast, hierarchy, and memorable anchors required to construct stable and differentiated cognitive maps.

Morphological repetition suppresses perceptual contrast; weak landmark hierarchy disrupts legibility and memory formation; and overly repetitive spatial sequencing collapses Cullen's (1961) notion of serial vision. Functional redundancy produces identical behavioral scripts, while configurational predictability (uniform street alignments, turning sequences, or nodal patterns) generates recurring kinetic experiences that feel interchangeable across locations. Combined, these mechanisms create a condition of perceptual underload, in which environments feel familiar yet indistinguishable: a core characteristic of the Urban Déjà Vu phenomenon.

The consequences extend beyond spatial reasoning. Prolonged exposure to monotonous and weakly differentiated environments induces perceptual fatigue, reduces aesthetic satisfaction, and gradually erodes affective attachment (a weakening of emotional bonds and sense of belonging (Proshansky et al., 1983)). This progression defines the conceptual chain underpinning the present study: Visual Monotony → Weak Imageability → Cognitive Disorientation → Affective Detachment. Together, these dynamics explain how formal sameness in contemporary urban districts translates into diminished perceptual clarity, reduced memory resilience, and declining place-based identity.

### 3.6 Perceptual Factors Enhancing Clarity and Imageability

While monotony, uniformity, and weakened spatial hierarchy diminish perceptual clarity, several perceptual and design-based qualities can strengthen imageability and restore cognitive anchoring. Visual distinctiveness (the clarity and contrast of form, texture, and color) enables rapid recognition and supports stable memory formation (Lynch, 1960). Legibility further reinforces this process by providing clear spatial cues, identifiable paths, and coherent spatial hierarchies.

Drawing from Kaplan and Kaplan's (1989) Preference Framework, balanced complexity enhances engagement by introducing moderate variety without overwhelming the observer, while coherence maintains order and perceptual stability. Cullen's (1961) principle of sequential variation sustains perceptual rhythm by offering alternating vistas, transitions, and scene changes that enrich the narrative of movement. Memorability arises when environments incorporate distinctive visual moments or emotionally resonant cues, allowing users to form durable affective impressions. Finally, affective coherence (the alignment between perceptual clarity and emotional comfort) translates spatial order into deeper forms of attachment and place identity (Nasar, 1998).

These dynamics are supported by four cognitive–perceptual factors consistently identified in the literature:

- **Exposure**: Frequent and prolonged engagement with the environment strengthens familiarity and memory consolidation (Passini, 1996).
- **Form**: Distinctive, clear physical elements enable quick perceptual recognition and cognitive differentiation (Lynch, 1960).
- **Meaning**: Cultural, symbolic, social, or emotional significance deepens attachment and enhances recall (Proshansky et al., 1983; Rapoport, 2016).
- **Structure**: Spatial organization, continuity, and relational logic support orientation, wayfinding, and legibility (Cullen, 1961; Lynch, 1960).

Collectively, these elements act as cognitive stabilizers. When absent or insufficiently developed, the environment becomes vulnerable to weak imageability, diminished spatial distinction, and heightened perceptual fragmentation.

### 3.7 Scales and Modes of Spatial Experience

We frame spatial perception within the broader concept of spatial experience (the integrated sensory, cognitive, emotional engagement with place through movement and social interaction). Crucially, experience varies by mode and speed of perception:

- **Pedestrian mode** (slow, immersive, multi-sensory): Highly sensitive to human scale, texture, micro-rhythms, and near-field landmarks.
- **Vehicular mode** (fast, panoramic, temporally compressed): Reliant on macro-rhythm, skyline articulation, hierarchy, and long-view landmarks.

Building on Appleyard et al. (1964), the framework incorporates a mode-sensitive sub-indicator, sequential clarity at varying speeds, to assess how speed and viewing distance modulate imageability and disorientation. This integration enhances the framework's explanatory strength and external validity across real mobility conditions.

**Table 1** Conceptual framework: from visual monotony to perceptual clarity

| Perceptual layer | Key components/variables | Observed effect or process | Related conceptual constructs |
|---|---|---|---|
| **Visual** (sensory) | Façade repetition; material and color diversity; visual clutter/order; sequential variation | Visual monotony reduces sensory richness and rhythm; visual diversity restores perceptual engagement | Visual monotony; perceptual uniformity; visual clutter |
| **Cognitive** (spatial) | Landmark visibility; path hierarchy; spatial sequencing; enclosure and legibility | Loss of distinctive anchors weakens imageability and spatial memory, leading to disorientation | Imageability; mental mapping; cognitive disorientation |
| **Affective** (emotional) | Comfort and safety perception; belonging/attachment; aesthetic preference | Reduced perceptual clarity leads to affective detachment and diminished place identity | Place attachment; affective coherence; placelessness |
| **Integrative construct** | – | Combined variables across the three perceptual layers form a composite metric of perceptual performance | Perceptual clarity index (PCI) via VAM |

*Source* Author's own compilation based on the reviewed literature

### 3.8 Derivation of the Tripartite Perceptual Structure

The tripartite perceptual structure that encompassing visual, cognitive, and affective dimensions emerges from the synthesis of cumulative theoretical and empirical precedents identified in the literature. By integrating insights from earlier frameworks, each perceptual dimension addresses disciplinary fragmentation and contributes to a unified analytical structure. The visual dimension synthesizes Ewing and Handy's (2009) Urban Design Qualities and Rosenholtz's (2007) Visual Clutter Model, combining imageability, perceptual load, and sensory contrast into a coherent visual domain. The cognitive dimension extends Lynch's (1960) Imageability theory and Space Syntax Visibility Graph Analysis (Hillier & Hanson, 1984) to quantify legibility, spatial hierarchy, and orientation logic. The affective dimension draws from Nasar's (1998) evaluative image framework, Gehl's (2011) human comfort criteria, and Proshansky et al.'s (1983) concept of place attachment to represent emotional coherence, comfort, and belonging.

Together, these foundations consolidate perceptual theory into a coherent analytical structure that bridges visual aesthetics, spatial cognition, and affective psychology, providing the conceptual foundation from which the VAM and its composite index (PCI) are operationalized.

### 3.9 Integrating the Conceptual Framework into the Visual Assessment Matrix (VAM)

The conceptual insights outlined across the preceding sections are consolidated and operationalized within the Visual Assessment Matrix (VAM), a mixed-method evaluative framework that integrates visual (sensory), cognitive (spatial), and affective (emotional) dimensions into a coherent analytical system. By translating perceptual theory into measurable spatial indicators, the VAM provides a replicable, evidence-based tool for assessing the experiential quality of urban environments and diagnosing the degree to which they support or undermine perceptual clarity.

At the core of the VAM is the Perceptual Clarity Index (PCI), a composite diagnostic metric that synthesizes variables across the three perceptual layers. Through this structure, the PCI captures the cumulative effects of visual differentiation, cognitive anchoring, legibility, sequential variation, and affective coherence. Environments characterized by excessive sameness, weak landmarks, or collapsed spatial rhythm typically exhibit low PCI values, signaling diminished imageability and a heightened risk of perceptual fragmentation. Conversely, environments that demonstrate clear spatial hierarchy, distinctive visual anchors, and meaningful experiential transitions exhibit higher perceptual clarity.

Table 1 summarizes the relationships between the three perceptual layers and the conceptual constructs that underpin the VAM framework.

## 4 Methodology

### 4.1 Research Design and Rationale

This study employs a sequential mixed-method design, integrating qualitative exploration with quantitative validation to investigate how visual repetition affects perceptual clarity, cognitive orientation, and emotional attachment in contemporary spatial environments. This approach was strategically selected because the studied phenomena (imageability, cognitive disorientation, and place attachment) span both subjective human experience and objective spatial form (Creswell & Plano Clark, 2017). Relying on a single methodological lens would have been insufficient to capture this experiential–spatial duality.

## 4.2 Sequential Phases of Implementation

The adopted research design was operationalized through three applied phases that ensured systematic integration between perceptual observation, analytical refinement, and empirical validation:

- **Phase 1. Qualitative Grounding**: Exploratory fieldwork, guided observations, and brief intercept interviews were conducted to surface perceptual issues and generate preliminary indicators for measuring perceptual clarity.
- **Phase 2. Instrument Development and Pilot Testing**: Following indicator extraction, a combined panel of academic experts and professional practitioners (spanning architecture, urban planning, urban design, and environmental psychology) reviewed the preliminary version of the Visual Assessment Matrix (VAM) through a modified Delphi consultation and focused brainstorming sessions to assess content validity, clarity, and feasibility of urban application. Pilot testing was then conducted in central areas of selected Riyadh districts (where urban repetition and orientation are most pronounced). Expert feedback and pilot outcomes were integrated to refine the VAM structure and ensure its practical feasibility and conceptual robustness.
- **Phase 3. Quantitative Validation**: Large-scale field application followed by multi-level statistical verification (EFA, CFA, SEM) tested the reliability, structural validity, and internal consistency of the VAM and its composite index (PCI).

This three-phase structure ensures methodological triangulation across human perception, behavioral evidence, and spatial measurement, thereby establishing a coherent and empirically grounded methodological foundation.

## 4.3 Development of the Visual Assessment Matrix (VAM)

The VAM was conceptualized as the study's core analytical framework, translating the perceptual sequence (visual monotony, weak imageability, cognitive disorientation, affective detachment) into a structured multi-domain tool capable of both diagnosis and strategic feedback. The matrix development involved four methodological stages:

1. **Indicator Extraction**: Derived from theoretical constructs in Lynch's (1960) *Image of the City* and Cullen's (1961) *Townscape*, further supported by applied urban design metrics (Ewing & Handy, 2009; Gehl, 2011; Nasar, 1998; Rosenholtz et al., 2007), and subsequently refined using insights from Phase 1 exploratory fieldwork to ensure contextual and perceptual validity.
2. **Expert Validation**: The preliminary VAM was critically reviewed through modified Delphi consultations and focused brainstorming sessions that engaged experts from urban design, environmental psychology, architecture, and urban planning, representing both academic and professional perspectives. This process ensured conceptual clarity, contextual relevance, and an effective balance between theoretical rigor and practical applicability.
3. **Pilot Testing**: The refined matrix was pilot-tested in the central areas of selected Riyadh districts, where visual repetition and orientation are most pronounced, using the Rapid Perceptual Screening Sheet (RPSS) to classify perceptual clarity and the detailed VAM to analyze moderate and weak zones, leading to adjustments in indicator wording, weighting, and scoring consistency.
4. **Two-Level Configuration**: Based on pilot feedback, the tool was restructured into two complementary levels to enhance methodological usability, minimize evaluator fatigue, and establish a logical progression from initial perceptual screening to detailed analytical diagnosis:
   - Rapid Perceptual Screening Sheet (RPSS): For fast, symbol-based perceptual screening (○, △, ×).
   - Detailed VAM: For quantitative and analytical evaluation (scored 1–5 with weighting and PCI computation).

## 4.4 Derivation and Conceptual of the Three Evaluative Dimensions

The three evaluative dimensions of the Visual Assessment Matrix (VAM) (visual, cognitive, and affective) were systematically derived from classical and contemporary perceptual theories in urban design and environmental psychology. Each dimension corresponds to a distinct phase in the human perceptual process, ensuring that the VAM captures both the objective configuration of urban form and the subjective experience of place.

The Visual dimension, rooted in Cullen's (1961) notion of the visual sequence and later operationalized by Ewing and Handy (2009) and Rosenholtz et al. (2007), translates visual stimuli into measurable indicators such as façade repetition, color and material diversity, and visual clutter to quantify perceptual richness and order.

The cognitive dimension builds on Lynch's (1960) concept of imageability and the broader field of spatial cognition (Golledge, 1999; Montello, 2005). It evaluates legibility, sequencing, and orientation through variables such as landmark visibility, path hierarchy, and spatial continuity, linking the structural logic of urban form to mental mapping and wayfinding behavior.

The affective dimension, grounded in Nasar's (1998) evaluative image theory and Proshansky et al.'s (1983) place-identity framework, captures users' emotional and psychological responses (including comfort, attachment, and aesthetic preference) as manifestations of perceptual coherence and sense of belonging.

Together, these dimensions operationalize the full perceptual chain (visual monotony → weak imageability → cognitive disorientation → affective detachment) establishing a theoretically grounded structure for evaluating perceptual clarity and urban legibility.

## 4.5 Perceptual Clarity Index (PCI)

The Perceptual Clarity Index (PCI) constitutes the quantitative core of the Visual Assessment Matrix (VAM), synthesizing visual, cognitive, and affective evaluations into a unified perceptual metric. Although the PCI employs empirically validated weights (visual = 0.35, cognitive = 0.40, affective = 0.25), its methodological robustness arises from its multi-scalar operational logic, in which computational procedures adapt to the perceptual granularity of the spatial unit under analysis.

### 4.5.1 Micro-scale PCI (Segment-Level Evaluation)

At the micro-scale, the PCI is calculated for short, visually coherent street segments that represent a stable perceptual field during movement. Classical perceptual frameworks (Cullen, 1961; Gehl, 2011) and contemporary urban design metrics (Ewing & Handy, 2009) emphasize that such perceptual units typically range from 20 to 30 m. Given the extended sightlines and wider cross-sectional characteristic of Riyadh's urban form, the present study adopts a **fixed 50 m segment** to ensure that each unit captures a complete and coherent visual impression while maintaining methodological consistency across sites.

Each domain score ($D_{\text{visual}}$, $D_{\text{cognitive}}$, $D_{\text{affective}}$), representing the standardized mean of its indicators (1–5), is integrated through the weighted formulation:

$$\text{PCI}_{\{\text{segment}\}} = \left(0.35 \times D_{\{\text{Visual}\}}\right) + \left(0.40 \times D_{\{\text{Cognitive}\}}\right) + \left(0.25 \times D_{\{\text{Affective}\}}\right)$$

This micro-scale PCI serves as the foundational perceptual unit from which meso-level analysis is derived.

### 4.5.2 Meso-scale PCI (Area-Level Aggregation and Internal Consistency Adjustment)

When multiple micro-scale segments collectively form a perceptual entity (such as a neighborhood center or mixed-use sub-district) the PCI must reflect not only the central tendency of perceptual quality but also the internal consistency of the experiential field. The initial area-level value is obtained by aggregating segment-level results:

$$\text{PCI}_{\{\text{mean}\}} = \text{Mean}\left(\text{PCI}_{\{\text{segment}\}}\right)$$

However, perceptual clarity at the meso-scale is rarely uniform. Areas may contain internally mixed perceptual conditions (high-clarity pathways adjacent to monotone or weakly legible segments). Averaging alone obscures these contrasts and may overstate the experiential coherence of the area.

To address this methodological limitation, the aggregation process incorporates a dispersion-based adjustment, grounded in perceptual research that treats intra-area variability not as statistical noise but as an intrinsic property of experiential stability. The perceptual dispersion factor (PDF) is defined as follows:

$$\text{PDF} = \left\{\text{SD}\left(\text{PCI}_{\{\text{segment}\}}\right)\right\} \Big/ \left\{\text{PCI}_{\{\text{mean}\}}\right\}$$

The refined meso-scale PCI becomes

$$\text{PCI}_{\{R\}} = \text{PCI}_{\{\text{mean}\}} - (k \times \text{PDF})$$

where $k$ (0.15–0.25) is a calibration constant ensuring sensitivity to instability without distorting the interpretive range of the PCI. This refinement **does not modify the original PCI formula**, but rather **completes** the area-level computation by integrating perceptual coherence (an essential characteristic of neighborhood-scale clarity that cannot be inferred from means alone).

### 4.5.3 Interpretive Logic Across Scales

- **Segment-level PCI** captures immediate perceptual clarity and is methodologically sufficient without correction.
- **Unadjusted meso-level PCI** represents the average experiential condition of the area.
- **Refined meso-level PCI ($\text{PCI}^{\text{R}}$)** evaluates whether the area exhibits perceptual stability (low dispersion) or contains internal fragmentation that undermines clarity (high dispersion).

Through this dual-scale design, the PCI maintains conceptual fidelity at the micro-scale while gaining analytical depth and contextual sensitivity at the meso-scale. This multi-scalar structure ensures that the PCI remains an accurate, transferable, and decision-relevant index capable of diagnosing perceptual strength, identifying weak experiential pockets, and guiding design interventions within complex urban environments.

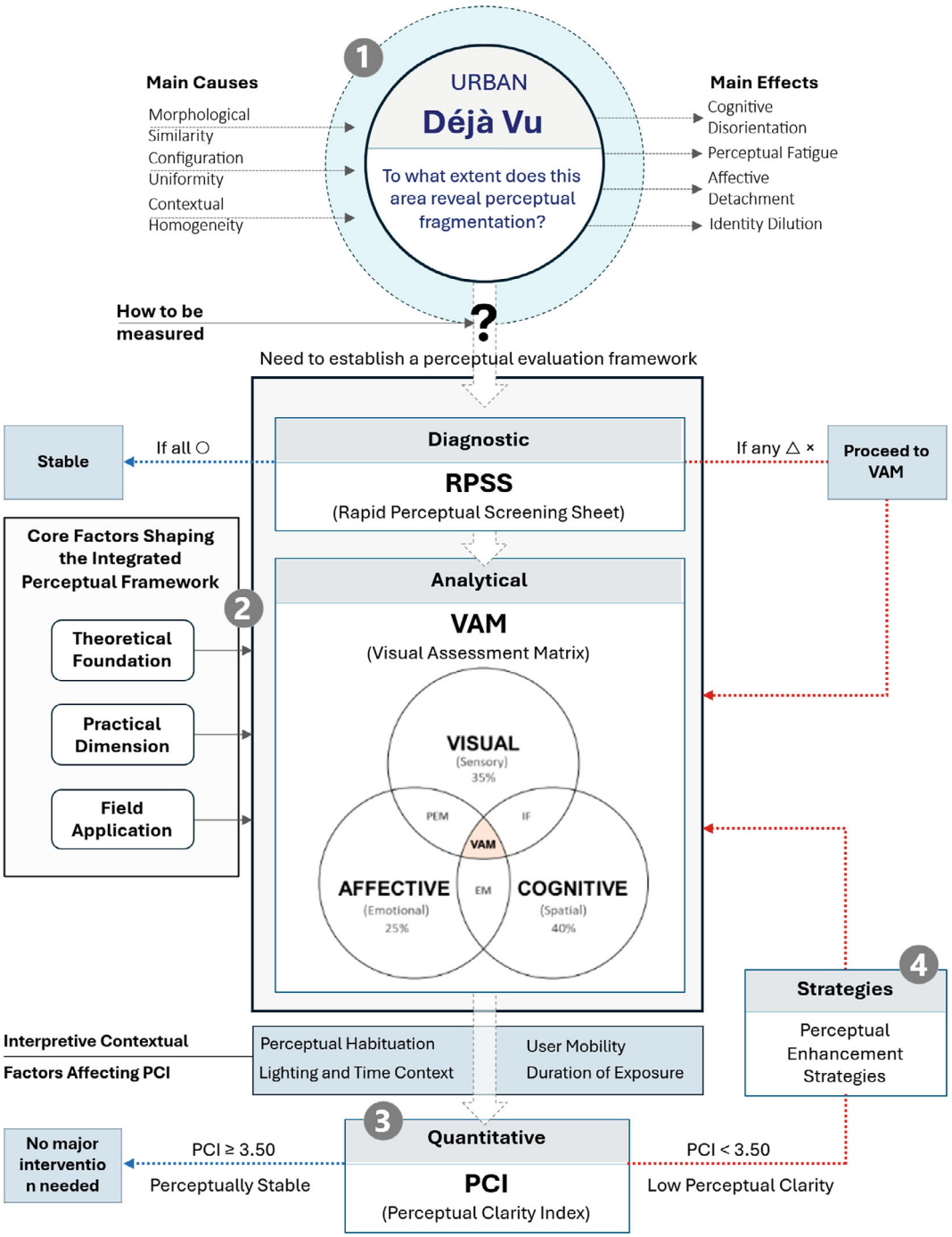



**Fig. 4** Integrated perceptual evaluation framework (RPSS–VAM–PCI). *Source* Conceptualized and designed exclusively by the author (2025)

**The methodological pathway** linking the diagnostic (RPSS), analytical (VAM), and quantitative (PCI) stages is summarized in Fig. 4. This integrated framework illustrates how the phenomenon of *Urban Déjà Vu* was operationalized into a measurable perceptual structure, connecting theoretical grounding, perceptual dimensions, and quantitative validation.

The figure summarizes the methodological pathway linking diagnostic screening (RPSS), analytical assessment (VAM), and quantitative validation (PCI) for operationalizing Urban Déjà Vu as a measurable perceptual structure.

### 4.6 Study Area and Sampling

Field investigations were conducted across three selected districts in Riyadh City (King Fahd, Al-Massif, and Al-Wadi) representing central urban areas where daily perceptual experience, spatial familiarity, and visual repetition are most pronounced. These sites were not selected solely for their morphological variation, but rather because they constitute the perceptual nuclei of everyday urban life in Riyadh, where users repeatedly engage with the built environment and thus experience the full spectrum of imageability, orientation, and perceptual fatigue.

The selection of these districts was guided by three methodological criteria:

- Degree of visual similarity (low, medium, high).
- Pedestrian accessibility and presence of active street frontages.
- Contextual diversity encompassing residential, commercial, and transitional areas.

**Although Riyadh** is predominantly structured around a large-scale grid composed of 2 × 2 km superblocks as shown in Fig. 5, and the grid itself does not generate uniform perceptual monotony across the city. Certain districts (such as Al-Massif, Al-Wadi, and King Fahd, as shown in Fig. 6) exhibit particularly high levels of morphological repetition and façade uniformity, making them analytically suitable for examining Urban Déjà Vu. In contrast, other districts within the same macro-structure display more distinctive spatial and visual compositions that mitigate repetition effects. Accordingly, the selected districts represent prototypical high-repetition cases within the Riyadh grid, offering a clear and focused context for evaluating perceptual clarity without overgeneralizing the findings to the city as a whole.

Extract from the greater Riyadh metropolitan map illustrating the dominant 2 km × 2 km gridiron planning structure and the spatial location of the three study districts. This macro-scale layer supports perceptual analysis by shaping legibility, directional predictability, and kinetic familiarity across the urban field.

Comparative meso-scale neighborhood layouts of selected districts within the Riyadh Metropolitan Area (Al-Massif, King Fahd, and Al-Wadi) illustrating repetitive block structures, uniform parcel subdivision, and consistent grid patterns. These maps highlight the meso-morphological conditions relevant to VAM analysis, revealing reduced perceptual differentiation and reinforcing experiential patterns associated with urban déjà vu.

A stratified purposive sampling strategy was employed to ensure proportional representation of morphological typologies and user profiles. Although no formal a priori power analysis was conducted, the achieved sample ($n = 180$) is consistent with accepted adequacy standards for mixed perceptual studies, satisfying conventional criteria ($\geq 150$ cases and 5–10 cases per indicator). This size provides sufficient stability for EFA/CFA and moderate-complexity SEM, given the study's indicator structure and model scope.

At the operational level, each central area was subdivided into short observation segments of approximately 20–25 m, ensuring systematic spatial coverage and reducing observer bias. During the Rapid Perceptual Screening Sheet (RPSS) stage, these segments were preliminarily evaluated to identify perceptual strength or weakness, after which segments rated as moderate or weak were subjected to detailed analysis using the Visual Assessment Matrix (VAM). This two-tier sequence (rapid screening followed by analytical evaluation) achieved both methodological rigor and diagnostic efficiency, enhancing the spatial representativeness and empirical depth of the assessment.

A total of approximately 180 participants were engaged across the three study sites, reflecting different levels of spatial intensity and visual activity. The demographic and spatial distribution of participants is summarized in Table 2.

### 4.7 Data Collection and Analysis

Between 2022 and 2025, the researcher has continuous engagement with the selected districts (King Fahd, Al-Massif, and Al-Wadi) as part of regular urban mobility and professional field exposure. This sustained interaction provided a cumulative understanding of the perceptual and morphological dynamics of these environments prior to the formal fieldwork phase.

The official field survey dedicated to this research was conducted between August and October 2025, with approximately 2 weeks of intensive on-site recording per district. Observations were systematically distributed across different times of day: morning and mid-day in King Fahd and Al-Wadi, and morning, mid-day, and evening in Al-Massif. Repeated visits ensured both contextual familiarity and observational neutrality, maintaining methodological consistency throughout the study.

To ensure comprehensive coverage of both the objective urban form and the subjective human perception, data collection was structured into three complementary streams, each representing a specific layer of the perceptual experience as shown in Table 3.

**The data analysis process** was designed to combine descriptive, inferential, and spatial analyses to verify the reliability, construct validity, and empirical robustness of the Visual Assessment Matrix (VAM) and its composite Perceptual Clarity Index (PCI). These analyses were conceptually




**Fig. 5** Macro-configurational context of the study area within the Riyadh Metropolitan Grid. *Source* Google Earth (2024), processed, compiled, and annotated by the researcher

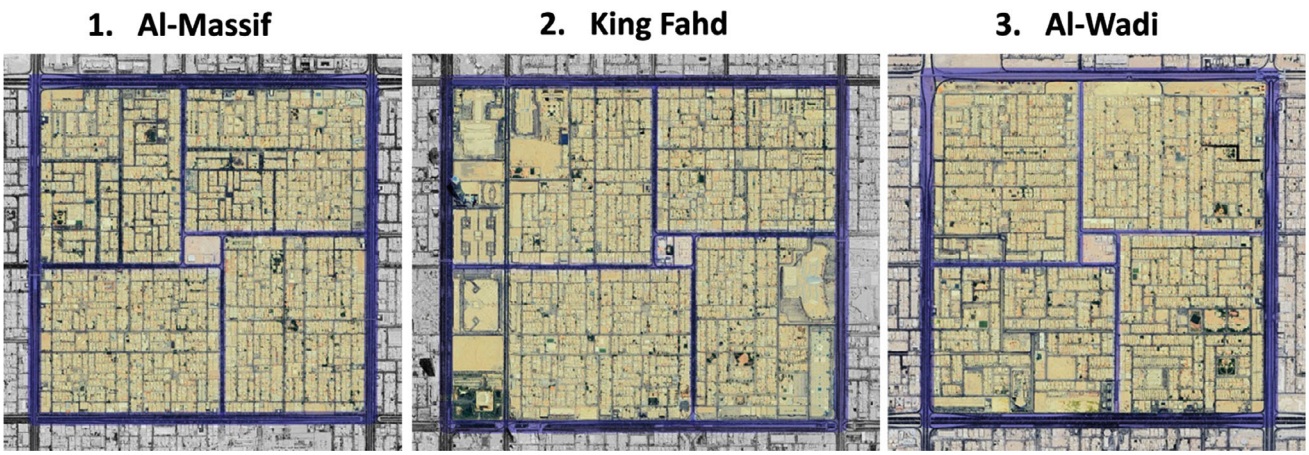



**Fig. 6** Comparative meso-morphological layouts of the selected neighborhoods. *Source* Google Earth (2024), processed, compiled, and annotated by the researcher

**Table 2** Fieldwork and participant profile across the three study districts

| Variable | Category/indicator | King Fahd district | Al-Massif district | Al-Wadi district |
|---|---|---|---|---|
| *Fieldwork overview* | | | | |
| Central area | Size ($m^2$) | 64,400 | 63,000 | 60,420 |
| | Main feeder streets (n) | 4 | 4 | 4 |
| Observation period | For this specific study | Aug–Oct 2025 (2 weeks/site) | | |
| | Main observation times | Morning/mid-day | Morning/mid-day/evening | Morning/mid-day |
| Segments | RPSS | 18 | 16 | 14 |
| | VAM | 10 | 8 | 7 |
| *Demographic profile of participants across the three study districts* | | | | |
| Gender ratio | Male | 56 | 59 | 36 |
| | Female | 24 | 1 | 4 |
| Age group (years) | 18–25 | 20 | 12 | 6 |
| | 26–35 | 24 | 15 | 6 |
| | 36–55 | 20 | 9 | 4 |
| Residence status | Permanent resident | 40 | 42 | 32 |
| | Visitor | 40 | 18 | 8 |
| Primary activity context | Worker | 32 | 25 | 18 |
| | Shopper | 20 | 20 | 12 |
| | Passerby | 12 | 15 | 10 |
| Total participants (n) | | **80** | **60** | **40** |

*Source* Field data collected and organized by the author

**Table 3** Data collection streams, instruments, and measured variables

| Data stream | Data sources and instruments | Techniques/procedures | Measured variables | Key references |
|---|---|---|---|---|
| Spatial and visual data | • Field photography and panoramic videos (every 10 m at pedestrian eye level)<br>• GIS spatial layers (street geometry, land use, building footprints) | • Standardized urban audit following Ewing and Handy (2009) and Gehl (2011) protocols<br>• Image documentation and geo-tagging | • Façade repetition ratio<br>• Signage density<br>• Enclosure ratio<br>• Color/material variation<br>• Height variance<br>• Edge continuity<br>• Landmark visibility | Ewing and Handy (2009), Gehl (2011), Lynch (1960) |
| Behavioral and cognitive data | • Field observation sheets<br>• Wayfinding task records<br>• Sketch maps and recall forms | • Behavioral mapping of pedestrian flows and social zones (4 time bands: morning, mid-day, evening, weekend)<br>• In situ navigation without maps<br>• Recording time, errors, GPS reliance, and landmark recall | • Wayfinding efficiency<br>• Cognitive legibility<br>• Sketch-map accuracy<br>• Movement and interaction frequency | Gehl (2011), Golledge (1999), Montello (2005) |
| Affective and evaluative data | • Structured perception–emotion survey (25 Likert-scale items)<br>• Open-ended qualitative responses | • Questionnaire for perceptual clarity, distinctiveness, comfort, safety, and attachment | • Perceptual clarity<br>• Distinctiveness<br>• Comfort and safety<br>• Emotional attachment<br>• Aesthetic preference | Nasar (1998), Proshansky et al. (1983) |

*Source* Developed by the author based on methodological synthesis

structured as presented in Table 4, to move from field observation to statistical validation while maintaining interpretive transparency.

These procedures together established a coherent methodological pathway that bridges empirical field observation with quantitative perceptual validation, ensuring analytical rigor and contextual reliability in assessing visual repetition, imageability, and perceptual clarity within Riyadh's urban environments.

## 4.8 Ethical Considerations

The study complied with institutional and international ethical standards governing field-based research in the built environment. All participants provided informed verbal consent prior to engagement, and no personally identifiable data were collected. Participation was entirely voluntary, and all visual materials (photographs and recordings) were anonymized to preserve privacy.

**Table 4** Analytical framework for quantitative and spatial validation

| Analytical phase | Method/statistical test | Purpose/output | Thresholds/validation criteria | Software |
|---|---|---|---|---|
| 1. Descriptive analysis | Mean, standard deviation | Summarize perceptual domain scores and sub-indicators | – | SPSS v27 |
| 2. Factor validity | • Exploratory factor analysis (EFA)<br>• Confirmatory factor analysis (CFA) | Identify and confirm the five-domain VAM structure | CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $\leq$ 0.06 (Hu & Bentler, 1999) | AMOS v26 |
| 3. Reliability testing | Cronbach's $\alpha$ and inter-rater ICC | Assess internal consistency and coding reliability | $\alpha \geq 0.80$; ICC $\geq 0.75$ | SPSS v27 |
| 4. Correlational analysis | Pearson correlation and regression models | Examine associations among visual repetition, PCI, and emotional attachment | $p < 0.05$ | SPSS v27 |
| 5. Causal modeling | Structural equation modeling (SEM) | Test causal chain: *visual repetition* $\rightarrow$ *weak imageability* $\rightarrow$ *disorientation* $\rightarrow$ *detachment* | Model fit indices as above | AMOS v26 |
| 6. Spatial visualization | GIS spatial mapping | Map PCI values across districts and identify weak/strong perceptual clusters | Spatial autocorrelation (Moran's I) | ArcGIS Pro |
| 7. AI-based validation | Correlation and Bland–Altman analysis between manual and AI repetition/clutter scores | Cross-validate human versus algorithmic perception measures | $r \geq 0.70$ consistency | SPSS v27; Python (CV models) |

*Source* Author's original methodological design

The study entailed minimal risk and qualified for exempt status under standard academic ethics protocols. Importantly, formal institutional ethical approval was not required, as the research involved no collection of personal, medical, or sensitive data, and all interactions were limited to voluntary perceptual observation within public spaces.

All procedures adhered to the principles of the Declaration of Helsinki (2013) and relevant institutional policies for non-intrusive human-subjects research.

### 4.9 Scope and Limitations

The study primarily focuses on diagnosing perceptual clarity in urban environments rather than predicting long-term behavioral or socio-spatial change.

Its scope encompasses medium-density urban districts in Riyadh that exhibit varying levels of visual repetition, representing the city's dominant morphological patterns. Fieldwork was confined to three principal districts, deliberately selected to ensure a balanced morphological and perceptual diversity across residential, commercial, and transitional settings.

The sample size of approximately 180 participants emerged from the nature of the fieldwork, which relied on direct one-to-one interactions and in situ observations rather than online or large-scale digital surveys. Accordingly, the sampling strategy aimed not at statistical representation but at achieving perceptual saturation and analytical balance among diverse experiential profiles (an approach fully consistent with mixed perceptual methodologies that privilege depth of understanding over numerical breadth).

Despite the methodological robustness, several contextual limitations are acknowledged:

- Observations were limited to daytime periods, with no nocturnal perception data collected.
- Cultural variation in affective and aesthetic responses may influence subjective evaluations.
- Potential self-selection bias due to voluntary participation.
- Minor approximation errors may exist in AI-based visual metrics and spatial analyses.
- Socio-economic variables were intentionally excluded to preserve focus on perceptual and morphological dimensions.

Despite these constraints, the methodological framework remains replicable, adaptive, and empirically grounded, reinforcing the reliability of perceptual assessment and supporting the advancement of more legible, distinctive, and perceptually coherent urban environments.

## 5 Results

The results are organized into five analytical stages corresponding to the operational logic of the Visual Assessment Matrix (VAM) and its composite Perceptual Clarity Index (PCI):

1. Descriptive analysis of perceptual domain scores.
2. Factorial and structural validation (EFA, CFA).
3. Correlation and mediation analysis (SEM).
4. Spatial and visual mapping (GIS + AI integration).
5. Synthesis of findings.

This structure ensures that each perceptual layer (visual, cognitive, and affective) is examined both individually and in combination, maintaining coherence between field observations and analytical validation.

## 5.1 Descriptive Overview and Field Coverage

Field observations were conducted across the central areas of three Riyadh districts (King Fahd, Al-Massif, and Al-Wadi) each representing distinct morphological and perceptual contexts of everyday urban experience. Each district's main streets were divided into short observation segments (≈20–25 m) during the Rapid Perceptual Screening Sheet (RPSS) phase to classify perceptual strength (○ = clear, △ = moderate, × = weak).

Segments rated as moderate or weak were subsequently analyzed using the Visual Assessment Matrix (VAM) to compute the Perceptual Clarity Index (PCI). This two-tier structure (rapid screening followed by analytical evaluation) provided balanced methodological depth and diagnostic precision.

(See Table 2 in the Methodology section for detailed field coverage and participant distribution across the three study sites.)

## 5.2 Descriptive Results of the VAM Domains

Descriptive statistics summarizing the perceptual scores across the five VAM domains are presented in Table 5. The results highlight clear variations among perceptual dimensions, reflecting the differing visual and spatial conditions of the studied districts.

The results shown in Table 5 indicate that spatial legibility achieved the highest relative performance, signifying that the basic urban structure and landmark hierarchy remain perceptually recognizable. Conversely, visual coherence and wayfinding recorded lower values, reflecting the influence of repetitive urban form and limited spatial differentiation. The moderate levels of emotional impression further imply that the perceptual experience in these settings (while not overtly negative) lacks strong affective attachment or memorable visual diversity. Collectively, the aggregated PCI (3.20) denotes a balanced yet moderately indistinct perceptual quality across the study sites.

## 5.3 Factorial and Structural Validation (EFA and CFA)

Exploratory Factor Analysis (EFA) using principal axis factoring with oblique rotation confirmed a five-factor structure explaining 68.4% of total variance, with all indicators loading ≥0.60 on their designated domains and minimal cross-loadings (<0.30).

Confirmatory Factor Analysis (CFA) demonstrated excellent model fit: $\chi^2(220) = 376.1$, CFI = 0.958, TLI = 0.951, RMSEA = 0.045, SRMR = 0.047 (all within accepted thresholds (Hu & Bentler, 1999)).

Reliability was consistently high (Cronbach's $\alpha = 0.81$–0.89), with Average Variance Extracted (AVE ≥ 0.50) and Composite Reliability (CR ≥ 0.80) supporting convergent validity. These findings confirm that the visual, cognitive, and affective domains of the VAM are both empirically distinct and theoretically integrated.

## 5.4 Correlations and Mediation Effects (SEM)

Correlation analysis revealed strong and statistically significant associations ($p < 0.01$) among perceptual constructs:

**Table 5** Descriptive statistics of the VAM domains

| VAM domain | Mean (M) | SD | Interpretation |
|---|---|---|---|
| Spatial legibility | 3.84 | 0.61 | Clear structure and orientation |
| Visual richness | 3.22 | 0.69 | Moderate sequential variation |
| Wayfinding and orientation | 3.11 | 0.71 | Partial navigational difficulty |
| Visual clutter and coherence | 2.46 | 0.74 | High uniformity and monotony |
| Emotional impression | 3.35 | 0.68 | Moderate comfort and attachment |
| **Weighted PCI** | **3.20** | – | **Moderate overall perceptual clarity** |

*Note* PCI = Perceptual Clarity Index; results represent mean scores aggregated across the three study districts
*Source* Statistical analysis conducted by the author (2025)

- Visual Repetition ↔ Imageability: $r = -0.63$.
- Imageability ↔ Disorientation: $r = -0.58$.
- Disorientation ↔ Attachment: $r = -0.52$.

Structural Equation Modeling (SEM) verified the hypothesized causal chain: Visual Repetition → Weak Imageability → Cognitive Disorientation → Affective Detachment.

The indirect effect of visual repetition on affective detachment, mediated through imageability and disorientation, was statistically significant ($\beta = 0.31$, $p < .001$). This confirms that perceptual monotony influences emotional detachment not directly but through accumulated cognitive strain, consistent with the theoretical propositions of Relph (1976) and Nasar (1998) on urban placelessness and perceptual fatigue.

### 5.5 Spatial and Visual Mapping (GIS + AI Integration)

Spatial analysis of PCI values using ArcGIS Pro revealed distinct geographic patterns of perceptual performance:

- Zones characterized by high façade uniformity and repetitive grid geometry recorded the lowest PCI values (<2.8), predominantly within peripheral residential grids.
- Conversely, mixed-use and morphologically diverse corridors exhibited higher PCI values (>3.6), reflecting stronger imageability and perceptual comfort.

AI-based visual clustering further corroborated these trends: segments with higher visual similarity overlapped spatially with low PCI zones, reinforcing the empirical link between morphological monotony and perceptual weakness. Cross-validation with field photographs ensured consistency between human-coded observations and algorithmic classifications, thus strengthening analytical credibility.

### 5.6 Summary of Findings

1. Excessive visual repetition substantially reduces perceptual clarity and imageability, confirming the detrimental effect of morphological monotony.
2. Weak imageability induces cognitive disorientation and diminishes emotional attachment, validating the proposed causal sequence.
3. The Visual Assessment Matrix (VAM) demonstrated strong reliability and construct validity as an operational diagnostic framework.
4. Spatial mapping revealed a positive association between morphological diversity and perceptual clarity.
5. Collectively, the findings confirm the full conceptual chain: Visual Repetition → Weak Imageability → Cognitive Disorientation → Emotional Detachment, thereby substantiating Urban Déjà Vu as a measurable and empirically verifiable perceptual condition.

## 6 Visual Assessment Matrix (VAM): Structure and Application

This section presents the Visual Assessment Matrix (VAM) as the central analytical and applied framework of this research. The framework is termed the Visual Assessment Matrix (VAM) not to confine analysis to the visual field, but because vision constitutes the primary sensory gateway through which cognitive and affective perceptions of urban space emerge.

Beyond its evaluative role, the VAM reframes perception as a form of measurable design intelligence, translating subjective spatial experience into transferable diagnostic knowledge for planners and urban decision-makers.

The matrix thus employs visual observation and imagery as empirical proxies for the broader perceptual process, integrating sensory, spatial, and emotional cues within one evaluative system. While earlier sections detailed its design, validation, and field testing, the following pages introduce the matrix in its finalized structure, integrating both diagnostic and strategic dimensions. The VAM serves as a dual-purpose framework:

1. **An empirical evaluation tool** that quantifies perceptual quality and cognitive legibility in existing urban environments.
2. **A strategic reference model** that guides design interventions toward enhancing urban imageability, orientation, and emotional coherence.

By combining visual, cognitive, and affective indicators within a weighted quantitative model (followed by a rubric-based qualitative interpretation) the VAM bridges theoretical constructs with practical decision-making. It transforms the abstract dimensions of perception into measurable design knowledge, offering a replicable instrument for human-centered urban analysis.

In applying the VAM, the Perceptual Clarity Index (PCI) is interpreted according to its multi-scalar logic, whereby segment-level values reflect localized perceptual conditions while aggregated center-level values express the broader experiential coherence of the urban setting.

The VAM is structured around a sequential perceptual logic that progresses from macro-scale urban structure, to the meso-level of street-based visual experience, and finally to the micro-scale of cognitive and affective interpretation. This hierarchical ordering ensures that the three domains (visual, cognitive, affective) operate as an integrated continuum, reflecting the actual order through which users perceive,

process, and internalize urban environments. By aligning the matrix with this macro- to micro-perceptual sequence, each indicator is positioned within the level where it becomes most diagnostically meaningful.

## 6.1 Weighting Formula and Domain Structure

The operational design of the VAM integrates three interdependent perceptual dimensions (visual, cognitive, and affective) each contributing a weighted proportion to the overall perceptual performance.

Methodologically, the VAM advances a hybrid perceptual validation model that integrates human-coded perceptual responses with AI-based visual analysis. This dual verification enhances reliability and operationalizes the convergence between computational perception and human spatial cognition.

Empirical calibration, based on pilot testing and expert review, established the following proportional weights to ensure a balanced representation between structural clarity, cognitive complexity, and emotional resonance:

- **Domain Weights (Total = 1.00)**: (visual = 0.35, cognitive = 0.40, affective = 0.25)
- **Perceptual Clarity Index (PCI) Formula**:

$$\mathrm{PCI} = \left(0.35 \times D_{\{\mathrm{Visual}\}}\right) + \left(0.40 \times D_{\{\mathrm{Cognitive}\}}\right) + \left(0.25 \times D_{\{\mathrm{Affective}\}}\right)$$

where "*D*" represents the mean domain score (on a 1–5 Likert scale) derived from its sub-indicators.

**The PCI produces** a single, transparent score of perceptual performance that links morphological, spatial, and emotional factors within one framework.

## 6.2 Two-Tier Evaluation Logic (RPSS–VAM Integration)

While the Visual Assessment Matrix (VAM) was originally conceived as a single analytical framework, pilot testing and field observations revealed the need for a **two-tier evaluation structure** that distinguishes between rapid perceptual screening and detailed analytical assessment. This restructuring improved usability, minimized evaluator fatigue, and established a logical progression from initial perception to comprehensive diagnosis as summarized in Table 6.

The two-tier configuration enhances methodological rigor and aligns with real-world urban assessment practices, where preliminary audits precede advanced analyses. Accordingly, the VAM now consists of two complementary evaluation tools:

1. **Rapid Perceptual Screening Sheet (RPSS)**: A simplified, symbol-based diagnostic instrument designed for quick on-site assessment and participatory perception feedback. It allows evaluators to detect perceptual strengths and weaknesses through intuitive observation without requiring quantitative measurement.
2. **Detailed Visual Assessment Matrix (VAM)**: A quantitative, evidence-based matrix that measures perceptual clarity across visual, cognitive, and affective dimensions. It identifies specific weaknesses, quantifies perceptual conditions, and links outcomes to design enhancement and guidance strategies.

**Table 6** Comparative summary: RPSS versus detailed VAM

| Aspect | RPSS (level 1) | Detailed VAM (level 2) |
|---|---|---|
| Purpose | Rapid diagnostic screening | Analytical evaluation and strategic linkage |
| Timeframe | 10–15 min per segment | 1–2 h per segment |
| Data nature | Visual observation and user perception | Empirical measurements and analytical data |
| Scoring system | Symbolic (○ = good/△ = moderate/× = weak) | Numeric (1–5 Likert scale, weighted PCI computation) |
| Domain structure | Five subdomains derived from the three main perceptual dimensions:<br>• **Cognitive**: Spatial legibility, wayfinding, and orientation<br>• **Visual**: Visual richness, visual clutter, and coherence<br>• **Affective**: Emotional impression | Three principal analytical dimensions:<br>• **Visual (sensory)**<br>• **Cognitive (spatial)**<br>• **Affective (emotional)** |
| Output | Perceptual readiness profile | Perceptual clarity index (PCI) and interpretation |
| When to apply | Initial site walkthroughs or user perception surveys | Confirmed perceptual issues or detailed urban audits |
| Evaluator profile | Urban auditors, survey teams, and design reviewers | Specialists, planners, and research analysts |

*Source* Author's original development of the RPSS–VAM evaluative structure (2025)

This dual configuration ensures a structured evaluation flow (screening first, analyzing second) providing efficiency across large urban samples while maintaining analytical depth.

**Diagnostic Flow**

1. Conduct RPSS during site walkthroughs or interviews.
2. If all domains score "○" (good), no further analysis is required.
3. If one or more domains score "△" or "×", proceed with the detailed VAM to quantify underlying causes and develop targeted design enhancement responses.

This integrated evaluation logic allows the VAM to function as both a **perceptual audit framework** and a **design performance instrument**, maintaining methodological clarity while strengthening real-world applicability in perceptual urban analysis.

## 6.3 Rapid Perceptual Screening Sheet (RPSS)

The **Rapid Perceptual Screening Sheet (RPSS)** was developed as a complementary diagnostic tool to the Visual Assessment Matrix (VAM). Its function is to enable **quick, field-based perceptual screening** of urban segments before engaging in detailed VAM analysis. Unlike the full matrix, the RPSS functions as a diagnostic filter; as it captures the minimum set of cues required to reveal perceptual strengths and weaknesses within a few minutes, providing an efficient first-layer assessment for both experts and non-specialist participants.

Indicator selection followed three methodological criteria:

- Theoretical representativeness: Each indicator embodies a core construct from perceptual theory (imageability and legibility (Lynch 1960), sequential variation (Cullen, 1961; Ewing & Handy, 2009), visual clutter (Rosenholtz et al., 2007), and comfort/attachment (Gehl, 2011; Nasar, 1998; Proshansky et al., 1983).
- Perceptual salience: All indicators are directly observable on-site and can be intuitively judged without technical instruments or analytical tools.
- Minimal completeness: Pilot testing confirmed that two indicators per domain were sufficient to capture the dominant perceptual conditions and reliably flag whether detailed analysis is required.

This selection ensures full coverage of the three VAM domains (visual, cognitive, and affective) through a concise, symbol-based evaluation (○ = good, △ = moderate, × = weak). The RPSS therefore represents a balance between coverage and speed: it diagnoses whether a perceptual problem exists, while the detailed VAM subsequently explains why and how it occurs as shown in Table 7.

**Interpretation Logic**

- ○ **(Good)** = Perceptually strong (no detailed analysis required).
- △ **(Moderate)** = Partial weakness (optional VAM analysis recommended).
- × **(Weak)** = Perceptual deficiency (detailed VAM analysis required).

**Decision Rule**

Sites scoring two or more (×) in any domain are automatically flagged for full VAM analysis and subsequent strategic intervention.

## 6.4 Detailed Visual Assessment Matrix (Indicators and Rubric)

The Detailed Visual Assessment Matrix (VAM), as shown in Tables 8 and 9, constitutes the analytical backbone of the study. It operationalizes the three perceptual dimensions (visual, cognitive, and affective) into measurable indicators, each with defined data sources, analytical tools, scales, and theoretical rationale. The VAM enables quantification of perceptual clarity and identification of spatial or visual weaknesses that generate Urban Déjà Vu conditions.

The VAM constitutes the first operational framework that quantifies Urban Déjà Vu (the perceptual condition of visual uniformity and cognitive fatigue) as a measurable construct. This bridges long-standing theoretical discourse on imageability and place identity with empirical diagnosis and policy-oriented application.

- **Scale Note (1–5)**: 1 = very poor/2 = weak/3 = fair/4 = good/5 = excellent.
- **Perceptual Domain Weights (Total = 1.00)**: (Visual = 0.35 · Cognitive = 0.40 · Affective = 0.25).
- **Formula for Perceptual Clarity Index (PCI)**: Where D represents the mean domain score (on a 1–5 Likert scale).

**Table 7** Rapid perceptual screening sheet

| VAM domain | Indicator | Questions | | Evaluation |
|---|---|---|---|---|
| | | First | Second | |
| 1. Spatial legibility | Landmark visibility | Can you easily identify a unique or recognizable landmark here? | Do you use any building or feature to orient yourself while walking? | ○ △ × |
| | Path hierarchy | Can you easily distinguish main routes from side streets? | Do you feel directionally confident when moving here? | ○ △ × |
| 2. Visual richness | Façade variety | Do the buildings look visually similar or different to each other? | Does this variation make the street feel interesting or monotonous? | ○ △ × |
| | Sequential openness | Does the street view change as you move forward? | Do you notice new perspectives or repeated scenes? | ○ △ × |
| 3. Wayfinding and orientation | Navigation ease | Is it easy for you to find your way around this area? | Do you ever feel disoriented or confused about direction? | ○ △ × |
| | Landmark recall | Can you remember specific visual points after leaving this place? | Are there any features that help you recall the route later? | ○ △ × |
| 4. Visual clutter and coherence | Visual load | Do you feel there are too many visual elements (signs, colors, ads)? | Is it easy to focus on important visual features here? | ○ △ × |
| | Repetition ratio | Do the façades or shapes feel repetitive? | Does this repetition make it harder to distinguish one spot from another? | ○ △ × |
| 5. Emotional impression | Comfort and safety | Do you feel comfortable and safe walking here? | Does the lighting, visibility, or openness make you feel secure? | ○ △ × |
| | Belonging and character | Does this area feel unique or similar to others? | Would you describe it as a memorable or indistinct place? | ○ △ × |

Source: Author's original development of the RPSS instrument (2025)

$$\mathrm{PCI} = \left(0.35 \times D_{\{\mathrm{Visual}\}}\right) + \left(0.40 \times D_{\{\mathrm{Cognitive}\}}\right) + \left(0.25 \times D_{\{\mathrm{Affective}\}}\right)$$

## 6.5 Perceptual Enhancement Strategies

Each indicator in the VAM is linked to a set of **enhancement and guidance strategies** derived from evidence-based design literature. These strategies are not corrective prescriptions but **context-sensitive recommendations** intended to improve perceptual clarity and reinforce spatial identity in visually monotonous or cognitively ambiguous areas. They serve as reference actions that designers or planners may adopt selectively based on local priorities and perceptual objectives. See Table 10.

## 6.6 Integration Within the Urban Design Process

The Visual Assessment Matrix (VAM) and its associated Rapid Perceptual Screening Sheet (RPSS) are part of a comprehensive decision-support framework for perceptual urbanism. Integrating both within the design process translates perceptual insights into actionable interventions through a three-phase loop:

- **Phase 1: Diagnostic (RPSS)**: (where perceptual issues exist)—quick perceptual screening using symbolic ratings (○, △, ×). If all domains score ○, the site is perceptually stable.
- **Phase 2: Analytical (VAM)**: (why they occur and quantifies them)—quantitative evaluation of indicators; aggregation to domain scores and PCI to locate weaknesses.
- **Phase 3: Strategic**: (how they can be addressed)—apply evidence-based strategies targeted at weak indicators; then re-assess via RPSS to confirm improvement.

The iterative feedback loop, shown in Table 11, between the RPSS and VAM establishes a new model of perceptual governance, where urban design decisions are continuously evaluated through human-centered perceptual metrics. This cyclical mechanism embeds perceptual quality as a measurable dimension of sustainable urban policy.

**Table 8** Detailed visual assessment matrix (VAM)

| Domain | Indicator | Evaluator | Data source and analytical method | Scale (1–5) | Rationale/measurement logic |
|---|---|---|---|---|---|
| **Visual** (sensory) **(0.35)** | Façade repetition ratio | Expert | • Field imagery<br>• Façade photos every 10 m<br>• AI image analysis (pattern detection via CNN clustering) | 1 = High repetition<br>5 = High diversity | Quantifies the degree of visual sameness; derived from façade segmentation variance (Ewing & Handy, 2009) |
| | Material and color diversity | Expert | • On-site palette inventory<br>• Material/color grouping<br>• Manual variance check of chromatic/textural diversity | 1 = Monotone<br>5 = Richly diverse | Measures textural and chromatic diversity as an index of visual richness and perceptual stimulation (Kaplan & Kaplan, 1989) |
| | **Visual clutter index** | Expert | • Street-level imagery<br>• Clutter element count (signs, cables, poles)<br>• Expert noise classification<br>• Rosenholtz clutter model + pixel entropy (AI) | 1 = Overloaded<br>5 = Clear and ordered | Evaluates perceptual load caused by signage and detail density (Rosenholtz et al., 2007) |
| | **Sequential variation** (rhythm) | Expert | • Panoramic photo transects<br>• Cullen-style serial vision analysis<br>• Identify spatial transitions (enclosure, alignment, vista depth) | 1 = Static<br>5 = Dynamic | Captures visual rhythm across sequential views; relates to perceptual engagement and scene memory |
| **Cognitive** (spatial) **(0.40)** | **Landmark visibility index** | Expert | • GIS visibility mapping<br>• Field verification at multiple nodes<br>• Street-to-landmark sightline assessment | 1 = Hidden<br>5 = Highly visible | Tests spatial prominence and role of landmarks as orientation anchors (Lynch, 1960) |
| | **Path hierarchy clarity** | Expert | • Spatial layout plan<br>• Field audit<br>• Space syntax axial integration analysis | 1 = Indistinct<br>5 = Clear hierarchy | Evaluates navigational clarity via spatial connectivity metrics (Hillier, 1996; Montello, 2005) |
| | **Spatial sequencing** (continuity) | Expert | • Photo-sequence analysis (10–15 m intervals)<br>• Frontage continuity mapping<br>• Transition entropy (calculating spatial breaks)<br>• Assessing enclosure, deflection, alignment, depth variation<br>• Serial vision (Cullen) for experiential unfolding | 1 = Disconnected/confusing<br>5 = Continuous/navigable | Evaluate the continuity and cognitive readability of spatial progression (Cullen, 1961). It integrates<br>• Structural coherence (physical sequencing)<br>• Experiential rhythm (how the space unfolds)<br>• Orientation cues (wayfinding clarity)<br>• Directional confidence (user-reported) |

(continued)

**Table 8** (continued)

| Domain | Indicator | Evaluator | Data source and analytical method | Scale (1–5) | Rationale/measurement logic |
|---|---|---|---|---|---|
| | | Users | • Wayfinding confidence (Likert-scale survey)<br>• Route-recall prompts<br>• Secondary landmark recognition (cognitive anchors)<br>• Reported directional clarity (residents vs. visitors) | | |
| | **Edge continuity** | Expert | • GIS land-use layers<br>• Street-edge profiles (frontage mapping)<br>• On-site verification of façade continuity<br>• Line density (built frontage %)<br>• Transition entropy (frequency of breaks, gaps, recesses)<br>• Continuity coefficient (manual classification) | 1 = Fragmented<br>5 = Consistent | Assesses the structural coherence of the street edge by evaluating the degree of continuity in building frontages. Higher continuity stabilizes the perceptual field, supports cognitive mapping, increases navigational confidence, and reduces visual fragmentation. Fragmented edges disrupt spatial flow, weaken legibility and contribute to urban déjà vu conditions |
| **Affective** (emotional) **(0.25)** | **Perceived comfort and safety** | Users | • On-site user surveys (n ≥ 150)<br>• Comfort, lighting, openness scoring | 1 = Discomfort<br>5 = Strong comfort | Reflects perceived safety and affective stability shaped by enclosure, lighting, and visibility (Gehl, 2011) |
| | **Sense of belonging/ attachment** | Users | • User interviews<br>• Open-ended responses<br>• Text sentiment analysis (AI + coding) | 1 = Detachment<br>5 = Strong attachment | Measures place identity, emotional anchoring, and experiential familiarity (Proshansky et al., 1983) |
| | **Aesthetic preference** | Users | • Survey (user visual preference scoring)<br>• Optional photo comparison | 1 = Unpleasant<br>5 = Very appealing | Captures aesthetic appraisal of spatial coherence and environmental quality (Nasar, 1998) |

*Source* Author's original development of the Visual Assessment Matrix (VAM) (2025)

**Table 9** Interpretation framework (Rubric)

| PCI range | Perceptual condition | Interpretation/diagnostic meaning |
|---|---|---|
| 4.20–5.00 | High clarity (excellent) | Environment is visually distinct and cognitively legible; strong sense of place |
| 3.50–4.19 | Moderate clarity (good) | Minor repetition; adequate cues for orientation and comfort |
| 2.80–3.49 | Marginal clarity (moderate) | Noticeable uniformity; potential for confusion in spatial mapping |
| 2.00–2.79 | Low clarity (weak) | Repetitive structure causing perceptual fatigue and low attachment |
| <2.00 | Critical disorientation (poor) | Severe visual monotony and disconnection; immediate intervention required |

*Source* Author's original construction of the perceptual interpretation rubric (2025)

**Table 10** Evidence-based perceptual enhancement strategies linked to VAM indicators

| Domain | Indicator | If weak (≤3) | Recommended strategy (evidence-based) | Key references |
|---|---|---|---|---|
| **Visual** (sensory) | Façade repetition ratio | Uniform façades across blocks | Introduce façade modulation, vertical articulation, and color zoning | Cullen (1961), Ewing and Handy (2009) |
| | Material and color diversity | Monotone color schemes | Apply complementary material palettes and textural layering | Kaplan and Kaplan (1989), Gehl (2011) |
| | Visual clutter | Excess signage and chaotic order | Regulate signage hierarchy; simplify street furniture layout | Rosenholtz et al. (2007), Carmona (2021) |
| | Sequential variation (rhythm) | Static view with no experiential unfolding | Enhance spatial rhythm through depth modulation, façade stepping, and controlled deflection. Introduce view corridors and dynamic alignments across movement paths | Cullen (1961), Gehl (2011) |
| **Cognitive** (spatial) | Landmark visibility | Hidden or indistinct landmarks | Enhance prominence via lighting, height contrast, or framing | Lynch (1960) |
| | Path hierarchy | Indistinguishable routes | Reinforce hierarchy via pavement texture, width, and edge definition | Hillier (1996), Gehl (2011) |
| | Spatial sequencing | Static spatial flow | Introduce rhythmic variation and vista framing along routes | Cullen (1961) |
| | Edge continuity | Fragmented frontage, irregular setbacks, or broken spatial edges | Increase built-frontage continuity and reduce inactive gaps. Align façade lines and strengthen enclosure through consistent street walls | Carmona (2021), Gehl (2011) |
| **Affective** (emotional) | Comfort and safety | Low perceived comfort | Improve lighting, visibility, and human-scale frontages | Gehl (2011), Nasar (1998) |
| | Belonging and attachment | Weak sense of place | Integrate cultural cues and public art reinforcing identity | Proshansky et al. (1983), Relph (1976) |
| | Aesthetic preference | Low visual appeal | Balance coherence with contrast and greenery elements | Nasar (1998), Kaplan and Kaplan (1989) |

*Source* Developed by the author based on evidence from the reviewed literature (2025)

**Table 11** Schematic logic of integration

| Stage | Input/trigger | Process | Output | Decision path |
|---|---|---|---|---|
| 1. RPSS | Field observation/user survey | Symbolic rapid assessment (○, △, ×) | Perceptual readiness score | If weak → proceed to VAM |
| 2. VAM | RPSS flags + spatial data | Quantitative analysis of 11 indicators | PCI score + diagnostic Map | Identify weak indicators |
| 3. Strategies | VAM indicators ≤ 3 | Apply evidence-based strategies | Design interventions | Re-assess via RPSS |

*Source* Author's original integrative design of the RPSS–VAM–PCI evaluation loop (2025)

## 7 Discussion and Interpretation

This discussion interprets the empirical findings within the perceptual tradition of Lynch (1960) and Cullen (1961), and its subsequent extensions by Kaplan and Kaplan (1989), Nasar (1998), Ewing and Handy (2009), and Gehl (2011). The results confirm the study's central premise: visual monotony and perceptual uniformity diminish imageability, thereby increasing cognitive disorientation and weakening emotional attachment. By triangulating quantitative evidence, behavioral mapping, and AI-assisted visual analysis, the study establishes an empirical bridge between classical perceptual theory and measurable urban indicators. The discussion proceeds on three analytical levels: (1) perceptual–cognitive mechanisms; (2) urban morphological and design implications; and (3) human experience and emotional dimensions.

### 7.1 Perceptual and Cognitive Mechanisms

Empirically, findings substantiate Lynch's (1960) claim that imageability arises from clarity, distinctiveness, and hier-

archy among spatial elements. It should be noted that references to the PCI throughout this section pertain to the dispersion-refined center-level index ($PCI^R$), which accounts for internal experiential variability and thus provides a more coherent basis for interpreting perceptual strength and weakness across the study areas. Segments with repetitive façades and rigid block modules (typical of perceptual uniformity) scored lowest in spatial legibility and wayfinding. This aligns with cognitive mapping models (Golledge, 1999; Montello, 2005), where orientation depends on discriminable cues and reference points. The observed negative association between visual repetition and imageability ($r = -0.63$) indicates that sameness suppresses the informational richness required for coherent mental representations. Mediation analysis further shows that weak imageability transmits the effect of morphological repetition to cognitive disorientation, supporting the view that perceptual overload is not purely sensory but also cognitive (consistent with clutter research (Rosenholtz et al., 2007)).

## 7.2 Urban Morphological and Design Implications

Through the VAM, morphological repetition, uniform materials, and codified setbacks collectively reduce sequential variation and visual rhythm, undermining the serial vision that Cullen (1961) considered vital to engagement. The Visual Richness domain correlates positively with emotional attachment ($r = 0.54$), indicating that diversity in perspective, enclosure, and façade rhythm sustains attention and improves affective appraisal. These results echo Ewing and Handy's (2009) operationalization of imageability, enclosure, transparency, human scale, and complexity as measurable design qualities. Hence, promoting morphological differentiation (variation in height, material palettes, frontage articulation, and node hierarchy) is not an aesthetic garnish but a perceptual requirement for legibility and spatial identity.

## 7.3 Human Experience and Emotional Dimensions

At the human scale, visual monotony fosters emotional detachment (consistent with Nasar's (1998) "evaluative image" and Proshansky et al.'s (1983) place identity). Participants in uniform settings reported confusion, placelessness, and weak belonging, while areas with higher visual richness and spatial legibility elicited stronger comfort and attachment. This pattern supports Gehl's (2011) emphasis on human scale and the Kaplan and Kaplans' (1989) Preference Framework, where environments balancing coherence and complexity score higher on preference and perceived safety. In essence, perceptual variety structured by spatial order sustains both cognitive legibility and emotional engagement.

## 7.4 Perceptual Adaptation Versus Comparative Awareness

The findings revealed a marked divergence between long-term residents, particularly those living and working within the same district, exhibited lower sensitivity to morphological sameness and visual monotony, suggesting a process of perceptual habituation, where prolonged exposure normalizes repetitive environments and reduces attentional differentiation.

Conversely, transient users and cross-district commuters demonstrated heightened awareness of sameness and perceptual fatigue, as their evaluations operate comparatively across diverse urban contexts. This contrast indicates that Urban Déjà Vu is not a purely spatial phenomenon but an experiential condition emerging from the tension between perceptual familiarity and comparative differentiation.

Therefore, when interpreting the Perceptual Clarity Index (PCI) derived from the Visual Assessment Matrix (VAM), analysts should account for contextual perceptual variables (such as user mobility, duration of exposure, and perceptual habituation) which may modulate how visual repetition and imageability are experienced. Recognizing these adaptive differences ensures that low PCI values are not misattributed solely to environmental weakness but are understood within the broader dynamics of perceptual adaptation and comparative awareness.

## 7.5 Synthesis: The "Urban Déjà Vu" Condition

Integrating these strands, the study conceptualizes Urban Déjà Vu as a perceptual syndrome produced by the intersection of morphological uniformity and cognitive fatigue. It is not a stylistic quirk but a cognitive–emotional disconnect: insufficient cues for differentiation generate perceptual ambiguity, which then weakens spatial identity and attachment. Accordingly, enhancing imageability and reducing repetition are core, human-centered strategies for restoring legibility, orientation, and psychological coherence in contemporary urban environments.

Hence, the VAM and PCI jointly operationalize the phenomenon of Urban Déjà Vu, transforming an elusive perceptual experience into a quantifiable and actionable urban metric.

## 8 Recommendations

Grounded in the empirical analysis and the theoretical pathways established through the VAM–PCI framework, the following recommendations aim to mitigate cognitive disorientation, strengthen perceptual clarity, and reinforce affective attachment to place. These interventions draw directly upon the refined meso-scale PCI ($PCI^R$), ensuring that proposed actions respond not only to average perceptual weakness but also to the internal variability that shapes experiential stability within neighborhood centers. Recommendations are structured across three interdependent scales of urban experience ((1) urban design and morphological structure, (2) architectural and visual treatment, and (3) behavioral and policy-level mechanisms) each translating the perceptual sequence (visual repetition → weak imageability → cognitive disorientation → emotional detachment) into actionable design and planning strategies.

### 8.1 Urban Design and Morphological Strategy

1. Encourage Morphological Diversity Within Regulatory Frameworks: Embed perceptual-variability metrics (e.g., façade modulation ratios, differentiated block lengths) in zoning and building codes to mitigate visual monotony without sacrificing coherence (Ewing & Handy, 2009).
2. Promote Sequential Experience and Spatial Rhythm: Following Cullen's (1961) serial vision, design corridors with alternating openness, perspective shifts, and focal nodes to sustain perceptual engagement.
3. Integrate Legibility Anchors in Urban Layouts: Use Lynch's (1960) five elements—paths, edges, districts, nodes, landmarks—as the backbone of new development, especially in visually uniform contexts.
4. Rehabilitate Monotone Districts via Micro-Differentiation: Introduce small-scale interventions (façade pattern variation, pocket plazas, street art) to restore distinctiveness and reduce cognitive fatigue.

### 8.2 Architectural and Visual Treatment

1. Balance Coherence and Complexity: Per Kaplan and Kaplan (1989), combine order with moderate complexity; avoid both excessive uniformity and chaotic diversity.
2. Use Material and Color Differentiation Strategically: Vary texture, color, and reflectivity to enhance visual richness while maintaining a unifying logic at block/district scale to prevent visual clutter (Rosenholtz et al., 2007).
3. Enhance Human Scale and Eye-Level Detail: Consistent with Gehl (2011), integrate transparent edges, fine-grain articulation, and pedestrian-level details to stimulate multi-sensory engagement and orientation.
4. Integrate Cognitive Wayfinding Cues: Strengthen landmarking, signage, and lighting hierarchies for day/night legibility; digital aids should complement (not replace) physical cues.

### 8.3 Behavioral and Policy-Level Interventions

1. Embed Perceptual Criteria in Planning Guidelines: Evaluate visual diversity, legibility, and sequential engagement alongside density/land-use metrics in design review.
2. Implement Perceptual Audits in Urban Renewal: Conduct VAM audits pre-redevelopment to diagnose weaknesses and prioritize interventions.
3. Encourage Participatory Perception Mapping: Use community surveys and "walking interviews" to surface cognitive and affective readings of place for context-sensitive design.
4. Integrate Technology Responsibly: Apply AI-based visual analytics, VR simulations, and mobile apps to augment analysis while remaining anchored in human sensory experience.

### 8.4 Strategic Vision

Creating perceptually legible and emotionally resonant cities requires a paradigm shift (from designing for form and efficiency to designing for perception and meaning). Urban environments must move beyond visual repetition toward experiential diversity, ensuring that every street segment offers cognitive orientation, visual memory, and affective comfort. The VAM and PCI thus function as operational instruments bridging perceptual theory and policy practice, enabling planners to transform visual repetition into measurable urban distinctiveness.

## 9 Conclusion and Future Research

This study examined how visual repetition and excessive morphological similarity influence human perception, spatial orientation, and emotional attachment. Integrating the perceptual theories of Lynch (1960) and Cullen (1961) with later frameworks (Ewing & Handy, 2009; Gehl, 2011; Kaplan & Kaplan, 1989; Nasar, 1998), it conceptualized *Urban Déjà Vu* as a measurable condition of cognitive

disorientation. The development and validation of the Visual Assessment Matrix (VAM) provided a structured method to evaluate perceptual clarity, imageability, and affective response.

The Perceptual Clarity Index (PCI) empirically verified this theoretical relationship, demonstrating how visual repetition quantitatively translates into cognitive disorientation and affective detachment.

Findings reveal that excessive uniformity (where visual coherence turns into sameness) correlates negatively with perceptual clarity and sense of place, while balanced morphological consistency enriched by controlled diversity enhances orientation, recognition, and emotional attachment. Urban identity, therefore, emerges not from visual uniformity alone, but from a dynamic equilibrium between order and variation, grounding spatial experience in both cognitive legibility and affective resonance.

## 9.1 Theoretical Contributions

This research advances the perceptual paradigm by introducing Urban Déjà Vu as a quantifiable construct linking morphological uniformity with cognitive and affective disorientation.

1. **Conceptualizing Urban Déjà Vu** as the intersection of visual uniformity, cognitive confusion, and affective detachment.
2. **Integrating classical and contemporary frameworks**, merging imageability and serial vision with behavioral and computational lenses.
3. **Operationalizing perceptual clarity** via VAM, translating qualitative theory into measurable indicators.
4. **Reframing urban identity** as a function of perceptual clarity and affective coherence.

## 9.2 Practical Implications

1. VAM offers a diagnostic instrument to assess perceptual quality across urban spaces.
2. Policymakers can embed **perceptual metrics** in zoning and design review to prevent cognitive monotony.
3. Urban renewal can prioritize **VAM-based** interventions that restore imageability and orientation.
4. The methodology provides a replicable template integrating AI-based analysis with human-centered design practice.

## 9.3 Limitations and Directions of Future Research

The analysis focused on medium-density contexts; future research should include high-rise and suburban settings. Cross-cultural studies are needed to examine cultural/climatic effects on perception. Temporal factors (nighttime perception, dynamic lighting) warrant deeper investigation. Integration with neuro-physiological tools (eye-tracking, EEG) can refine understanding of perceptual load and memory. Longitudinal designs could test whether perceptual improvements drive durable behavioral and emotional recovery.

Ultimately, the study positions perceptual clarity as both a diagnostic lens and a design imperative for future urbanism.

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