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REINTERPRETING URBAN PUBLIC SPACES THROUGH ARTIFICIAL INTELLIGENCE: A VISUAL EXPLORATION OF THREE ISTANBUL SQUARES

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ABSTRACT
This study examines the representational capacities and limitations of artificial intelligence in the visual reinterpretation of urban public spaces through three major squares in Istanbul: Taksim, Bakırköy, and Beşiktaş. Using current photographs and map imagery, alternative design scenarios were generated via AI for each site and comparatively analyzed through visual reading based on spatial organization, urban continuity, user experience, material and landscape language, and socio-cultural references. The findings indicate that AI produces differentiated visual tendencies aligned with generalized spatial archetypes: centralized order and monumentality in Taksim, dispersed activity and livability in Bakırköy, and directional flow in Beşiktaş. These outcomes reflect aesthetic pattern recognition rather than context-aware or functionally accurate design intelligence. While the method provides a repeatable visual evaluation framework grounded in differentiated descriptive inputs, algorithmic aesthetic preferences and input scope introduce representational bias. Accordingly, artificial intelligence is positioned not as a designer, but as an experimental and critical visual collaborator.

Keywords: *Artificial intelligence, Urban public space, Istanbul squares, Design scenarios*

YAPAY ZEKÂ İLE KENTSEL KAMUSAL ALANLARIN YENİDEN OKUNMASI: ÜÇ İSTANBUL MEYDANI ÜZERİNE GÖRSEL BİR DENEYİM

ÖZET
Bu çalışma, İstanbul'daki üç önemli kentsel meydan—Taksim, Bakırköy ve Beşiktaş—üzerinden yapay zekânın kentsel kamusal mekânların görsel yeniden yorumlanmasındaki temsili kapasite ve sınırlılıklarını incelemektedir. Güncel fotoğraflar ve harita görselleri kullanılarak her bir alan için yapay zekâ aracılığıyla alternatif tasarım senaryoları üretilmiş ve bu çıktılar; mekânsal organizasyon, kentsel süreklilik, kullanıcı deneyimi, malzeme ve peyzaj dili ile sosyo-kültürel göndermeler ölçütleri doğrultusunda görsel okuma yoluyla karşılaştırmalı olarak analiz edilmiştir. Bulgular, yapay zekânın genelleştirilmiş mekânsal arketiplerle uyumlu farklı görsel eğilimler ürettiğini göstermektedir: Taksim Meydanı'nda merkezi düzen ve anıtsallık, Bakırköy Meydanı'nda dağınık etkinlik ve yaşanabilirlik, Beşiktaş Meydanı'nda ise yönelimsel akış ön plana çıkmaktadır. Bu çıktılar, bağlama duyarlı ya da işlevsel olarak doğru bir tasarım zekâsından ziyade estetik örüntü tanıma süreçlerine dayanmaktadır. Yöntem, farklılaştırılmış betimleyici girdilere dayalı olarak tekrarlanabilir bir görsel değerlendirme çerçevesi sunmakla birlikte, algoritmik estetik eğilimler ve girdi kapsamı temsili yanlılıklara yol açabilmektedir. Bu doğrultuda yapay zekâ, bir tasarımcı olarak değil, deneysel ve eleştirel bir görsel işbirlikçi olarak konumlandırılmaktadır.

Anahtar Kelimeler: *Yapay zeka, Kentsel kamusal alan, İstanbul meydanları, Tasarım senaryoları*

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EXTENDED SUMMARY

Research Problem

In the contemporary design landscape, artificial intelligence has increasingly influenced architectural and urban design practices, particularly through visual generation and scenario-based exploration. Beyond computational efficiency, generative AI systems enable the rapid production of alternative spatial representations by recognizing visual patterns and associating them with descriptive inputs. However, the extent to which such systems can meaningfully reinterpret public spaces—especially those embedded with urban memory and socio-cultural significance—remains contested. This study addresses this gap by examining how generative AI visually reinterprets major urban squares in Istanbul, focusing not on design accuracy but on representational tendencies and visual differentiation across distinct public-space identities.

Literature Review

Recent literature emphasizes the growing role of artificial intelligence in reshaping architectural design processes, particularly in conceptual design, automation, and visualization (Castro Pena et al., 2021; Harapan et al., 2021). Evolutionary algorithms and deep learning models enable the generation of multiple alternatives, supporting exploratory design thinking (Lukovich, 2023). The integration of AI with BIM and CAD platforms has further expanded data-driven decision-making capacities in architectural workflows.

Generative algorithms and neural networks have significantly advanced architectural visualization, improving visual coherence and aesthetic richness while facilitating early-stage communication between designers and users. Nevertheless, scholars highlight ongoing limitations related to ethical responsibility, representational bias, and user control (Sharma et al., 2023). Ethical discussions increasingly frame AI not merely as a technical instrument but as a medium that shapes cultural representation and authorship (Softaoğlu, 2024), underscoring the need for transparent and responsible use in design education and practice (Park & Kim, 2024).

In conceptual design and education, AI tools are recognized for accelerating ideation and expanding formal possibilities (Smith & Jones, 2024; Chen et al., 2024; Aslan & Aydın, 2023). Studies in architectural and interior design education report enhanced creativity and efficiency, alongside persistent challenges related to realism and contextual interpretation (Avinç, 2024; Marşoğlu & Özdemir, 2025). Overall, the literature positions AI as an experimental and supportive system rather than a substitute for contextual reasoning or human design judgment.

Methodology

The study adopts a qualitative visual–analytical methodology structured in three stages. First, three major public squares in Istanbul—Taksim, Bakırköy, and Beşiktaş—were selected due to their contrasting socio-spatial identities. Each site was introduced to the AI system through current photographic and cartographic data, accompanied by short descriptive texts outlining general historical and spatial characteristics. Second, the generative model ChatGPT was used to produce alternative visual representations for each square through structured prompts emphasizing spatial organization, circulation, material expression, and public use scenarios. Third, the generated outputs were comparatively analyzed through visual reading based on five criteria: spatial organization, urban continuity, user experience, material and landscape language, and socio-cultural references. The analysis relied exclusively on visual outputs rather than AI-generated textual explanations, aiming to evaluate representational tendencies rather than functional or contextual accuracy. This methodological framing intentionally avoids claims of design validity, focusing instead on visual differentiation and representational logic. A representative sample of the prompt structure used in the visual production process is provided in Appendix A.

Results and Conclusions

The findings indicate that the AI-generated outputs exhibit differentiated visual tendencies aligned with generalized spatial archetypes rather than site-specific intelligence. In Taksim Square, centralized order and monumentality dominate, visually neutralizing historical and political memory. In Bakırköy Square, dispersed activity and human-scale elements emphasize livability and everyday social use. In Beşiktaş Square, directional flow and openness toward the waterfront become prominent, while stable focal points remain weak. These variations suggest that generative AI responds to descriptive input framing through aesthetic pattern recognition rather than through context-aware spatial reasoning.

The study proposes a repeatable visual evaluation framework for examining AI-generated urban representations, highlighting both the potential and limitations of such systems. While algorithmic aesthetic preferences and restricted input scope introduce representational bias, AI can function as a critical and experimental collaborator by expanding visual exploration and supporting comparative analysis in early design stages. Future research may enhance this approach through participatory evaluation, multi-temporal scenarios, and quantitative environmental and accessibility metrics to further investigate AI’s role beyond visual representation in public space design.

1. INTRODUCTION

In recent years, the rapid development of artificial intelligence technologies has led to the emergence of new design tools and methodologies in the fields of architecture and urban design. The process of digitalization has progressively transformed design practices from computer-aided design to parametric and algorithmic approaches. With the paradigm of Industry 4.0, computational systems have evolved beyond representational support toward data-driven, generative, and decision-support mechanisms. Within this trajectory, artificial intelligence—particularly machine learning and generative models—has begun to influence architectural thinking by enabling the rapid production of alternative spatial scenarios based on learned visual and textual patterns. In this context, artificial intelligence is no longer considered solely as a representational tool, but rather as an active agent capable of generating alternative spatial configurations and shaping early-stage design exploration, while still requiring critical interpretation and human judgment.

Public spaces are key components of urban life where social, cultural, and spatial interactions converge, and urban squares constitute some of the most prominent and symbolic elements of these spaces. Squares are not merely physical voids; they embody multiple layers of meaning, including collective memory, circulation, encounter, and public representation. As intensified nodes of public space, urban squares simultaneously function as transit fields, social meeting grounds, and symbolic stages for public life. Therefore, square design represents a complex design problem that requires the simultaneous consideration of physical form, spatial organization, and social dynamics.

This study aims to discuss the potential and limitations of artificial intelligence in square design, with a particular focus on how AI-assisted visual generation processes are reflected in the configuration of public spaces. Within this framework, Taksim Square, Beşiktaş Square, and Bakırköy Square in Istanbul were selected as case study areas. The selection of these three squares is based on their distinct historical backgrounds, usage intensities, and socio-spatial identities. While Taksim Square stands out as a symbolic center associated with collective memory and public representation, Beşiktaş Square is characterized by intense pedestrian movement and its strong relationship with the waterfront, and Bakırköy Square is defined by socio-cultural interaction and commercial density. These differences provide a comparative basis for evaluating how artificial intelligence responds to diverse public-space scenarios through visual representation.

Although various artificial intelligence–based tools can be employed within contemporary design processes, this study specifically utilizes ChatGPT as a central component of the experimental framework. The preference for ChatGPT is grounded in its capacity to translate descriptive and narrative inputs into structured textual prompts that guide visual generation processes in a consistent

and traceable manner. Rather than directly producing finalized design solutions, ChatGPT functions as a scenario-framing and prompt-structuring agent, enabling the systematic articulation of spatial criteria, identity parameters, and contextual narratives. This approach allows the study to focus on how generative AI systems visually reinterpret public spaces based on differentiated descriptive inputs, rather than on technical optimization or performance-based design outcomes. Accordingly, the study seeks to examine the extent to which ChatGPT can function as a "design collaborator" in an experimental and representational sense, and to identify the limitations inherent in such an approach.

In this study, the term "design collaborator" is used strictly in a critical and exploratory context, referring to artificial intelligence as a visual and representational medium rather than as a context-aware or decision-making design intelligence.

Research Problem; Despite their growing popularity in conceptual visualization, generative AI systems still struggle to produce context-aware, functionally grounded, and culturally specific public-space proposals. In the design of urban squares—where spatial form is inseparable from memory, symbolism, and everyday practices—AI outputs may appear visually coherent while masking representational bias, generic spatial archetypes, and limited responsiveness to site-specific constraints. Therefore, the core problem addressed by this study is not whether AI can "design" squares accurately, but how and to what extent it misrepresents or simplifies urban public-space identity through aesthetic pattern recognition, and what methodological framework can be used to critically evaluate these representational tendencies.

Problem Definition; The central problem motivating this research is that generative AI can produce visually persuasive public-space images while remaining insufficient in context-aware reasoning, functional accuracy, and socio-cultural specificity. This creates a risk of interpreting AI outputs as design intelligence rather than as representational artifacts shaped by dataset aesthetics and input framing. Accordingly, the study investigates the representational logic, limits, and biases of AI-driven visual reinterpretations of urban squares.

Case Selection Rationale; The three case areas—Taksim, Bakırköy, and Beşiktaş—were selected through purposeful sampling to represent contrasting socio-spatial identities within Istanbul. Taksim functions as a symbolic and ceremonial center strongly tied to collective memory and political representation; Bakırköy represents a district-scale everyday public realm shaped by commercial and socio-cultural density; and Beşiktaş exemplifies a mobility-driven square defined by transfer flows and a waterfront-oriented urban interface. This contrast enables a comparative reading of how generative AI differentiates—or fails to differentiate—public-space imagery when exposed to distinct identity framings.

2. LITERATURE REVIEW

Artificial intelligence (AI) has assumed a transformative role in architecture by reshaping both creative and technical design processes. This transformation did not occur abruptly; rather, it evolved alongside broader processes of digitalization and computational design. Early digital tools primarily supported representation and drafting, whereas contemporary AI-based systems actively participate in design thinking by generating alternatives, interpreting complex datasets, and supporting decision-making processes. Within this framework, AI has shifted from a supplementary visualization tool to a generative and analytical agent within architectural practice.

Recent studies emphasize the significant impact of AI on conceptual design, automation, and visualization processes. Castro Pena et al. (2021) and Harapan et al. (2021) highlight that AI-driven design environments alter how architects conceptualize form, function, and spatial relationships. In particular, evolutionary algorithms and deep learning-based models introduce dynamic variability into design workflows by producing multiple alternatives across diverse scenarios, thereby enriching architects' decision-making processes (Lukovich, 2023). These methods support originality and creative exploration, providing a critical foundation for redefining emerging spatial needs and enhancing architectural creativity.

The integration of AI systems with big data infrastructures and distributed information networks has further accelerated analytical capabilities within architectural design platforms. Especially within BIM (Building Information Modeling) and CAD (Computer-Aided Design) environments, AI enables the simultaneous evaluation of structural, environmental, and contextual data, leading to more comprehensive and accurate design decisions. This integration not only improves productivity but also facilitates the management of complex urban and architectural systems. Moreover, AI-assisted visualization technologies have gained increasing importance in architectural education, where they have been shown to significantly enhance students' conceptual thinking, spatial perception, and aesthetic sensitivity.

Generative algorithms and deep neural networks represent a major advancement in architectural visualization, improving both technical accuracy and aesthetic quality. These systems enable more intuitive and interactive communication between designers and users, allowing design intentions to be conveyed visually at early stages. However, despite their widespread adoption, the literature also points to persistent challenges related to ethical considerations, economic accessibility, and user experience (Sharma et al., 2023). These limitations highlight the necessity of critically evaluating AI not only as a technological innovation but also as a socio-cultural actor within architectural practice.

From an ethical perspective, the responsible use of AI in architecture requires the establishment of interdisciplinary ethical frameworks. Softaoğlu (2024) emphasizes that AI should be understood not merely as a technical instrument but as a medium of cultural representation, where issues such as cultural diversity, authorship, and authenticity become central. In parallel, Park and Kim (2024) argue that institutional policies and educational models must be developed to ensure the transparent, equitable, and socially beneficial implementation of AI technologies within design disciplines.

The contribution of AI to conceptual design is particularly evident in early-stage ideation and decision-support processes. Smith and Jones (2024) argue that AI significantly accelerates the generation of innovative concepts while supporting analytical evaluation during the initial phases of design. Similarly, Chen et al. (2024) demonstrate that AI-based models provide substantial advantages in rapid prototyping and multi-directional alternative generation. Aslan and Aydın (2023) further note that AI-supported prototyping systems enhance user control, improve design quality, and enable the rapid testing of diverse solution scenarios.

The use of AI tools in architectural and interior design education has expanded considerably in recent years. Research indicates that text-to-image systems often generate nature-inspired forms—such as daisy-like geometries—while advanced diffusion models like Stable Diffusion 2.1 produce more refined and diverse visual outcomes (Buldaç, 2024). Avinç (2024) reports that AI tools accelerate experimental design processes in interior architecture education and increase student satisfaction, although challenges related to prompt interpretation and technical limitations persist. Similarly, a study conducted at Istanbul Kent University found that AI-supported early-stage design studios foster creativity and speed but may also produce visuals perceived as unrealistic by students (Marşoğlu & Özdemir, 2025).

AI-supported educational tools have also demonstrated effectiveness in enhancing analytical thinking, creative problem-solving, and sustainability-oriented design approaches. By facilitating the visualization of complex concepts, these tools introduce new pedagogical opportunities within studio-based education (Adetayo, 2024). Nevertheless, experimental research by Almaz et al. (2024) suggests that although AI contributes strongly to ideation and data analysis, its integration into architectural education has not yet reached a fully holistic level.

Beyond efficiency and productivity, AI technologies open new possibilities in architectural design in terms of sustainability, accessibility, and multi-dimensional representation. The combined use of generative algorithms and BIM integration strengthens data-driven strategies in architectural decision-making processes (Ploennigs & Berger, 2023). Tools such as ChatGPT, Midjourney, DALL·E, and

Stable Diffusion are particularly favored during the conceptual development stage, where they demonstrate high effectiveness in parametric design exploration, idea generation, and client-oriented visual communication (Sheikh & Crolla, 2023).

Recent studies further indicate that the integration of virtual reality technologies into architectural education provides interactive and decision-support mechanisms for understanding modeling and construction details (Cao et al., 2024; Mammadov et al., 2025). While text-based generative AI systems enable the rapid visualization of abstract concepts, several authors stress that human supervision and creative judgment remain essential to achieving context-sensitive and high-quality design outcomes (Abd El-Maksoud & Ahmed, 2024).

Within this context, artificial intelligence should be regarded not only as a technical facilitator but also as an intuitive, experimental, and holistic instrument of architectural thinking. The transition from traditional drawing and modeling practices to digitally mediated environments has fundamentally altered architectural modes of thought, positioning AI systems at the center of contemporary design transformation.

2.1. Experimental Study and Visual Production Process

During the experimental phase of this study, three major public squares in Istanbul—Taksim, Beşiktaş, and Bakırköy—were examined, and AI-assisted redesign scenarios were developed for each site. The methodological approach was based on introducing the existing visual, cartographic, and contextual data of each square to ChatGPT and subsequently generating alternative design proposals through structured prompts. This approach allows artificial intelligence to be evaluated not only as a visual production tool but also as a creative collaborator capable of spatial analysis, contextual interpretation, and urban scenario development.

Figure 1. Locations of the three case-study squares in Istanbul: Taksim, Beşiktaş, and Bakırköy (Google Maps, 2025).

The case-study areas selected for this research—Taksim Square, Beşiktaş Square, and Bakırköy Square—represent three distinct public-space typologies within Istanbul's urban structure (Figure 1). Although all three function as major nodes of everyday mobility and social encounter, each square embodies a differentiated socio-spatial identity shaped by its historical layering, surrounding land-use patterns, and urban connectivity. Taksim Square operates as a symbolic and ceremonial center associated with collective memory and civic representation; Beşiktaş Square is defined by intense pedestrian flows and its strong spatial relationship with the waterfront; and Bakırköy Square reflects a district-scale public realm characterized by socio-cultural interaction and commercial density. This contrast provides a comparative framework for examining how AI-generated visual scenarios respond to varying contextual framings, and to what extent such outputs reproduce generalized spatial archetypes rather than site-specific public-space characteristics.

Data Preparation and Input Structure

For each square, a consistent input package was prepared, including updated satellite images**,** field and city photographs, and density and transportation information**.** Satellite images were used as the primary morphological reference to define spatial boundaries, open-space configurations, and urban scale. Field photographs supported the interpretation of materiality, human-scale experience, and everyday use patterns, while density and transportation data informed circulation logic and intensity of use.

These datasets were transformed into descriptive inputs to enable ChatGPT to interpret both the physical and experiential characteristics of the sites. In addition to visual data, short explanatory texts describing the historical, cultural, and socio-spatial significance of each square were provided as narrative inputs. This combination of data-driven and narrative information aimed to enhance the AI's capacity to interpret urban space as both a morphological structure and a contextual entity.

Identity Parameters and Scenario Definition

Based on the collected data, identity parameters were defined for each square:

- **Taksim Square:** public memory and multifunctionality,
- **Beşiktaş Square:** pedestrian movement and waterfront connection,
- **Bakırköy Square:** socio-cultural density and commercial flow.

These parameters guided the formulation of prompts designed to generate alternative spatial configurations under different scenarios, including daytime and nighttime use**,** event periods**,** and everyday low-intensity conditions**.**

Site-Specific Contextual Inputs

For Taksim Square**,** the AI was provided with an explanatory text emphasizing its historical and symbolic role in Istanbul's collective memory. The square was described as a focal point for ceremonies, celebrations, protests, and commemorations since the early twentieth century, and characterized as an "urban stage" rather than merely a transit space. The spatial configuration around the Republic Monument was explained as the intersection of major urban axes such as İstiklal Avenue, Gezi Park, and Tarlabaşı**,** each contributing to the square's socio-cultural complexity. These narratives were supported by current maps and satellite images, enabling the AI to develop a holistic understanding of the square's morphology and urban scale.

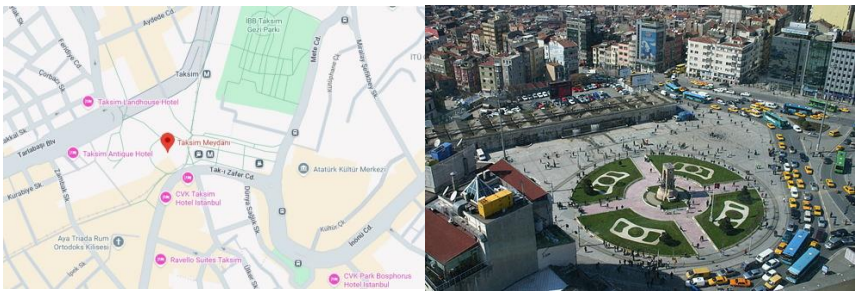

Figure 2. Current condition of Taksim Square, field/city view (Google Maps, 2025).

For **Bakırköy Square**, the explanatory input defined the area as a significant public space on the western side of Istanbul, holding an important place in the city's urban memory since the second half of the twentieth century. The square was described as a social meeting place rather than solely a transportation hub, supporting everyday social interaction and public events. Its environmental organization was explained through its relationship with Özgürlük (Freedom) Square**,** İncirli Avenue**,** and the Marmaray connection axis, highlighting the interaction between socio-cultural and commercial dynamics. These descriptions were accompanied by maps and satellite images to support morphological and contextual interpretation.

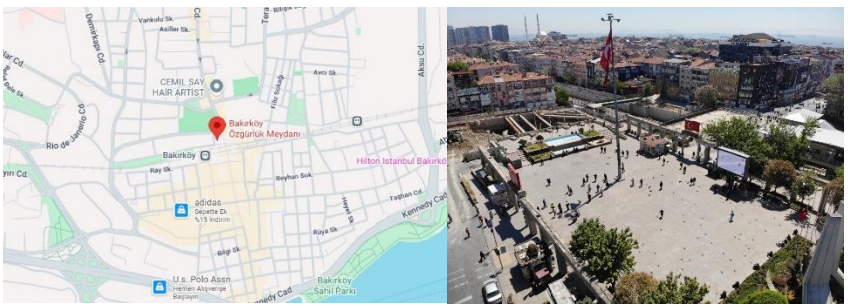

Figure 3. Current condition of Bakırköy Square, field/city view (Google Maps, 2025).

For **Beşiktaş Square**, the AI received an explanatory text describing the area as a symbolic public space closely connected to Istanbul's relationship with the sea. Since the late nineteenth century, Beşiktaş Square has functioned as a dynamic center of transportation, social mobility, and everyday urban life. The square was characterized as a social meeting ground rather than merely a transit node. Its spatial organization was described in relation to key urban axes such as Barbaros Boulevard**,** the Dolmabahçe coastal line**,** and the Beşiktaş Bazaar district, forming an urban node shaped by multiple cultural and commercial layers. Current maps and satellite images supported the AI's interpretation of its morphological structure and environmental relationships.

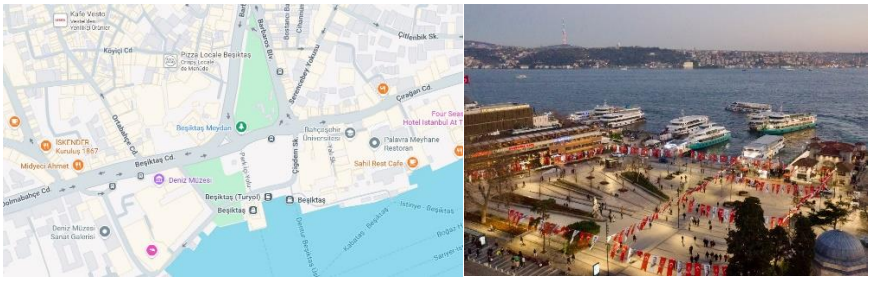

Figure 4. Current condition of Beşiktaş Square, field/city view (Google Maps, 2025).

Visual Production Process

After the introduction of visual and narrative inputs, the AI was instructed to generate alternative public space design proposals for each square. The primary objective of the production process was to create contemporary, sustainable, and human-centered public spaces while preserving the historical and cultural identity of each site. Each square was generated in separate AI sessions to minimize unintended visual element transfer between cases.

To ensure consistency and comparability, the AI was guided by five standardized design criteria:

- **Spatial organization:** defining circulation patterns, orientation, and gathering areas,
- **Urban continuity:** ensuring permeability, accessibility, and scale harmony with the surrounding fabric,
- **Material and landscape language:** integrating paving materials, vegetation, water elements, and seating through a contemporary approach,
- **User experience:** supporting everyday use, rest, social interaction, and cultural exchange,
- **Socio-cultural context:** reflecting identity cues, symbolic references, and urban memory.

The prompt structure included architectural visualization descriptors such as *urban square redesign, high realism, human scale, green integration, inclusive design*, and was expanded to include both **daytime and nighttime conditions** in response to reviewer feedback.

AI-Based Urban Public Space Designs

This section presents representative alternative square designs generated through artificial intelligence. The AI-produced visuals demonstrate the system's potential to reinterpret public spaces by synthesizing contextual narratives, spatial data, and identity parameters into coherent design proposals.

The AI-generated visualization of **Taksim Square** reimagines the area as a greener, more permeable, and user-oriented public environment while maintaining its monumental character and symbolic role. Landscape elements, seating areas, and water features are used to integrate the square into everyday urban life, softening its historical gravity and repositioning it within a more neutral and accessible aesthetic framework.

Figure 5. Alternative public space design for Taksim Square generated by artificial intelligence.

The AI-generated visualization of **Bakırköy Square** presents an open and human-centered public space emphasizing the everyday rhythm of urban life. A water element integrated with pedestrian circulation forms the central focal point, surrounded by seating areas and cafés that encourage social interaction. The design highlights sustainable material use and natural landscaping, reinterpreting the square as a calmer, community-oriented urban environment.

Figure 6. Alternative public space design for Bakırköy Square generated by artificial intelligence.

The AI-generated visualization of **Beşiktaş Square** proposes an open, fluid, and multifunctional public space establishing a strong visual and spatial connection with the sea. Broad pedestrian axes, water elements, and modular arrangements defined by trees and seating units support varied scales of interaction. The design harmonizes with Beşiktaş's dynamic social fabric while reinterpreting its historical identity through a contemporary architectural language.

Figure 7. Alternative public space design for Beşiktaş Square generated by artificial intelligence.

Based on the advantages and limitations summarized above, the study positions artificial intelligence as an experimental and critical visual collaborator rather than a context-aware design agent. While AI-assisted visual generation offers significant benefits in terms of speed, accessibility, and visual diversity, its outputs remain constrained by aesthetic pattern recognition, dataset bias, and limited responsiveness to site-specific socio-spatial conditions. Accordingly, the methodological framework of this study intentionally avoids claims of functional accuracy or design validity and instead focuses on comparative visual interpretation (Table 1).

Future research may address these limitations by incorporating richer and more structured datasets, multi-temporal and atmospheric scenarios (e.g., day–night and seasonal variations), and participatory evaluation methods involving designers and users. Such extensions would enable a more comprehensive assessment of AI's potential role in public-space design, moving beyond visual representation toward more context-sensitive and critically informed applications.

Table 1. Advantages and limitations of AI-assisted visual scenario generation in urban public-space studies.

Aspect	Advantages	Limitations / Risks	Mitigation Strategy in This Study
Speed and productivity	Enables rapid generation of multiple visual scenarios and accelerates early-stage exploration	May encourage superficial iteration without deep spatial reasoning	Use of fixed evaluation criteria and comparative visual analysis
Visual coherence	Produces visually persuasive and coherent public-space imagery	Risk of "false realism" and over-aestheticized representations	Explicit rejection of design validity claims; focus on representation
Contextual differentiation	Responds to descriptive framing and identity-based inputs	Relies on generalized spatial archetypes rather than site-specific intelligence	Purposeful variation of narrative inputs across cases
Accessibility of tools	Low technical entry barrier supports experimental research and education	Limited transparency regarding training data and internal decision logic	Methodological transparency through prompt structure and protocol description
Exploratory value	Expands formal imagination and supports speculative scenario testing	Outputs may reflect cultural and aesthetic bias embedded in datasets	Critical framing of AI as a representational medium, not an autonomous designer
Reproducibility	Prompt-based structure allows repeatable experimental setup	Output variability cannot be fully controlled	Standardized prompt framework and selection of representative samples

3. ANALYSES

This section evaluates the AI-generated public square proposals through a comparative and interpretive framework. The analysis is based exclusively on the visual reading of the generated images. No AI-generated textual explanations were used in the interpretation process; therefore, all analytical observations derive from the spatial, formal, and compositional characteristics visible in the visual outputs. The aim of this section is not to verify the contextual accuracy of the proposals, but to examine the extent to which artificial intelligence can produce visually coherent and differentiated spatial scenarios when exposed to distinct descriptive inputs.

It is important to emphasize that the richness and productivity of AI-generated outputs are directly influenced by the amount, quality, and specificity of the data provided to the system: the more detailed and qualified the input, the more nuanced and generative the results can become. In the present study, the physical environmental conditions of the squares were defined and framed by the author through selected visual references and descriptive inputs. However, to maintain comparability across the three cases and to focus the evaluation on representational spatial tendencies rather than atmospheric effects, the visual production process was intentionally limited to daytime and sunny-weather scenarios. Accordingly, the absence of nighttime, seasonal, or alternative weather conditions in the generated square images should be understood as a methodological choice within the defined scope of the study rather than as an inherent limitation of the AI system.

Analysis of Taksim Square

The AI-generated proposal for Taksim Square presents a spatial configuration characterized by centralized organization and a controlled layout. This interpretation is derived solely from the visual structure of the generated image, where a dominant central focus and symmetrical spatial relationships are evident. The persistence of centrality appears to align with the AI's general aesthetic tendency to organize symbolic public spaces around focal points rather than as a direct outcome of explicit prompt instructions.

The continued presence of a monumental element can be understood as a visual response to the emphasis on public memory within the descriptive inputs, rather than the result of a direct instruction to preserve specific monuments. From a visual perspective, circulation appears structured and restrained, with gathering areas defined by spatial order instead of dynamic movement. These characteristics suggest that the AI produced a representational and formally ordered public-space image, reflecting a generalized visual interpretation of monumentality rather than a site-specific functional logic.

Analysis of Bakırköy Square

In contrast to Taksim Square, the AI-generated visualization for Bakırköy Square demonstrates a more dispersed and permeable spatial structure. This reading is based on visual cues such as the distribution of open spaces, the absence of a dominant central focal point, and the integration of pedestrian paths into informal gathering areas. The perception of liveliness and social interaction emerges from the visual composition itself, rather than from explicitly stated functional or commercial directives.

Elements such as water features, seating clusters, and café-like interfaces contribute to a human-scale and accessible public-space image. These features suggest that the AI visually interpreted Bakırköy as a socially active environment through generic spatial elements commonly associated with lively urban spaces. Accordingly, the resulting proposal reflects a visually driven understanding of everyday urban life rather than a precise translation of socio-cultural or commercial data.

Analysis of Beşiktaş Square

The AI-generated proposal for Beşiktaş Square is visually distinguished by its directional and flow-oriented spatial organization. This assessment is based on the presence of linear pedestrian axes, open corridors, and visual openness toward the waterfront. The relationship with the sea is interpreted through perspective, orientation, and spatial openness observable in the generated image, rather than through explicit spatial measurements or predefined rules.

The spatial layout appears dynamic and movement-oriented, with circulation guiding users across the space instead of concentrating activity in fixed gathering zones. Tree groupings, seating elements, and water features are arranged to support visual continuity and spatial flow. These design characteristics indicate that the AI visually associated Beşiktaş with movement and openness, consistent with a generalized visual logic for waterfront-adjacent public spaces.

Comparative Analysis

A comparative reading of the three AI-generated proposals reveals distinct visual tendencies rather than uniform aesthetic outcomes. Taksim Square is represented through centralized order and monumentality, Bakırköy Square through dispersed activity and human-scale interaction, and Beşiktaş Square through directional flow and openness. These differences suggest that, even though the analysis is based solely on visual outputs, the AI was capable of producing differentiated spatial images when provided with varying descriptive contexts.

However, these distinctions should not be interpreted as evidence of context-aware or functionally accurate design intelligence. Instead, they demonstrate the AI's ability to generate visually diverse public-space representations based on generalized spatial archetypes and aesthetic pattern recognition. If identical prompts had been applied without differentiating descriptive inputs, it is likely that the resulting images would exhibit stronger visual similarities. Within this framework, the study positions artificial intelligence not as a tool for producing design accuracy, but as an experimental system whose visual coherence and limitations in spatial correctness can be critically observed. Although the analysis relies solely on visual outputs, the term 'descriptive context' refers to the differentiated input framing rather than verified contextual understanding.

4. CONCLUSION AND DISCUSSION

This study examined the use of artificial intelligence in public square design through AI-assisted visual generation processes, focusing on three major urban squares in Istanbul: Taksim, Beşiktaş, and Bakırköy. Rather than proposing finalized design solutions, the research aimed to explore how artificial intelligence responds to differentiated descriptive inputs and identity framings at a representational and visual level. In this respect, the study contributes to current discussions on the potential and limitations of AI as an experimental design tool within architectural and urban design contexts.

The findings indicate that artificial intelligence is capable of producing visually coherent and differentiated public-space representations when exposed to varied descriptive inputs. The AI-generated proposals exhibited distinct spatial tendencies, such as centralized monumentality, dispersed social activity, and flow-oriented organization, corresponding to generalized spatial archetypes

commonly associated with symbolic squares, district centers, and waterfront-adjacent public spaces. However, these differences should not be interpreted as evidence of context-aware, functionally accurate, or decision-making design intelligence. Instead, they reveal how generative AI systems visually respond to descriptive framing through aesthetic pattern recognition.

The visual evaluation of the AI-generated outputs was conducted using five criteria: spatial organization, urban continuity, user experience, material and landscape language, and socio-cultural references. These criteria were informed by established public-space and urban design literature emphasizing human-scale experience, accessibility and continuity, everyday use patterns, and the socio-cultural meanings embedded in urban open spaces. In particular, the framework draws on human-centered public-space theories highlighting experiential quality and public life (Gehl, 2011), conceptual models addressing public-space needs, rights, and meanings (Carr et al., 1992), place-quality assessment approaches focusing on access, comfort, sociability and broader urban design dimensions discussed in contemporary theory (Carmona, 2021). Accordingly, the criteria were not developed arbitrarily but grounded in widely recognized analytical approaches to public-space evaluation.

One of the key outcomes of the study is the recognition that AI-generated spatial configurations are primarily shaped by aesthetic conventions and learned visual patterns rather than by a deep understanding of socio-cultural, historical, or functional conditions. Consequently, limitations observed in the outputs—such as the absence of seasonal variation, precise functional differentiation, or context-specific spatial accuracy—should not be attributed to inherent deficiencies of artificial intelligence. Rather, they reflect the representational nature of the method and the controlled scope of the input framing adopted in this research.

In this context, the absence of nighttime and seasonal scenarios in the presented visuals results from an intentional methodological decision rather than from a technical limitation of AI systems. During the visual production process, prompts were deliberately limited to daytime conditions in order to maintain comparability across the three case studies and to focus the analysis on representational spatial tendencies rather than atmospheric effects. Nighttime and seasonal prompts were therefore excluded from the published visual set. Future studies may explicitly incorporate multi-temporal and multi-atmospheric scenarios to examine how such variables influence AI-generated public-space representations.

From a methodological perspective, the study underscores the importance of clearly defining the role of artificial intelligence within the design process. When positioned as an experimental and visual exploration tool, AI can support designers in rapidly generating alternative spatial scenarios, stimulating discussion, and expanding the range of formal possibilities. However, the findings also

emphasize that AI should not be considered a substitute for contextual analysis, site-specific reasoning, or human design judgment, particularly in complex public-space projects.

In conclusion, this research highlights that artificial intelligence holds value in architectural and urban design primarily as a representational and exploratory system rather than as a producer of design accuracy. Its effectiveness depends on how clearly its scope, limitations, and role within the design workflow are defined. Future research may extend this approach by integrating richer spatial data, multi-temporal and seasonal inputs, and iterative human–AI collaboration models, thereby enabling a more comprehensive and critically informed evaluation of AI's role in public-space design beyond visual representation.

5. APPENDIX A. REPRESENTATIVE PROMPT STRUCTURE (SAMPLE)

To enhance methodological transparency, a representative sample of the prompt structure used during the visual production process is presented below. This sample illustrates the general descriptive framework rather than a site-specific, deterministic, or prescriptive instruction.

"Generate an alternative public square design based on the provided visual references. Emphasize pedestrian accessibility, open and permeable spatial organization, landscape integration, and a human-scale urban experience. The proposal should reflect a contemporary public-space atmosphere while visually referencing the identity and character described in the accompanying explanatory text. The output should be presented as an architectural visualization."

This prompt sample represents the overall structure and descriptive language applied throughout the experimental process. In practice, variations were introduced through differentiated contextual framing rather than fixed design commands. For Taksim Square, the explanatory inputs emphasized symbolic public memory and ceremonial use; for Bakırköy Square, everyday social interaction and district-scale livability; and for Beşiktaş Square, pedestrian movement and waterfront-oriented openness. These variations informed the visual outputs indirectly through descriptive emphasis rather than through explicit or rule-based instructions.

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