Hapres | Journal of Sustainability Research

sustainability.hapres.com

Article

Towards Greener Futures: AI-Powered Designs for Sustainable, Accessible, and Energy-Smart Urban Furniture to Improve Happiness and Well-Being in Public Parks

May A. Malek Ali [1], Khaled Al-Saud [2], Rommel AlAli [3,*], Ali M. Katat [4], Amira Abouelela [2]

[1] Interior Architecture Department, Faculty of Fine Arts, Alexandria University, El-Shatby 21526, Alexandria, Egypt; May.ali@alexu.edu.eg (MAMA)

[2] Department of Art Education, King Faisal University, Al-Ahsa 31982, Saudi Arabia; Kmsoud@kfu.edu.sa (KA-S); aabouelela@kfu.edu.sa (AA)

[3] The National Research Center for Giftedness and Creativity, King Faisal University, Al-Ahsa 31982, Saudi Arabia

[4] Independent Researcher, Richmond Hill, Ontario L4E4T1, Canada; ali@edukosaghape.ca (AMK)

* Correspondence: Rommel AlAli, Email: ralali@kfu.edu.sa

Abstract

This study examines the application of artificial intelligence (AI) in designing urban furniture, with a particular focus on public parks and their surrounding areas. The study addresses the demand for welcoming and sustainable urban environments that promote psychological well-being, accessibility, and community engagement. The study aimed to examine how AI-assisted design may help create public furniture that is user-centered and environmentally friendly. A mixed-methods approach was used to identify the design priorities and assess the feasibility of AI applications to design sustainable urban furniture. This included a literature review, authors proposed designs with the help of AI, and a public opinion poll. Artificial intelligence techniques were used to develop innovative furniture concepts, while the authors guided the process to meet functional and aesthetic needs. The findings show that AI could significantly enhance the creativity and efficiency of the design possibilities when driven by human input, resulting in adaptive and visually appealing solutions. Respondents highlighted that including green energy, accessible features, and community-specific considerations within the design will encourage users to be more engaged with public parks and will enhance community well-being. However, the study identified shortcomings in current AI technologies, particularly in terms of functional evaluation and lifecycle concerns, as they require more human intervention.

KEYWORDS: AI-powered designs; public parks; urban furniture design; sustainability; accessibility; energy efficiency; urban well-being; happiness; inclusive design; environmental psychology

Received: 24 Jan 2025
Accepted: 06 Jun 2025
Published: 24 Jun 2025

INTRODUCTION

Designing public parks and integrating outdoor furniture can create a strong sense of place. This approach inspires creativity in park designs, allowing designers to shape spaces that serve the community and reflect their vision and goals. When outdoor furniture is integrated and used in public garden design to fulfill functional features while adding a beautiful touch, it creates an identity and sense of place. When selecting outdoor furniture, affordability, durability, and a design that allows for a smooth transition between different furniture pieces should be considered [1].

Sustainability has become increasingly important in all fields recently due to environmental and climatic matters. After the industrial revolution, the increasing number of people increased the demand for more products, accordingly increase in the use of raw material and energy resources and an increase in environmental pollution caused the development of more sustainable concepts [2].

Sustainability can be perceived and defined in different ways. Sustainable development is defined as “an environmentalist world view that aims to ensure economic development without sacrificing the principle of using environmental values and natural resources in a rational way that does not lead to waste, taking into account the rights and benefits of present and future generations”. In a similar statement made by Chapin et al., sustainability can be explained as the ability of all parts of the existing ecosystem to operate on their own effectively and efficiently without disrupting the order [3].

Sustainable urban and public park furniture is characterized by a low environmental impact and meets all the needs of users. When designing, producing, and using public parks’ furniture that has no harmful environmental impact, it is essential to focus on the use of local amenities, adopt innovative approaches, and strive to enhance the economic and social well-being of communities. Sustainable public park furniture requires minimizing the use of natural resources and reducing waste by focusing on the use of sustainable materials with a low environmental impact. It is essential to prevent the release of pollutants, thereby reducing environmental impact, encouraging the use of recycled materials for this purpose, and applying sustainable design principles to the design and production of public park furniture. The foundation and focus of sustainable design include planning processes from the design concept, raw material procurement, production, conversion into products, their use and disposal after use, and using low-impact materials on the environment throughout their life cycle. Using local resources and local production strategies whenever possible in converting materials into products is crucial, both in terms of reducing harmful compounds emitted into the atmosphere and supporting local policies. In all these processes, reducing the use of energy derived from fossil fuels and replacing it with environmentally friendly, renewable, and sustainable energy sources contributes to protecting natural resources and environments [4].

Urban planning that integrates sustainable practices and emerging technologies is vital for creating livable, inclusive, and environmentally friendly cities. In this sense, integrating artificial intelligence (AI) into urban planning is a state-of-the-art tactic that enhances creativity and practical efficiency when designing public parks' furniture. Artificial intelligence promotes creativity by offering diverse design choices and by supporting urban furniture design visualization. While encouraging innovation by providing adaptable solutions that meet the demands of users. AI also increases sustainability by predicting energy performance, resource efficiency, and material selection based on lifespan assessments. Combining urban planning, artificial intelligence, and sustainable design principles improves public areas' functionality, accessibility, and users' well-being.

One of the main principles of this study is "spatial happiness", which recognizes that well-designed places can increase psychological comfort, build community identity, and decrease stress levels. Urban furniture that makes use of these concepts through sustainable materials, ergonomic design, and technology integration can improve the quality of urban environments.

This concept intends to produce urban furniture that not only fits aesthetic and practical standards, but also contributes significantly to environmental sustainability and human well-being [5].

LITERATURE REVIEW

Sustainability is understood to increase the standard of living through urban design in urban areas. It is believed that if the concepts of sustainability are incorporated into the urban planning process, then livable, resilient, and healthy cities could be conceived.

Abouelela et al. (2025) highlighted the capabilities of AI in creating sustainable furniture design that is inspired from Arabic calligraphy. The paper showed how AI promoted creative and sustainable furniture designs inspired from calligraphies' art works to revive cultural aspects [6].

Samavati S. et al. (2024) highlighted that the great emphasis of urban planning is in determining community satisfaction. The paper evaluated the factors affecting how users enjoy public areas. Evidence from 8 scholarly search engines was gathered for the PRISMA-based review. 64 features were found in 8 domains: physical, environmental, visual, functional, social, subjective, political, and personal, after reviewing 57 publications. This study offered a detailed analysis of their impact on urban happiness. This point of view can be used by urban planners to boost the happiness and well-being of their residents. This investigation presented a different view of how they affect users' happiness and well-being [7].

Moreover, the importance of dealing with artificial intelligence (AI) in the design process was highlighted by Ahmed (2024) to identify the

obstacles designers face when using AI in the design process, this paper highlighted the possibilities of using AI to create sustainable furniture. It showed the possibilities of creating eco-friendly, sustainable and creative designs with the help of AI tools. On the other hand, some difficulties may be faced as the need for collaborative design, shortage of the knowledge of using AI and lack of dataset. The paper also highlighted the ways to overcome these obstacles [8].

Afifi (2024) highlighted on the use of AI to design green sustainable furniture. The research found out the increasing demand in using AI in creating furniture to be efficient and environmentally friendly. Afifi studied the issues that the designers face when using AI in this matter and proposed defined tools and different approaches to come over those problems. The research concluded that, when these obstacles are solved, AI has can be a great part of enhancing furniture design's to be more creative and sustainable [9].

Zahra, N. (2023) emphasized that artificial intelligence (AI) has enabled creative applications in furniture design, such as the use of generative models. During the design process, furniture designers must consider several options due to the geometric complexity of designs. Additionally, the study wanted to highlight the current AI techniques in furniture design that have improved the capabilities, skills, and performance of furniture designers while also advancing the design process. The study highlighted the distinctions between design utilizing AI applications and design based on humans by presenting two models. Additionally, it offered a SWOT analysis to determine AI's advantages, disadvantages, opportunities, and threats. According to the study's findings, 89.4% of furniture designers think AI is superior at coming up with original concepts [10].

Additionally, Itair, M., et al. (2023) highlighted the importance of the inclusiveness of urban public spaces, given their significant role in promoting the physical, psychological, and social health of beneficiaries. To improve the inclusiveness of public spaces, the study makes the following contributions. (a) Establishing a comprehensive framework for assessing the inclusiveness of public spaces. (b) Using the framework to assess the inclusiveness of public spaces in Nablus, (c) Introducing the concept of smart public spaces, which engages citizens in managing these spaces, leverages smart technology for monitoring, improves facility efficiency, and creates an environmentally friendly environment that preserves resources. By addressing these aspects, this research promotes the principle of inclusivity. It also encourages the development of urban public spaces that meet the diverse needs of society and foster a sense of belonging and well-being for all [11].

In this context, Şatıroğlu, E., et al. (2023) added to the efforts to achieve environmental balance for a sustainable future. Emphasis was placed on the importance of using sustainable materials, such as those that consume less energy and are less harmful to the environment, nature, and human health. Sustainable urban furniture can contribute to the future by

reducing environmental problems. In this study, urban furniture, such as seating elements, lighting elements, trash bins, paving materials, playgrounds, and pergolas in newly constructed or renovated green areas in central Rize over the past five years, was examined in the context of sustainable materials. These criteria included durability/maintenance, performance, functionality, recyclability, aesthetics, and environmental friendliness. The results were evaluated, and assessments were made of the materials used in urban furniture to create ecological and sustainable environments [12].

Significantly, Alegaonkar and Avachat-Shirke (2023) examined artificial intelligence (AI) as a new technology under exploration. AI is widely used in the design aspect of creativity, as well as the development of the most influential AI generation tools in the design field. Designers benefit from AI applications by integrating AI technology with designers' technical skills to create designs characterized by originality and quality. The study presented AI from a designer's perspective to illustrate the impact of designers' use of these applications on technical skills. The study used a quantitative and qualitative survey to collect data from designers and design educators to understand their views on AI [13].

Moreover, Anantrasirichai, N., & Bull, D. (2022) examined the current state of artificial intelligence (AI) technologies in the creative industries, focusing on machine learning (ML) algorithms like CNNs, GANs, RNNs, and DRL. It categorizes creative applications into five groups: content creation, information analysis, content enhancement, information extraction, and data compression. The paper predicts that ML-based AI will be widely adopted as a tool for creativity, but its success in domains with fewer constraints remains modest. The paper concludes that AI's maximum benefit will be derived when it focuses on augmenting human creativity [14].

Among the studies that addressed the importance of public access to AI, Long, Jacob, and Magerko (2019) noted the increasing prevalence of AI and its accompanying misconceptions about its definition and working mechanism. The study demonstrated that technologically proficient groups are the ones most likely to benefit from its capabilities, limiting its wider dissemination and understanding. It also emphasized that expanding public access to AI can enhance shared creative experiences and contribute to building an inclusive public culture. Based on researchers' experiences in developing creative AI for public spaces, the study aimed to explore how this type of AI is designed and provide design guidelines that could help guide future research and assist those interested in this field [15].

By reviewing previous studies, it is noted that:

- Some agreed with the use of artificial intelligence in design, emphasizing the principle of collaboration between designers and artificial intelligence tools.

- Most studies relied on experimental and descriptive approaches, and all concluded with results demonstrating the effectiveness of the tools used. This study, however, used a descriptive, analytical, and experimental approach.
- Most studies addressed various variables, while this study focused on the design of smart, sustainable public parks' furniture that is accessible to all segments of society and powered by artificial intelligence.
- By reviewing previous studies, we noted that the current study agrees with previous studies in its general objective, which is to use artificial intelligence technology in urban design and public parks' furniture elements, and to collaborate between designers and artificial intelligence applications in producing diverse generative designs that are well designed and function, emphasizing the importance of employing technology in a manner that is consistent with the requirements of the era and the desire of beneficiaries to enhance their well-being and psychological health.

PROBLEM STATEMENT

Given the numerous design challenges facing urban areas, which can impact the quality of life and well-being of residents, these challenges are related to environmental issues resulting from the lack of sustainable infrastructure in public parks. The absence of sufficiently sustainable urban parks for users prevents them from accessing recreational environments and healthy public parks. Many initiatives focus on aesthetic urban design, but they may fall short of meeting the practical and inclusive design requirements of various user groups, such as the elderly with disabilities, as well as youth and children. Furthermore, these initiatives may lack the integration of smart technologies such as solar energy systems, charging stations, and Wi-Fi networks, which are currently in demand and whose availability would ensure that beneficiaries visit public parks, positively impacting their health and well-being. Therefore, we need urban designs that are aesthetically, functionally, and technically compatible with modern requirements, environmentally responsible, and promote psychological well-being.

STUDY OBJECTIVES

This study aims to achieve a greener future by exploring the potential of AI-powered design to achieve creativity and innovation in sustainable urban furniture, helping to improve adaptability to user preferences. It also explores user feedback to address future design requirements for public park furniture, using sustainable materials to promote sustainable development and user comfort. Furthermore, it explores the potential for integrating renewable energy into the design of public park furniture elements and its impact on improving the quality of life in urban environments, and enhancing happiness and well-being in public parks.

THE IMPORTANCE OF STUDY

Enhancing urban well-being by incorporating accessible urban furniture, which increases the happiness and satisfaction of city dwellers. This positively contributes to psychological and mental health.

- Improving urban design by improving urban furniture design, which attracts the residents.
- Promoting environmental sustainability by applying sustainable design principles and renewable energy technologies to urban furniture, reducing the carbon footprint, and promoting sustainable urban living.
- Encouragement of inclusivity will help to guarantee social justice and ensure that urban furniture is accessible to everyone, including persons with disabilities. This will make all people of society able to access urban areas.
- Urban furniture design and artificial intelligence applications open the path for more flexible and responsive urban environments, enhancing user experiences and smart urban planning.
- Opinions of beneficiaries help the design process for urban furniture that fully satisfies the needs and tastes of society, thus improving the relevance and acceptance of urban development.

STUDY LIMITATIONS

Despite the various proposals for incorporating sustainable practices and AI into urban furniture, the study notes significant constraints. One of the major difficulties is the lack of resources. Financial constraints, material availability, technological infrastructure, and technical competence are all factors that influence the practicality of executing the offered solutions. Moreover, smart technologies maintenance may have an impact on their long-term usability in public settings. Furthermore, managing various stakeholders, including designers, local governments, and users, is difficult due to the diversity of their interests.

STUDY QUESTIONS

The study seeks to answer the following questions:

1. How can sustainable materials and renewable energy be integrated effectively in public parks?
2. How does energy-efficient public park furniture contribute to achieving environmental sustainability?
3. What is the role of functional design and innovative urban furniture in raising public awareness to promote environmental sustainability?
4. What is the role of artificial intelligence in supporting this type of research?
5. How does sustainable urban furniture design enhance urban environmental sustainability and the well-being of city residents?

MATERIALS AND METHODS

Overview

The descriptive approach was used in this study because it is appropriate for its purpose. The study focused on developing accessible urban furniture designs powered by sustainable energy. The authors surveyed to gather beneficiaries' opinions on the designs of furniture elements for public parks enhanced by artificial intelligence, to understand their impact on the happiness and well-being of city residents.

Design Creation Phase

Literature Review

The process begins with a literature analysis that focuses on sustainable, accessible, and energy-efficient urban furniture. This study explores current trends and best practices while also highlighting existing knowledge gaps that require additional investigation.

Design Development

Based on the findings of the literature review, proposed design concepts for public parks and furniture elements were developed. Artificial intelligence applications were used to produce preliminary designs for public park furniture, utilizing sustainable materials as environmentally friendly materials and incorporating clean energy technologies into urban furniture elements. Accessibility for people with special needs was considered through designs that accommodate them.

Opinion Poll Development and Distribution

a. The survey was designed to gather beneficiaries' opinions on the proposed furniture designs. The survey included a set of designs proposed by the authors, as well as a set of design evaluation questions to gauge their views on sustainability, accessibility, aesthetics, energy efficiency, and, in general, their opinions on the potential impact of these designs on happiness and well-being, as shown in Appendices A-E.
b. Target Audience: All age groups and socioeconomic levels of urban users to ensure inclusiveness.

Data Collection and Analysis

Data related to beneficiary responses to the survey were securely collected using a five-point Likert scale from 1 to 5. The data were then analyzed to reveal beneficiaries' opinions, attitudes, and preferences toward the proposed sustainable public garden furniture designs.

Reporting

Findings Presentation: The outcomes of the opinion poll were aggregated into a detailed report, showcasing the statistical analysis.

This approach is designed to close the knowledge gap on how sustainable, accessible, and energy-efficient urban furniture affects urban residents' happiness and well-being, aiming to provide practical recommendations for sustainable public parks.

TERMINOLOGY

Public Parks

Public parks are those spaces reserved for public use and enjoyment; they are generally urban settings. They are the green areas that help to promote neighborhood events and better the environment. Geography and socioeconomic conditions together will show quite naturally the physical attributes and functions of any public park, thus reflecting the features of the populations the areas serve [16].

Recycled and Upcycled Materials

Recyclability is the ability of a material to reacquire the same properties it originally had. According to this definition, many materials are not recyclable because once they go through a recycling process, they no longer have the properties they had in their virgin state, where the virgin state is defined as the purest form of the material before being processed or shaped for a specific use [17].

Upcycling is a way designers can directly reduce the net volume of household solid waste entering the waste stream. Upcycling represents a variety of processes by which "old" products get to be modified and get a second life as they're turned into a "new" product [18].

Accessible Designs

A design approach that takes into account the requirements of people with various disabilities [19].

Green Furniture

Green furniture requires many elements to be considered by responsible furniture makers during design and manufacturing. Green furniture is furniture made from environmentally friendly, recyclable, or rapidly renewable materials, or designed in a way that reduces energy and resource consumption and pollution [20].

Interactive Public Art Screens

Interactive screens contribute to enhancing social engagement among users in public parks and urban spaces through playful and creative participation and fostering a sense of initiative. Furthermore, these

interactive technologies can transform these urban screens from passive displays into dynamic tools for cultural interaction through interactive media art [21].

Weather-Resistant and Durable Designs

Studies indicated that urban furniture must be durable and weather-resistant. As material selection is more than simply aesthetics or sustainability, it is about selecting materials that can survive harsh weather, resist damage, and require minimal care. Experts advise using natural, locally sourced, and recyclable materials as they are more durable, resistant to environmental wear, and compliant with safety laws. Prioritizing these materials enables the development of furniture that is not only long-lasting but also accessible and adaptable to a range of climates and social contexts, ensuring that public places remain welcoming and inclusive [22].

Eco-Friendly Lighting

Smart urban lighting is a very effective element of sustainable urban furniture, providing both environmental and social advantages. These lighting systems can be used to improve public participation and safety while increasing energy efficiency [23].

AI-Powered Designs

Artificial intelligence is revolutionizing design processes across disciplines by allowing for automation, data-driven decision-making, and creative experimentation. In domains such as architecture, AI enables designers to broaden their creative ability by evaluating enormous datasets, modeling outcomes, and producing novel solutions that were previously difficult to imagine manually. These intelligent systems assist in both optimizing functional performance and personalizing designs based on user experience and environmental data [24].

THE IMPORTANCE OF PUBLIC PARKS

Public parks have greatly contributed to the process of cleaning the urban environment from carbon emissions and air pollution; they are very essential for people concerning their psychological and physical condition, especially in the city [25].

THE IMPACT OF PUBLIC PARKS ON INDIVIDUALS AND SOCIETY

The impacts of public parks greatly affect individuals and communities [26]. For example, the quantity and quality of urban parks and the access to those spaces have an important effect on the quality of life in the city and relate to many constituents of the health and well-being of individuals as shown in Figure 1 [27].

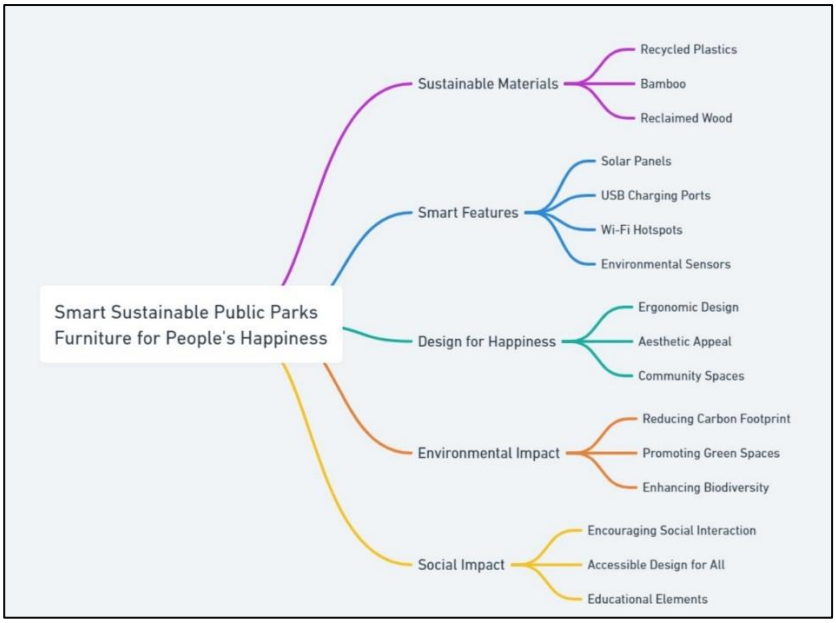


Figure 1. The chart shows smart, sustainable public park furniture for people's happiness.

SUSTAINABLE PUBLIC PARK DESIGN

Designing public parks with sustainability in mind supports a balance between social equity, economic viability, and environmental stewardship. Zavadskas, Baušys, and Mazonaviciute (2019) developed a multi-criteria Safety Evaluation Methodology of Urban Public Parks (SEMUPP) to assess the safety of urban parks in a structured, sustainability-oriented framework. Their methodology identifies key safety components and design features such as accessibility, functionality, and flexibility that are especially valuable in guiding the planning of small-scale or adaptive urban parks [28].

INTEGRATED STRATEGIES FOR SUSTAINABLE URBAN DEVELOPMENT

Incorporating renewable energy technologies into urban furniture is a practical strategy to promote sustainable urban development.

Solar-powered benches and smart lights enhance environmental awareness by making suitable designs recognized and usable in everyday life [29]. Also allowing the reduction of carbon footprint by it and encouraging the concept of clean energy. Cities that have implemented such systems have witnessed meaningful decreases in greenhouse gas emissions and significant long-term energy savings [30].

Furthermore, future-focused urban furniture designs that incorporate modularity and smart technologies enhance adaptability and user experience, while also contributing to healthier, more connected urban environments [31].

Future Design and Implementation Strategies

Newer, prospective, and forward-looking ways and means are required to flourish in the development and applications of urban furniture that may integrate renewable sources of energy. In all future design projects, modularity-based adaptability will be a core principle for enhancing the user experience and efficiency with the help of cutting-edge technologies such as the Internet of Things (IoT) [32].

FEATURES OF SUSTAINABLE URBAN DESIGN

Sustainable urban design is the planning of urban spaces to achieve better urban development and reduce negative environmental impacts. The following features are essential to this approach:

- Protecting environmental resources by conserving energy and water and reducing CO_2 emissions. This is achieved by prioritizing these elements in the designs of various garden furniture powered by solar energy and rainwater harvesting, contributing to the achievement of sustainable development goals in society [33].
- Urban resilience is the ability to survive and adapt after disasters [34].
- Accessibility is achieved by designing sustainable public parks with clarity, simple features, and design considerations that are appropriate for people with various disabilities and the elderly, helping them integrate and participate in society and its various groups, providing a more inclusive experience for all, and improving their quality of life and overall well-being [35].

Environmental integration, integrating natural elements into built environments and enhancing their connection to nature, has a positive impact on the users' physical and mental health. Biophilic design is a concept based on the idea of the innate human tendency to connect and integrate with nature, whether directly or indirectly. There is a close relationship between humans and nature, and the quality of this relationship determines individuals' thinking, culture, and health. Nature plays a clear role in the design of built spaces, including designed buildings. This is to create a more productive and healthier built environment for people. The natural world is important for human well-being [36].

- -Smart infrastructure incorporates solar energy into urban furniture as a sustainable and innovative approach that helps reduce the carbon footprint and the environmental impact of urban furniture, and offers numerous cost-effective, practical, and aesthetic benefits [37].
- -Cultural and aesthetic harmony through sustainable urban development can be applied by drawing inspiration from cultural identity in design, in a way that is functionally and aesthetically compatible with public parks and furniture to help preserve local heritage [38].

THE IMPACT OF SUSTAINABLE URBAN DESIGN ON ENVIRONMENTAL QUALITY AND HUMANS

The Impact of Sustainable Urban Design on Environmental Quality

Sustainable urban design is an economic and social approach that aims to improve development and reduce negative impacts on the environment. It plays a crucial role in improving environmental quality by reducing the carbon footprint, achieving sustainability, reducing the use of fossil fuels, and promoting energy-efficient building practices [39]. Improving air and water quality through sustainable and environmentally friendly design that relies on the use of natural materials, energy-efficient technologies, green spaces, and water management techniques, which helps improve air quality and conserve natural resources [40].

The Impact of the Quality of Sustainable Public Parks on Humans

Access to well-designed green spaces in urban areas helps in the improvement of physical and psychological well-being [41]. Public parks promote social cohesion and community building while improving the social structure of cities [42]. Parks offer cultural and recreational activities, and improve the quality of life and well-being for urban residents [43]. Evidence connects urban design and walkability to good mental health [44].

We define public park quality as a constantly developing concept that includes environmental designs, safety, and maintenance [45]. Inclusive design ensures accessibility and meets a wide range of social requirements, taking into consideration that infrastructure that is maintained promotes both usefulness and safety [44]. In the context of sustainable park design, “quality” encompasses perceived safety, ecological components, inclusive design, and physical maintenance. Visitors are more likely to perceive parks with well-kept, useful amenities such as benches, lights, and clear walkways as safe and welcoming [28].

Biodiversity and ecological design benefit the environmental sustainability, psychological rehabilitation, as well as public appreciation of natural beauty [46]. Creating flexible spaces and user-centered facilities promotes social connections while also making different demographic groups accessible. Finally, spatial layouts that promote openness, visibility, and human-scale interactions improve perceptions of safety and comfort, which are essential for consistent park use and community participation [44].

SUSTAINABLE URBAN FURNITURE AND DESIGN PRINCIPLES

Urban furniture is elements that simplify people’s individual and social lives in city areas, help them establish social communication with other individuals, add visual aesthetics to the space, and enrich the space. Functionally, it can be in different forms and shapes. The space gives

character to the space. Therefore, the city element is very important not only for functional purposes but also for giving identity to the urban. Designing urban Furniture in public spaces with a holistic approach makes urban life more enjoyable and meaningful, positively affects the welfare level of the city, and contributes to creating City comfort and urban aesthetics. The most important task, providing all these positive features, depends on the harmony in the design and placement of urban equipment [22].

SUSTAINABLE MATERIALS FOR PUBLIC PARK FURNITURE

Sustainable materials such as recycled metals and plastics, certified wood, and biodegradable composites are effective ways to reduce environmental impact in public park furniture, as shown in Figure 2

- Using recycled materials can help in the creation of custom, aesthetically pleasing, and environmentally friendly street furniture that can be created using 3D printing technologies [47].
- FSC-certified wood is a renewable, low-carbon alternative with increasing public awareness of its environmental benefits, as shown in Figures 3 and 4 [48,49].
- Recycled plastics such as HDPE are durable, water resistant, and ideal for outdoor use as shown in Figure 5 [50].
- Biodegradable materials, such as textile-starch composites and modified bamboo powder boards, are environmentally friendly and durable for outdoor use, as shown in Figure 6 [51].
- Repurposing materials like cardboard tubes into street furniture offers a low-cost, sustainable design opportunity. It is considered a green choice to support the environmentally sustainable goals [52].
- Eco-friendly 3D-printing filament was developed by reinforcing HDPE with the use of palm midrib nanoparticles (DPFNPs), proven potential for sustainable use in furniture design [53].
- The combination of recycled PET plastic with date palm frond nanoparticles (DPFNP) produced eco-friendly 3D-printing filaments that are suitable for furniture design, proposing a sustainable alternative material [54].
- Natural Stone and Concrete are locally sourced, reducing carbon emissions caused by transportation. Durability, low maintenance, and blending into the surroundings are some of the advantages of using those materials in public parks use as shown in Figure 7, creating urban landscapes that are resilient, sustainable, and aesthetically pleasing, as shown in Table 1 [55].

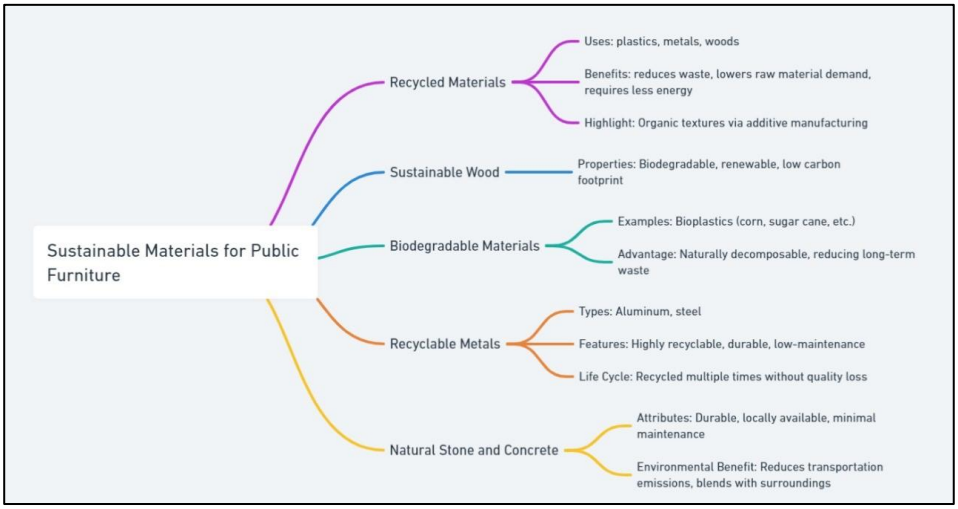


Figure 2. The chart shows Sustainable Materials for Public Parks Furniture.

Table 1. It explains examples of sustainable materials, their impact on humans and the environment, and their applications in garden furniture.

No	Sustainable Material	Impact on Humans and Environment	Applications in Park Furniture	Figure
1.	-Bamboo	-Ergonomic comfort -Eco-friendly, low embodied energy	Bamboo benches, picnic tables, signage, and decorative elements [56].	Figure 3
2.	-Recycled Wood	-Healthier indoor air quality -Reduced deforestation, lower carbon footprint	Recycled wood can be used for benches, tables, and playground structures [57].	Figure 4
3.	-High-Density Polyethylene (HDPE)	-Durable and safe -Highly recyclable, reduces plastic waste	HDPE is ideal for durable, weather-resistant benches, trash bins, and playground equipment [51].	Figure 5
4.	-Waste Textile-Starch Composites	-Customizable, non-toxic -Biodegradable, reduce textile waste	Suitable for unique, artistic installations, and non-structural decorative elements [58].	Figure 6
5.	-Natural Fiber Composites	-Comfortable, hypoallergenic. -Sustainable, reduce reliance on synthetic materials	Used in seating like benches and chairs, as well as in decorative fencing and signage [59].	Figure 7

Figure 3. Shows a seat design of a round bundle of bamboo supported in the middle for a flat seating surface. https://www.taketora.co.jp/diary/2015/09/2015world-bamboo-fair.html (accessed on 19 January 2024).

Figure 4. Shows a bench designed from recycled wood. https://i.pinimg.com/originals/31/a7/d5/31a7d5ab42e007b58b33ca8b16e62bb5.jpg (accessed on 19 January 2024).

Figure 5. Shows a bench designed and made with recycled high-density polyethylene (HDPE), The material is not susceptible to rotting or splintering. https://www.madetrade.com/products/loll-designstessellatebench?variant=40320113639487 (accessed on 19 January 2024).

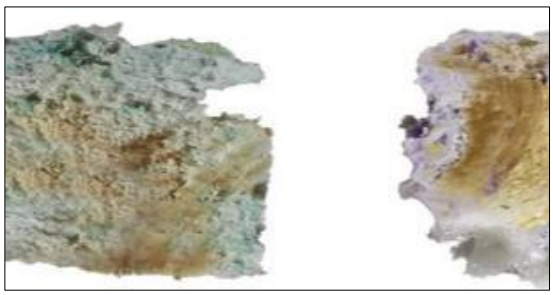


Figure 6. Shows Waste Textile-Starch Composites material https://doi.org/10.3390/su15043601 (accessed on 19 January 2024).

Figure 7. Shows a chair made of Natural Fiber Composites https://www.dezeen.com/2010/10/27/dune-by-rainer-mutsch/ (accessed on 19 January 2024).

THE IMPACT OF AI IN DESIGN FIELDS

AI Platforms for Architecture and Interior Design

Platforms like Midjourney, DALL-E 2, and Stable Diffusion have shown promise in aiding the design process by generating impressive images from simple text prompts. These tools assist designers during the ideation, sketching, and modeling stages, enabling the exploration of new design concepts and facilitating a workflow that combines the strengths of each platform for both interior and exterior design applications [60].

Enhancing Design Collaboration and Concept Exploration

AI has been recognized as a collaborative partner in architectural design, serving not just as a utility tool but also as a source of creative inspiration. Through text prompts and image references, AI platforms like Midjourney AI and Stable Diffusion encourage innovative design avenues, although they may focus more on aesthetics than on functional understanding. The research underscores the potential of AI to transform architectural design processes by combining human creativity with AI capabilities [61].

Applying AI in Furniture Design through Biomimicry

The concept of biomimicry involves drawing inspiration from nature to solve human problems, which has been applied in furniture design to enhance aesthetics and functionality. AI technology can further this approach by automating the design process, enabling the creation of innovative furniture pieces inspired by natural forms and structures [62].

Integrating AR for Real-Time Design Modifications

AR technology offers a dynamic platform for interior designers by allowing users to interact with virtual furniture within real-world environments. This interaction enables designers to visualize and modify furniture placements in real time, enhancing the design process and improving decision-making [63].

In conclusion, AI directly influences design disciplines by offering tools for automated model generation, facilitating creative design processes, and integrating interactive technologies like AR. These advancements enable designers to explore innovative concepts and designs.

Recent developments in AI-powered tools are reshaping creative disciplines by augmenting human capabilities in design analysis, pattern generation, and iterative exploration. Rather than replacing human designers, these systems increasingly act as co-creative agents. Argue that the integration of machine learning into architectural workflows supports a shift toward human-AI collaboration, where AI systems assist in early-stage ideation and data-driven form generation, enabling architects to explore a broader design space with greater speed and precision [24]. These new technologies also have some downsides. Some worries relying

too much on AI might make creative work look alike, as well as the unclearness of who gets credit when humans and AI work together. There are also some ethical concerns, especially about protecting your data [64].

Empirical insight into the adoption of AI tools in architectural design is offered by Naseri (2024), who evaluates three AI technologies—PlanFinder, TestFit, and Luma—used in real-world design and planning workflows. The study finds that these tools improve efficiency, visualization, and cost-awareness in design tasks, but also notes challenges such as limited customization, data dependency, and ethical concerns regarding automation's impact on labor and creativity [65].

THE INTEGRATION OF ARTIFICIAL INTELLIGENCE (AI) IN THE DESIGN PROCESS

Pros of Using AI in Design

The advantages of using artificial intelligence applications are found in multiple fields. In the design, artificial intelligence technology helps designers produce a variety of designs with diverse design styles and colors. This contributes to the constraints that designers identify at the beginning of the design process and when using artificial intelligence applications as a design tool to address both design and functional aspects. Among its advantages is its speed, which saves a lot of time in preparing initial designs. This helps designers reduce effort, focus on innovative design, and produce multiple designs with multiple ideas and trends. It also improves design efficiency [61].

Design supported by AI tools contributes to the production of high-quality, more realistic designs. The ability to integrate AI applications with augmented reality technologies enables the ability to modify designs and allows for design verification after modification through augmented reality, contributing to the opportunity to improve the design [10].

Cons of Using AI in Design

Cons of Using AI in Design: Designers' use of AI applications and tools has led to designs and patterns that are very similar in their characteristics. Some tools used in AI applications also offer designs with a complex vision. Although AI can produce high-quality designs, they may not always conform to specified requirements or standards, often necessitating software modifications. Overreliance on technology and smart tools can weaken the designers' creative and artistic skills.

PROPOSED DESIGNS—WORKFLOW USING AI

- Prompt creation: Writing prompts were the initial step in creating designs using AI tools (ChatGPT—DALLE), creating several design possibilities.
- Iteration and Refinement: The authors refined the AI-generated designs and modified them to meet the project's goals.

- Final Adjustments using Photoshop: Adjustments were made using Adobe Photoshop to achieve the final design. This step was vital for fine-tuning details and refining complex details beyond the AI's capabilities, ensuring the designs were fully adjusted and comprehended.
- This hybrid approach enhanced design creativity, making the designs realistic and imaginative.

RESULTS

The research proposes AI-assisted designs for sustainable, inclusive, and smart public park furniture, combining eco-friendly materials with modern technologies to improve user experience and environmental impact.

Collaborative efforts between AI tools and designers resulted in innovative and complex design options. While AI provided speed and diversity, designers made sure the ideas were functional, aesthetically pleasing, and user centered.

The suggested designs supported user convenience and sustainability by combining smart features (such as USB ports, Wi-Fi, and solar-powered lighting) with sustainable materials (like bamboo, HDPE, and recycled wood).

An opinion poll was conducted, in which participants evaluated the proposed designs and provided feedback on sustainability, comfort, accessibility, and psychological impact. User feedback was overwhelmingly positive, indicating that the designs would enhance comfort, well-being, social interaction, and the connection to nature.

Durability, low maintenance, and greater knowledge of sustainability were among the perceived long-term economic and environmental advantages of the designs.

Future implementation may be affected by material availability, financial constraints, and smart feature maintenance issues.

The design experiments of sustainable public garden furniture proposed in the current study demonstrated the potential for creating diverse designs that can be employed in public parks. The design experiments supported by artificial intelligence techniques for public garden furniture elements demonstrated their high flexibility, allowing them to be modified in design and function to suit the design requirements of the furniture elements and to accommodate people with special needs.

DISCUSSION

The discussion here is broken down into two main parts. First, we discuss the opinion poll results to understand more about the respondents' opinions. Then, we discuss our study questions as a way to add to our knowledge of sustainable urban design and its effect on community well-being.

-First, the opinion poll results

The researchers undertook the following steps:

-First Step:

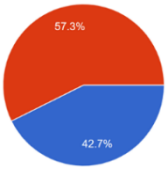
An opinion poll was designed to gather opinions on sustainable urban environmental designs through sustainable and energy-efficient furniture and to understand the physiological and psychological effects of sustainable urban design on public park beneficiaries. It comprised six sections, each containing a series of statements.

-Second Step:

The authors analyzed the opinion poll responses to uncover beneficiaries' views on the current reality of public park design adjacent to residential areas and surveyed beneficiaries about the proposed designs based on integrating sustainable design principles and renewable energy technologies into public garden furniture to enhance urban residents' well-being and quality of life. By analyzing the user's responses, the measurement unit for the analysis categories was determined, i.e., the frequency of answers to each question in every section. The total sample size was N = 200, with 150 responses received. Study sample characteristics include demographic data and participant characteristics, detailed in Table 2.

Study sample characteristics: consists of participant characteristics/demographic data. (Gender—educational level—age groups): shown in Table 2.

Table 2. Shows participant characteristics/ demographic data.

No	Personal Data	Discerption
1.	**Gender:** analysis of responses shows the number of male and female respondents. Female 86 (57.3%) Male 64 (42.7%) The total sample number equals 150	
2.	**Educational level:** Analysis of the Educational level of respondents Male Faculty member 20 (30%) Female Faculty member 19 (28.5%) Postgraduate student 24 (36%) Male Student 15 (22.5%) Female student 14 (21%) PhD student 7 (10.5%) Other 51 (76.5%)	
3.	**Age categories:** Analysis of the age groups of the respondents according to the educational level ranged from 13 years to 67 years.	

The statistical analysis of the 150 responses to phrase 1, shown in the fourth section of Table 3, indicates that 87.3% strongly agreed, 10.7% agreed, 2% were neutral, 0% disagreed, and 0% strongly disagreed, as shown in Figure 8. Through these responses, it can be seen that the respondents of the respondents strongly emphasized the importance of the role of public parks in enhancing communication with nature directly.

From the statistical analysis of the 150 responses to phrase 2 in the fourth section, the questionnaire (Table 3) indicates that 87.3% strongly agreed, 9.3% agreed, 2.7% were neutral, 0.7% disagreed, and 0% strongly disagreed, as shown in Figure 8. From this analysis, respondents' opinions about improving their ability to recover and refocus by visiting public parks were confirmed.

From the statistical analysis of the 150 responses to phrase 3 in the fourth section, the questionnaire (Table 3) indicates that 6% strongly agreed, 6% agreed, 9.3% were neutral, 19.3% disagreed, and 59.3% strongly disagreed, as shown in Figure 8. From this analysis, that public parks do not meet the needs of individuals with disabilities.

From the statistical analysis of the 150 responses to phrase 4 in the fourth section, the questionnaire (Table 3) indicates that 79.3% strongly agreed, 8% agreed, 8.7% were neutral, 2% disagreed, and 2% strongly disagreed, as shown in Figure 8. From this analysis, respondents' responses confirm that the design of public parks near their residences lacks sustainable design elements.

Table 3. Shows the frequencies of the second: (Public Parks).

No	Second Section: Public Parks	SD	D	N	A	SA
1.	Public parks play a vital role in enhancing direct contact with nature.	0	0	3	16	131
2.	Visiting public parks and taking a walk in them improves people's abilities to recover and refocus.	0	1	4	14	131
3.	Public parks meet the needs of individuals with disabilities.	89	29	14	9	9
4.	The design of public parks in your area lacks sustainable design elements	3	3	13	12	119

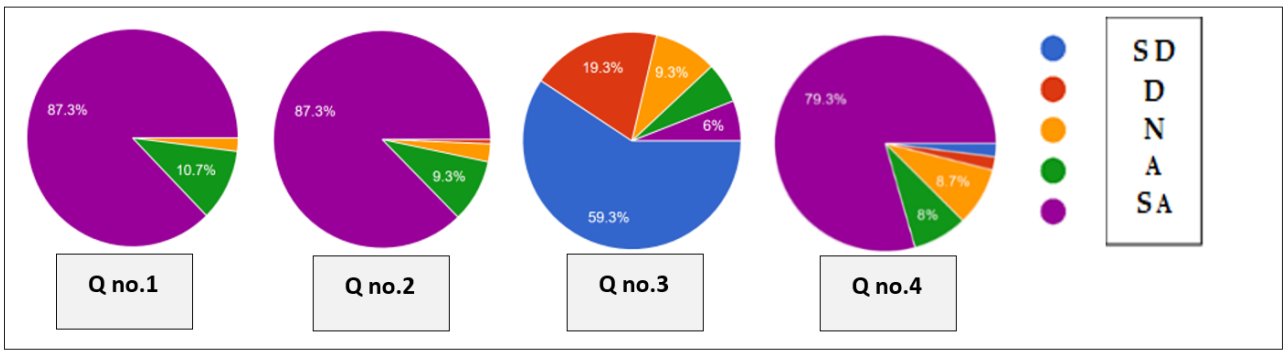


Figure 8. Analysis of responses to phrases 1, 2, 3, and 4 in the second section.

The statistical analysis of the 150 responses to phrase 1, shown in the fourth section of Table 4, indicates that 79.3% strongly agreed, 16% agreed, 4% were neutral, 0.7% disagreed, and 0% strongly disagreed, as shown in Figure 9. From this analysis, it can be seen that the responses of respondents strongly agreed on the importance of the modern design of public park furniture.

From the statistical analysis of the 150 responses to phrase 2 in the fourth section, the questionnaire (Table 4) indicates that 83.3% strongly

agreed, 14% agreed, 2.7% were neutral, 0% disagreed, and 0% strongly disagreed, as shown in Figure 9. From this analysis, it can be seen that the responses of respondents strongly agreed on the importance of achieving visual appeal in public park furniture.

From the statistical analysis of the 150 responses to phrase 3 in the fourth section, the questionnaire (Table 4) indicates that 81.3% strongly agreed, 15.3% agreed, 3.3% were neutral, 0% disagreed, and 0% strongly disagreed, as shown in Figure 9. From this analysis, it can be seen that the responses of respondents strongly agreed on the importance of creative and innovative design in public park furniture.

From the statistical analysis of the 150 responses to phrase 4 in the fourth section, the questionnaire (Table 4) indicates that 70.7% strongly agreed, 27.3% agreed, 1.3% were neutral, 0.7% disagreed, and 0% strongly disagreed, as shown in Figure 9. From this analysis, it can be seen that the responses of respondents strongly agreed on the availability of public park spaces for gathering and social interaction.

From the statistical analysis of the 150 responses to phrase 4 in the fourth section, the questionnaire (Table 4) indicates that 86% strongly agreed, 12.7% agreed, 1.3% were neutral, 0% disagreed, and 0% strongly disagreed, as shown in Figure 9. From this analysis, it can be seen that the responses of respondents strongly agreed on the importance of shading systems in public parks.

Table 4. Shows the frequencies of the third: (Design and comfort).

No	Third Section: Design and Comfort	SD	D	N	A	SA
1.	The importance of modern design in public.	0	1	6	24	119
2.	The importance of achieving visual appeal in public park furniture.	0	0	4	21	125
3.	The importance of creative and innovative design in public park furniture.	0	0	5	23	122
4.	The availability of public parks spaces for gathering and social interaction.	0	1	2	41	106
5.	The importance of shading systems in public parks.	0	0	2	19	129

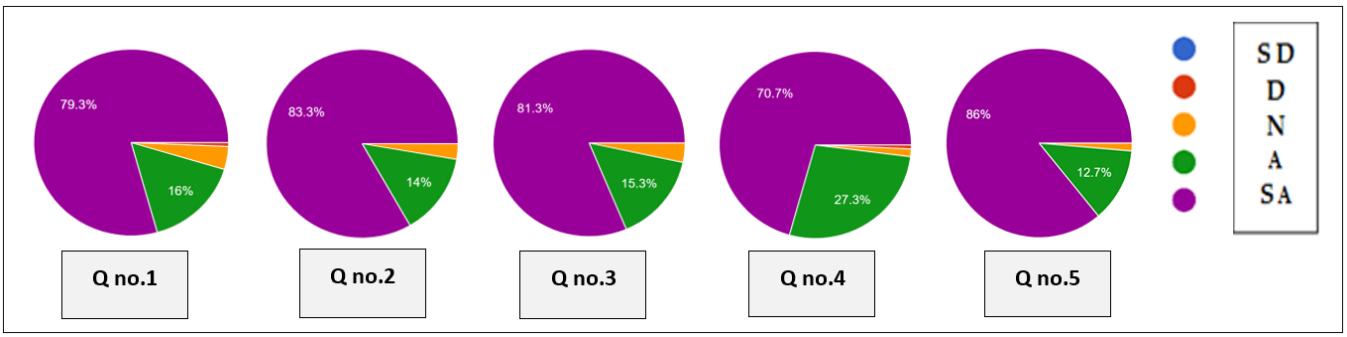


Figure 9. Analysis of responses to phrases 1, 2, 3, 4, and 5 in the third section.

The statistical analysis of the 150 responses to phrase 1, shown in the fourth section of Table 5, indicates that 89.3% strongly agreed, 9.3% agreed, 0% were neutral, 0.7% disagreed, and 0.7% strongly disagreed, as shown

in Figure 10. From the statistical analysis, it can be seen that the responses of respondents strongly agreed on using sustainable materials through innovative, unconventional designs of furniture in public parks. From the statistical analysis of the 150 responses to phrase 3 in the fourth section, the questionnaire (Table 5) indicates that 88% strongly agreed, 9.3% agreed, 2.7% were neutral, 0% disagreed, and 0% strongly disagreed, as shown in Figure 10. From this analysis, it can be seen that the responses of respondents strongly agreed that the Sustainable design of public parks provides safe outdoor environments that enhance well-being, health, and productivity.

From the statistical analysis, it can be seen that the 150 responses to phrase 4 in the fourth section, the questionnaire (Table 5) indicate that 82% strongly agreed, 14.7% agreed, 2% were neutral, 0.7% disagreed, and 0.7% strongly disagreed, as shown in Figure 10. From this analysis, it can be seen that the responses of respondents strongly agreed that the community enhances the quality of life for residents through public parks. From the statistical analysis of the 150 responses to phrase 5 in the fourth section, the questionnaire (Table 5) indicates that 88.7% strongly agreed, 8.7% agreed, 0.7% were neutral, 2% disagreed, and 0% strongly disagreed, as shown in Figure 10. From this analysis, it can be seen that the responses of respondents strongly agree that solar panels are integrated into public parks 'furniture to support sustainable design.

It can be seen that the 150 responses to phrase 6 in the fourth section, the questionnaire (Table 5) indicate that 84.7% strongly agreed, 10% agreed, 2.7% were neutral, 2% disagreed, and 0.7% strongly disagreed, as shown in Figure 10. From this analysis, it can be seen that the responses of respondents strongly agreed that the negative effects of public parks affect human health.

Table 5. Shows the frequencies of the fourth: (Sustainability and Materials).

No	Fourth Section: Sustainability and Materials	SD	D	N	A	SA
1.	Using sustainable materials through innovative, unconventional designs in furniture elements.	1	1	0	14	134
2.	The use of sustainable materials in public park furniture ensures the durability and longevity of the furniture.	0	0	1	17	132
3.	Sustainable design of public parks provides safe outdoor environments that enhance well-being, health, and productivity.	0	0	4	14	132
4.	The community enhances the quality of life for residents through public parks.	1	1	3	22	123
5.	Solar panels integrated into public park furniture to support sustainable design.	0	3	1	13	133
6.	The negative effects of public parks affect human health.	1	3	4	15	127

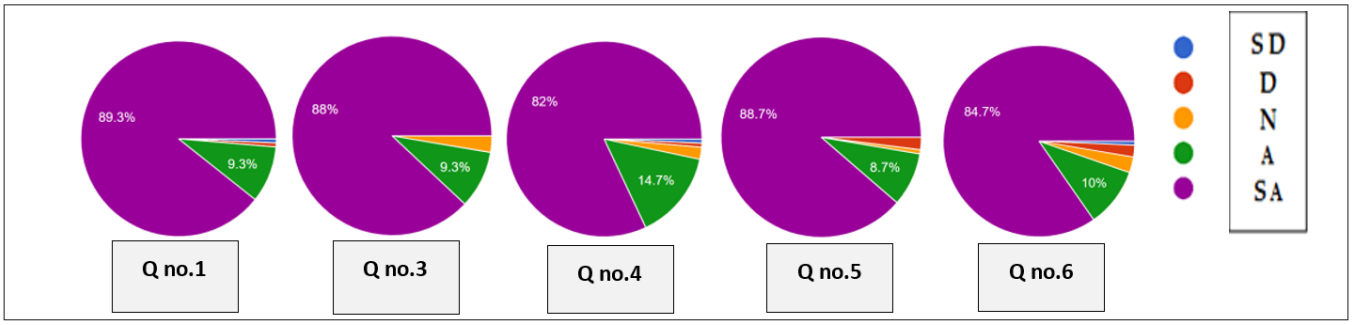


Figure 10. Analysis of responses to phrases 1, 3, 4, 5 and 6 in the fourth section.

The statistical analysis of the 150 responses to phrase 1, shown in the fifth section of Table 6, indicates that 86.7% strongly agreed, 7.3% agreed, 2.7% were neutral, 2% disagreed, and 1.3% strongly disagreed, as shown in Figure 11. From this analysis, it can be seen that the responses of respondents strongly agreed with the importance of having technological facilities such as Wi-Fi and interactive screens in public parks.

From the statistical analysis of the 150 responses to phrase 2 in the fifth section, the questionnaire (Table 6) indicates that 8.7% strongly agreed, 5.3% agreed, 2% were neutral, 7.3% disagreed, and 76.7% strongly disagreed, as shown in Figure 11. From this analysis, it can be seen that the responses of respondents strongly disagreed with the presence of technological services provided through the public parks that they visit.

From the statistical analysis of the 150 responses to phrase 3 in the fifth section, the questionnaire (Table 6) indicates that 88% strongly agreed, 9.3% agreed, 1.3% were neutral, 0.7% disagreed, and 0.7% strongly disagreed, as shown in Figure 11. From this analysis, it can be seen that the responses of respondents strongly agreed with the importance of energy efficiency used in public parks. From the statistical analysis of the 150 responses to phrase 4 in the fifth section, the questionnaire (Table 6) indicates that 83.3% strongly agreed, 11.3% agreed, 2% were neutral, 2% disagreed, and 1.3% strongly disagreed, as shown in Figure 11. From this analysis, it can be seen that the responses of respondents strongly agreed that Public parks meet the needs of family members of all age groups.

Table 6. Shows the frequencies of the fifth: (Design and technology integration).

No	Fifth Section: Design and Technology Integration	SD	D	N	A	SA
1.	The importance of having technological facilities such as Wi-Fi and interactive screens in public parks.	2	3	4	11	130
2.	Provides technological services in the public parks you visit.	115	11	3	8	13
3.	The importance of energy efficiency used in public parks.	1	1	2	14	132
4.	Public parks meet the needs of family members of all age groups.	2	3	3	17	125

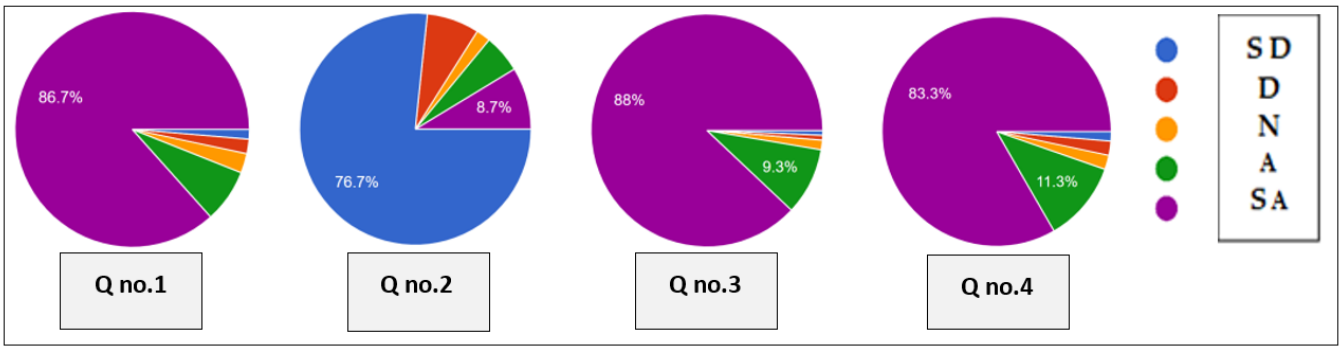


Figure 11. Analysis of responses to phrases 1, 2, 3, and 4 in the fifth section.

The statistical analysis of the 150 responses to phrase 1, shown in the fifth section of Table 7, indicates that 84% strongly agreed, 14.7% agreed, 1.3% were neutral, 0% disagreed, and 0% strongly disagreed, as shown in Figure 12. From this analysis, it can be seen that the responses of respondents strongly agreed that the design of public park furniture affects Comfort, happiness, and psychological safety for visitors.

From the statistical analysis of the 150 responses to phrase 2 in the fifth section, the questionnaire (Table 7) indicates that 78.7% strongly agreed, 16.7% agreed, 4% were neutral, 0.7% disagreed, and 0% strongly disagreed, as shown in Figure 12. From this analysis, it can be seen that the responses of respondents strongly agreed that the current proposed design and furnishing of public parks reduce feelings of anxiety for visitors.

From the statistical analysis of the 150 responses to phrase 3 in the fifth section, the questionnaire (Table 7) indicates that 87.3% strongly agreed, 12% agreed, 0% were neutral, 0.7% disagreed, and 0% strongly disagreed, as shown in Figure 12. From this analysis, it can be seen that the responses of respondents strongly agreed that the colors used in designing public park furniture are derived from natural colors that help give a feeling of vitality and activity.

From the statistical analysis of the 150 responses to phrase 4 in the fifth section, the questionnaire (Table 7) indicates that 87.3% strongly agreed, 9.3% agreed, 2.7% were neutral, 0.7% disagreed, and 0% strongly disagreed, as shown in Figure 12. From this analysis, it can be seen that the responses of respondents strongly agreed that the proposed design of public park furniture helps improve relationships and enhance a sense of psychological comfort, happiness, and harmony.

From the statistical analysis of the 150 responses to phrase 5 in the fifth section, the questionnaire (Table 7) indicates that 84.7% strongly agreed, 13.3% agreed, 2% were neutral, 0% disagreed, and 0% strongly disagreed, as shown in Figure 12. From this analysis, it can be seen that the responses of respondents strongly agreed that sustainable design for public parks supports positive interaction between humans and nature and encourages a sense of responsibility towards society and nature.

Table 7. Shows the frequencies of the sixth: (Happiness and Well-being).

No	Sixth Section: Happiness and Well-Being	SD	D	N	A	SA
1.	The design of public park furniture affects your comfort, happiness, and psychological safety.	0	0	2	22	126
2.	The current proposed design and furnishing of public parks reduce feelings of anxiety.	0	1	6	25	118
3.	The colors used in designing public park furniture are derived from natural colors and help give a feeling of vitality and activity.	0	1	0	18	131
4.	The proposed design of public park furniture helps improve relationships and enhance a sense of psychological comfort, happiness, and harmony.	0	1	4	14	131
5.	Supports positive interaction between humans and nature and encourages a sense of responsibility towards society and nature.	0	0	3	20	127

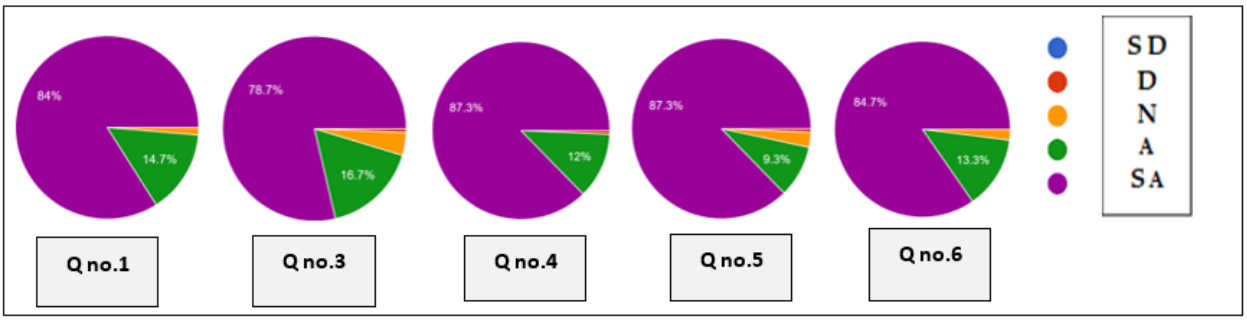


Figure 12. Analysis of responses to phrases 1, 2, 3, 4 and 5 in the sixth section.

Following the presentation of the opinion poll results and analysis, the answers to study questions will be presented to understand their impact on the design and utility of sustainable urban furniture.

-Second, the answers to the study questions:

The study questions and answers are as follows:

Question 1: How can sustainable materials and renewable energy be integrated effectively in public parks?

Using sustainable materials in public park furniture is important for supporting environmental responsibility and enhancing urban spaces. It is recommended to use sustainable materials in public park furniture, including recycled plastic, bamboo, metal, and reclaimed wood. Using local materials helps reduce carbon emissions and perfectly integrates public parks with the surrounding environment.

Question 2: How does energy-efficient public park furniture contribute to achieving environmental sustainability?

Energy-efficient public park furniture promotes environmental sustainability by utilizing renewable energy sources such as solar power, which reduces carbon emissions and energy consumption. It promotes eco-friendly habits and reduces waste by using durable and recyclable materials.

Question 3: What is the role of functional design and innovative urban furniture in raising public awareness to promote environmental sustainability?

Functional design and innovative urban furniture could also play a pivotal role in fostering public awareness and acceptance of sustainable living practices within urban centers by enhancing public engagement and encouraging eco-friendly behaviors. Other attributes are well placed and designed, such as benches, lighting, and waste bins made of recyclable materials, which serve as daily reminders of sustainability; and those representing viable renewable energy, which combine solar panels or wind turbines. These are facilities that help to undertake sustainable behavior, not only with a strong ecological vocation, such as elements of vertical gardens that would improve air quality or control the effects of the urban heat island effect. Furthermore, the community could be engaged in the design process, and urban furniture could be utilized to make artistic expressions related to sustainability that could even heighten a sense of involvement and responsibility. All such initiatives make city planning way smarter, and in turn, help forge a culture that supports sustainable urban living.

Question 4: What is the role of artificial intelligence in supporting this type of study?

Artificial intelligence (AI) helped in the visualization of the authors' proposed designs, since urban furniture design should incorporate sustainable design elements with renewable energy technology in public parks. This AI-assisted proposal emphasizes the creation of urban furniture that is not only functional and accessible but also aesthetically pleasing, durable, and environmentally sustainable. The authors provided instructions and prompts to include the following points:

- Functionality and sustainability: The designs prioritize comfort and sustainable design, but utilize a shading system, eco-friendly materials, and solar panels to support environmental sustainability.
- Aesthetics: The furniture is visually appealing and complements the urban aesthetics of parks and city places, improving the entire atmosphere and attracting more users.
- Accessibility: The furniture design is accessible to everybody, especially those with mobility issues.
- Social Connectivity: The inclusion of Wi-Fi and charging ports invites park-goers to stay connected and enjoy the outdoors, supporting social interaction and engagement.

The following AI-supported design concepts Figures 13–22 aim to transform public parks into more inviting and user-friendly spaces for the community by combining modern technology with sustainability and accessibility principles. This approach aims to improve the functionality

and appeal of public parks, as well as to advocate for a sustainable and inclusive urban future.

Figure 13. Tech-integrated eco-friendly park [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

Figure 14. Futuristic urban green space design. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

Figure 13 shows the public park's proposed design, where technology, accessibility, and sustainability are seamlessly blended to enrich the design. Those units have digital screens and charging stations using solar panels, while using eco-friendly design concepts and materials, emphasizing accessibility and environmental concepts. The design encourages social engagement and is equipped as well with WIFI. The design aims to improve health and well-being in public parks.

The concept combines natural forms with modern form. It incorporates solar panels to encourage renewable energy use and sustainability. The form emphasizes user-centered design by providing green spaces, and interactive zones that cater to the demands of users, resulting in an engaging and environmentally friendly public space as shown in Figure 14.

Figure 15. Modern eco-friendly shaded seating unit. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

Figure 16. Solar-powered smart shaded seating unit. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

As seen in Figure 15. Modern eco-friendly shaded seating unit. It is an example of eco-friendly and advanced technology. Equipped with energy-efficient LED lighting and solar panels that utilize clean energy, the seating is made from recycled materials.

As seen in Figure 16. Solar-powered smart shaded seating unit. It is an example of blending eco-friendliness with advanced technology. Equipped with Wi-Fi, energy-efficient LED lighting, and solar panels that utilize clean energy, the seat is made from recycled, sustainable materials. The unit is designed to survive different weather conditions and to be accessible. this unit integrates smart technologies, charging points, and is designed to be made from low-maintenance materials, along with safety lighting to enhance visibility at night.

Figure 17. Innovative bench with tech amenities. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

Figure 18. Smart bench with a digital interface. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

In Figure 17, A proposed public seat design that blends technology with sustainable practices and inventive design, making it perfect for urban park settings. The metal and wooden bench is underpinned by energy-saving LED lighting and topped with solar panel roofs to harness renewable energy. users can enjoy Wi-Fi and charging stations. This eco-friendly and smart seat is designed to enhance the users' experience to create a comfortable, welcoming, and engaging environment. Figure 18 illustrates a futuristic smart bench, ingeniously integrated with advanced technologies, Wi-Fi, Bluetooth, device charging, as well as a comfortable place to sit, with integrated lighting for evening use and weather information, and side planters.

Figure 19. Sustainable solar-powered urban canopy. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

Figure 20. Solar-powered urban park lounging. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

As shown in Figure 19, this proposed urban canopy integrates solar panels, ergonomically designed parametric chairs, LED lighting, and information display screens. It uses solar power to provide the units with energy. The design is welcoming to all and offers Wi-Fi connectivity. The design enhances comfort and community spirit in public spaces, reflecting a commitment to environmental sustainability.

The park is well integrated into the urban landscape. A large water feature is used in the park to enhance the aesthetic value of the park and for its cooling effects. In the maximum openness and park design, they aim to reach the daylight and clear sky, advantages of collecting solar energy, and helping the aesthetics of the visitors. There has also been a set-aside area for playing or unstructured activities and benches encircled by open spaces. According to the presented general design in Figure 20, modern development infrastructure with environment enhancement to promote sustainability has been held, whereby technology has been merged with nature.

Figure 21. Solar-paneled sustainable walkway design. [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

Figure 22. Green Tech Park with solar trees [Source: Generated by the authors using AI tools (DALL·E), with post-editing in Photoshop.]

Further, Figure 21 shows a modern public environment designed with the environmental concept, incorporating eco-friendly features to enhance the quality of life. using efficient LED lighting, solar panels for renewable energy, and plenty of green spaces to improve air quality. Additionally, the space is designed to encourage walking, with pedestrian-friendly walkways, urban seating, and the integration of smart technologies for public use, collectively contributing to a more sustainable and enjoyable urban experience. Figure 22 represents a sustainable park designed to harmoniously blend technology with nature. It features ergonomic seating for comfort, canopies resembling trees equipped with solar panels for energy, and spaces specifically designed to be accessible to everyone. The park offers universal Wi-Fi access and is lit by energy-efficient LED lighting. Additionally, this park is designed to cater to a wide range of recreational needs while placing a strong emphasis on inclusivity, environmental awareness, and the utilization of modern technology.

Question 5: How does sustainable urban furniture design enhance urban environmental sustainability and the well-being of city residents?

Sustainable outdoor furniture enhances urban life through different benefits:

- Improving Public Health by purifying the air, leading to better respiration.
- Economic Benefits as Sustainable furniture costs more at first, while having long-term financial benefits over time.
- Aesthetic and Recreational Value as it not only looks good but also is functional, improving urban landscapes and making them more enjoyable for inhabitants and visitors alike.
- Promoting Sustainability Awareness by featuring renewable energy technologies and sustainable materials, such as furniture, educates the public on sustainability, and encourages environmentally friendly practices.

Designing accessible furniture promotes community support and allows everyone to enjoy public spaces, leading to a healthier environment.

Material selection is essential for ensuring the sustainability, durability, and long-term usability of urban furniture. Recycled high-density polyethylene (HDPE) has proven to be ideal for outdoor applications due to its weather resistance, recyclability, low water absorption, and low maintenance requirements. Studies show that HDPE planks maintain mechanical strength and user satisfaction even after extensive outdoor exposure, making them a suitable alternative to traditional materials in public places [47]. Furthermore, cellular lightweight concrete has been successfully used in modular furniture systems for urban parks, providing exceptional resistance to extreme weather and longevity while allowing flexibility in design and social use across age groups [66]. Wood is a

popular natural material due to its aesthetic and natural appeal, nevertheless, it needs special treatment to survive UV and humidity. Recent research focuses on different treatments like coatings, thermal treatments, and bio-based repellents to greatly extend their lifespan. While this study focused on the conceptual sustainable furniture design, future research would include technical validation such as lifetime assessments (LCAs), structural and safety testing, and material degradation models [67].

Aesthetic and Psychological Factors of Public Parks Designed According to Sustainability Principles Using Artificial Intelligence

Public parks designed based on sustainability principles using artificial intelligence (AI) combine environmental beauty and psychological comfort while minimizing negative environmental impact. In this context, distinct aesthetic and psychological factors emerge, relying on the integration of technology, nature, and environmental awareness.

Psychological Factors in Sustainable Public Parks Designed with Artificial Intelligence

- Sustainable design focuses on eliminating visual and noise pollution while creating an environment that fosters psychological well-being.
- Creating a sense of environmental responsibility by including the community in public park design, which raises awareness and encourages care for the environment.
- Using natural shade, airflow, and water with smart technologies creates a comfortable sensory environment, helping to reduce stress levels.
- Encouraging healthy physical and social activities through smart walking paths and community public parks, which enhance mental and physical health.
- Inclusive design accommodates different categories of beneficiaries, taking into account the elderly, children, and people with disabilities, making everyone feel welcome and comfortable.

CONCLUSIONS

This study highlights how utilizing AI tools in creating sustainable, urban furniture can improve the well-being of societies. The study uses a hybrid design and evaluation technique to show how eco-friendly materials, smart technology, and community engagement can all work together to create a smart, sustainable future. To further develop on these findings, future research should include comparative studies of cities with different socioeconomic circumstances. In addition, emerging technologies such as AI-driven personalization, environmental sensors, and energy-harvesting materials present exciting possibilities for creating responsive and efficient public infrastructure. Their integration could enhance not only sustainability and user experience but also operational intelligence within urban systems.

AUTHOR CONTRIBUTIONS

Conceptualization, MAMA and AA; Methodology, MAMA and AA; Software, MAMA, AA and AMK; Validation, MAMA and AA; Formal Analysis, MAMA and AA; Investigation, MAMA and AA; Resources, MAMA, AA, KA-S RA and AMK; Data Curation, KA-S and RA; Writing—Original Draft Preparation, MAMA and AA; Writing—Review & Editing, AA and MAMA; Visualization, MAMA, AA and AMK; Supervision, MAMA and AA; Project Administration, MAMA and AA; Funding Acquisition, AA, RA, and KA-S.

FUNDING

This work was supported by the Deanship of Scientific Research, Vice Presidency for Graduate Studies and Scientific Research, King Faisal University, Saudi Arabia [Grant No.KFU252226].

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

APPENDIX A

Objective: Information gathering about Public Parks.

Description: The results of the sample's responses to this part of an opinion poll, which consists of 4 phrases about the current design of public parks in their residential area from the point of view of the sample.

Table A1. Public parks.

No	Public Parks	SD	D	N	A	SA
1.	Public parks play a vital role in enhancing direct contact with nature.					
2.	Visiting public parks and taking a walk in them improves people's abilities to recover and refocus.					
3.	Public parks meet the needs of individuals with disabilities.					
4.	The design of public parks in your area lacks sustainable design elements.					

APPENDIX B

Objective: Information gathering about Design and comfort.

Description: The results of the responses of the sample about this part of an opinion poll which consists of 5 phrases about the Design and comfort of modern public park furniture from the point of view of the respondents.

Table A2. Design and comfort.

No	Design and Comfort	SD	D	N	A	SA
1.	The importance of modern design in public.					
2.	The importance of achieving visual appeal in public park furniture.					
3.	The importance of creative and innovative design in public garden furniture.					
4.	The availability of public park spaces for gathering and social interaction.					
5.	The importance of shading systems in public parks.					

APPENDIX C

Objective: Information gathering about Sustainability and Materials.

Description: The results of the responses of the sample about this part of an opinion poll which consists of 6 phrases about the Sustainability and Materials of public parks and Furniture design from the point of view of the respondents.

Table A3. Sustainability and materials.

No	Sustainability and Materials	SD	D	N	A	SA
1.	Using sustainable materials through innovative, unconventional designs in furniture elements.					
2.	The use of sustainable materials in public park furniture ensures the durability and longevity of the furniture.					
3.	Sustainable design of public parks provides safe outdoor environments that enhance well-being, health, and productivity.					
4.	The community enhances the quality of life for residents through public parks.					
5.	Solar panels integrated into public park furniture to support sustainable design.					
6.	The negative effects of public parks affect human health.					

APPENDIX D

Objective: Information gathering about Design and technology integration.

Description: The results of the responses of the sample about this part of an opinion poll, which consists of 4 phrases about Design and technology integration in public parks design from the point of view of the respondents.

Table A4. Design and technology integration.

No	Design and Technology Integration	SD	D	N	A	SA
1.	The importance of having technological facilities such as Wi-Fi and interactive screens in public parks.					
2.	Provides technological services in the public parks you visit.					
3.	The importance of energy efficiency used in public parks.					
4.	Public parks meet the needs of family members of all age groups.					

APPENDIX E

Objective: Information gathering about Happiness and Well-being.

Description: The results of the responses of the sample about this part of an opinion poll which consists of 5 phrases about Public garden

furniture and its impact on achieving happiness, well-being, and psychological safety for visitors.

Table A5. Happiness and well-being.

No	Happiness and Well-Being	SD	D	N	A	SA
1.	The design of public park furniture affects your comfort, happiness, and psychological safety.					
2.	The current proposed design and furnishing of public parks reduce feelings of anxiety.					
3.	The colors used in designing public park furniture are derived from natural colors and help give a feeling of vitality and activity.					
4.	The proposed design of public park furniture helps improve relationships and enhance a sense of psychological comfort, happiness, and harmony.					
5.	Supports positive interaction between humans and nature and encourages a sense of responsibility towards society and nature.					

REFERENCES

1. Gupta N, Bhatti V. Importance of street furniture in urban landscape. Int J Latest Trends Eng Technol. 2015;5(3):174-9.
2. Amr AI, Kamel S, El Gohary G, Hamhaber J. Water as an ecological factor for a sustainable campus landscape. Procedia Soc Behav Sci. 2016;216:181-93.
3. Chapin FS III, Torn MS, Tateno M. Principles of ecosystem sustainability. Am Nat. 1996;148(6):1016-37.
4. Al Darwish L. Green Furniture: Sustainability, Consumer Choice, and Market Analysis in an Evolving Landscape. 2023. Available from: https://openresearch.ocadu.ca/id/eprint/4071/# accessed on 19 Dec 2024.
5. Kats G. Green Building Costs and Financial Benefits. Boston (US): Massachusetts Technology Collaborative; 2003. p. 2-8.
6. Abouelela AS, Al-Saud K, Mahmoud I, Moneim DAA, AlAli R, Ali MAM, et al. Towards a sustainable cultural identity for arabic calligraphy in furniture design through artificial intelligence applications. Sustainability. 2025;17(9):4047.
7. Samavati S, Desmet PM, Ranjbar E. Happy urban public spaces: A systematic review of the key factors affecting citizen happiness in public environments. Cities Health. 2024;9(1):112-28.
8. Ahmed Abdel Latif A. Artificial intelligence applications in sustainable furniture design. Arab Int J Digit Art Des. 2024;3:181.
9. Afifi. Artificial intelligence in sustainable furniture design: Challenges and opportunities. Int Arab J Digit Art Des. 2024;3:181-98.
10. Zahra N. Role of artificial intelligence technology in the development of furniture design process. Int Des J. 2023;13(6):503-20.
11. Itair M, Shahrour I, Hijazi I. The use of the smart technology for creating an inclusive urban public space. Smart Cities. 2023;6(5):2484-98.
12. Şatıroğlu E, Dinçer D, Korgavuş B. Urban furniture in the context of sustainable materials. Kent Akademisi. 2023;16(1):566-76.
13. Alegaonkar AA, Avachat-Shirke MA. Is artificial intelligence killing artistic skills in designers? In: Proceedings of the International Conference on Emerging Trends in Design & Arts. 2023. p. 109-15.

14. Anantrasirichai N, Bull D. Artificial intelligence in the creative industries: a review. Artif Intell Rev. 2022;55(1):589-656.
15. Long D, Jacob M, Magerko B. Designing co-creative AI for public spaces. In: Proceedings of the 2019 Conference on Creativity and Cognition. 2019. p. 271-84.
16. Kongphunphin C, Srivanit M. A multi-dimensional clustering applied to classify the typology of urban public parks in Bangkok Metropolitan Area, Thailand. Sustainability. 2021;13(20):11426.
17. Villalba G, Segarra M, Fernandez AI, Chimenos JM, Espiell F. A proposal for quantifying the recyclability of materials. Resour Conserv Recycl. 2002;37(1):39-53.
18. Richardson M. Design for reuse: Integrating upcycling into industrial design practice. In: International Conference on Remanufacturing. 2011. p. 1-13.
19. Harmsen EL. Inclusive, Accessible, Sustainable-Designing A Different Future. 2023. Available from: https://qspace.library.queensu.ca/server/api/core/bitstreams/513d6a8a-f533-4723-a7e3-b5c786c0c01b/content accessed on 25 Apr 2025.
20. Dotson S. Green furniture: An assessment of furniture society member work. J Green Build. 2015;10(3):47-66.
21. Gould C. Interactive Works for Urban Screens: A Practice-Based Study into Building New Ways of Engaging Communities in Urban Space Through Interactive Artworks for Urban Screens. [PhD Thesis]. Salford (UK): University of Salford; 2015.
22. Yasar D. Urban furniture in the framework of economic, social, and environmental sustainability. SAUC-Street Art Urban Creat. 2023;9(1):74-80.
23. Noroozi M, Khalili M. Design of smart urban lighting by using social sustainability approach. Int J Urban Civ Eng. 2018;12(4):462-71.
24. Özerol G, Arslan Selçuk S. Machine learning in the discipline of architecture: A review on the research trends between 2014 and 2020. Int J Archit Comput. 2023;21(1):23-41.
25. Elsayed EN, Ashrry AN. A proposed model for measuring the performance of smart public parks. Eng Res J. 2020;43(3):245-60.
26. Cohen DA, McKenzie TL, Sehgal A, Williamson S, Golinelli D, Lurie N, et al. Contribution of public parks to physical activity. Am J Public Health. 2007;97(3):509-14.
27. Larson LR, Jennings V, Cloutier SA. Public parks and wellbeing in urban areas of the United States. PLoS ONE. 2016;11(4):e0153211.
28. Zavadskas EK, Bausys R, Mazonaviciute I. Safety evaluation methodology of urban public parks by multi-criteria decision making. Landsc Urban Plan. 2019;189:372-81.
29. Alotaibi BS, Khalifa KRM, Abuhussain MA, Dodo YA, Alshenaifi M, Yahuza MS, et al. Integrating renewable-based solar energy into sustainable and resilient urban furniture coupled with a logical multi-comparison study of Cyprus and Saudi Arabia. Processes. 2023;11(10):2887.
30. Hussein NAHK, Basel OM. Integrating renewable energy systems into urban planning for sustainable cities. ESTIDAMAA. 2024;2024:15-21.

31. Eddine Khelfa I, Khelifa F. Overview on the role of intelligent urban furniture in improving the energy and environmental quality of public spaces. MAP Soc Sci. 2025;5:111-21.
32. Avila M, Toledo J, Córdova F, Icaza D, de los Angeles Tello M. Intelligent multifunctional solar urban furniture: A multidisciplinary methodological vision of technology. In: 2018 International Conference on Smart Grid (icSmartGrid). 2018. p. 184-94.
33. Nkengla-Asi L, Bernardini MDRC, Cohen MJ, Lawson-Lartego L, Coates K. Sustainable development goal 11: Make cities inclusive, safe, resilient, and sustainable. In: Handbook on Public Policy and Food Security. Cheltenham (UK): Edward Elgar Publishing; 2024. p. 268-80.
34. Jabareen Y. Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk. Cities. 2013;31:220-9.
35. Meria L, Hidayat S, Santiago ND, Saukani S, Khotimah SH. Blending work values, engagement, and satisfaction to drive OCB in technopreneurial startups. Aptisi Trans Technopreneursh. 2024;6(3):324-38.
36. Abouelela A. Biophilic design as an approach to integrating nature into the design of residential units to improve human mental health and well-being. Chem Bull J. 2023;12(1):1985-2006.
37. Avila M, Toledo J, Córdova F, Icaza D, de los Angeles Tello M. Intelligent multifunctional solar urban furniture: A multidisciplinary methodological vision of technology. In: 2018 International Conference on Smart Grid (icSmartGrid). 2018. p. 184-94.
38. Tweed C, Sutherland M. Built cultural heritage and sustainable urban development. Landsc Urban Plan. 2007;83(1):62-9.
39. Puchol-Salort P, O'Keeffe J, van Reeuwijk M, Mijic A. An urban planning sustainability framework: Systems approach to blue green urban design. Sustain Cities Soc. 2021;66:102677.
40. Park S. A preliminary study on connectivity and perceived values of community green spaces. Sustainability. 2017;9(5):692.
41. Lizee MH, Tatoni T, Deschamps-Cottin M. Nested patterns in urban butterfly species assemblages: Respective roles of plot management, park layout and landscape features. Urban Ecosyst. 2016;19:205-24.
42. Tweed C, Sutherland M. Built cultural heritage and sustainable urban development. Landsc Urban Plan. 2007;83(1):62-9.
43. Rodríguez-Parada L, De la Rosa S, Pardo-Vicente MÁ, Méndez-Salgueiro JR, Mayuet PF. Generation and characterization metrology of textures for design of urban furniture with recycled Material-A case of study for additive manufacturing. Key Eng Mater. 2023;958:139-47.
44. Wood L, Frank LD, Giles-Corti B. Sense of community and its relationship with walking and neighborhood design. Soc Sci Med. 2010;70(9):1381-90.
45. Montgomery C. Happy City: Transforming Our Lives through Urban Design. London (UK): Penguin; 2013.
46. Fernandez J, Song Y, Padua M, Liu P. A framework for urban parks: Using social media data to assess Bryant Park, New York. Landsc J. 2022;41(1):15-29.

47. Rodríguez-Parada L, De la Rosa S, Pardo-Vicente MÁ, Méndez-Salgueiro JR, Mayuet PF. Generation and characterization metrology of textures for design of urban furniture with recycled Material-A case of study for additive manufacturing. Key Eng Mater. 2023;958:139-47.
48. Falk RH. Wood as a sustainable building material. For Prod J. 2009;59(9):6-12.
49. Alves RR, Jacovine LAG, Pires VAV, Cyrillo FS, Albino AA. Forest certification and final consumer: A study in the furniture industrial park of Ubá, MG. Floresta Ambiente. 2023;16:40-8.
50. Bolong N, Saad I, Asman NSA, Choong WH, Roslan Z. Feasibility of recycled HDPE planks for sustainable furniture applications: A physio-mechanical study. MATEC Web Conf. 2024;397:03005.
51. Wang Y, Liu C, Zhang X, Zeng S. Research on sustainable furniture design based on waste textiles recycling. Sustainability. 2023;15(4):3601.
52. Jaramillo H, Gallardo R, Martinez C. Street furniture in recycled and resignified materials. J Phys Conf Ser. 2018;1126:012066.
53. El Shakhs A, Elessawy NA, El-Saka MF, Hassan GE, Ali MAM. Developing eco-friendly 3D-printing composite filament: utilizing palm midrib to reinforce high-density polyethylene matrix in design applications. Polymers. 2024;16(8):1135.
54. Elessawy NA, El Shakhs A, El-Saka MF, Youssef ME, Youssef BA, Ali MAM. Sustainable and eco-friendly 3D printing filament fabricated from different recycled solid wastes and evaluate its impact on interior and furniture design. Results Eng. 2024;23:102428.
55. Vengala J, Namratha KB, Anusha S. Precast bamboo reinforced furniture elements using self compacting concrete. IOP Conf Ser Mater Sci Eng. 2020;936:012010.
56. Iritani DR, Silva DL, Saavedra YMB, Grael PFF, Ometto AR. Sustainable strategies analysis through Life Cycle Assessment: A case study in a furniture industry. J Clean Prod. 2015;96:308-18.
57. IMPACT E. Introduction of a new line of high-density polyethylene (HDPE) based furniture. Int J Innov Manag Technol. 2023;14(1):7-12.
58. Ciupan E, Ciupan C, Câmpean EM, Stelea L, Policsek CE, Lungu F, et al. Opportunities of sustainable development of the industry of upholstered furniture in Romania. A case study. Sustainability. 2018;10(9):3356.
59. Yeo JQ, Wang Y, Tanary S, Cheng J, Lau M, Ng AB, et al. AICRID: AI-empowered CR for interior design. In: 2023 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct). 2023. p. 837-41.
60. Petráková L, Šimkovič V. Architectural alchemy: Leveraging artificial intelligence for inspired design-a comprehensive study of creativity, control, and collaboration. Archit Pap Fac Archit Des STU. 2023;28(4):3-14.
61. Tavsan F, Sonmez E. Biomimicry in furniture design. Procedia Soc Behav Sci. 2015;197:2285-92.
62. Phan VT, Choo SY. Interior design in augmented reality environment. Int J Comput Appl. 2010;5(5):16-21.

63. Huang L, Zheng P. Human-computer collaborative visual design creation assisted by artificial intelligence. ACM Trans Asian Low-Resour Lang Inf Process. 2023;22(9):1-21.
64. Tellios A, Koulali P, Valsamidou K. Designing tomorrow: AI and the future of architectural design process. Interdiscip J Archit Built Environ. 2023;(27):22-5.
65. Naseri S. AI in architecture and urban design and planning: Case studies on three AI applications. GSC Adv Res Rev 2024;21(2):565-77.
66. Thamrin D, Mulyono G. Usability evaluation of adaptable urban park furniture product with cellular light-weight concrete as material. IOP Conf Ser Mater Sci Eng. 2018;408:012033.
67. Jirouš-Rajković V, Miklečić J. Enhancing weathering resistance of wood—A review. Polymers. 2021;13(12):1980.

How to cite this article:
Ali MAM, Al-Saud K, AlAli R, Katat AM, Abouelela A. Towards greener futures: AI-powered designs for sustainable, accessible, and energy-smart urban furniture to improve happiness and well-being in public parks. J Sustain Res. 2025;7(2):e250040. https://doi.org/10.20900/jsr20250040.