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Original article

People's preferences and perceptions toward low-input versus conventional park design approaches using 3D images and interview-based questionnaires

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ABSTRACT

Future urban planning and public satisfaction will be significantly impacted by understanding people's preferences and perceptions of urban landscape design scenarios, particularly innovative sustainable development approaches. This study examined residents' preferences in Mashhad, Iran, for low-input park design versus conventional park design techniques. The research method integrated questionnaire-based interviews with 3D-simulated images of a site designed with the two approaches. Ninety-three respondents answered validated questions regarding their preference towards the planting and architecture of the parks, their perceptions about social sustainability, psychological feelings, and their perceptions of low-input and maintenance of the spaces. T-test analyses showed that people preferred the low-input park design more than the conventional design for the first four factors. However, the respondents needed to recognize significant differences between the two plans for the low-input and maintenance character of the parks. These results showed that people have positive views and perceptions toward sustainable design approaches like low-input park design. This approach can attract the public and meet their social, psychological, and aesthetic needs with appropriate planning and designs. However, people require education and awareness about the maintenance and sustainability aspects of landscape design approaches. Architecture and planting design visual preferences were suitable predictors for people's overall preference toward the low-input park design approach. The research outputs and the applied method provide insights into sustainable landscape planning in the urban environment.

1. Introduction

Urbanization, environmental pressures, and population growth have increased the importance of urban green spaces and has led to a shift in landscape design approaches towards sustainability (Forbes et al., 1997; Özgüner and Kendle, 2006; Nazemi et al., 2019; Kazemi et al., 2022).

One such sustainable landscape design approaches is xeriscaping proposed in Colorado, America, in 1982 (Sovocool et al., 2006). Due to concerns about urban water distribution and quality, public policy has shifted to xeriscaping (Martin and Stabler, 2001). Many metropolitan areas worldwide support this approach, which includes water-resistant and native plant species, improved irrigation techniques, and other methods to reduce long-term water use in urban environments (Rayno, 2016; Nazemi and Kazemi, 2021). Xeriscaping focuses on preserving the environment and water resources but lacks a framework to achieve social sustainability and satisfy people's aesthetic preferences. Research shows that meeting people's aesthetic preferences is still a challenge in this approach. The use of native plants in xeriscaping schemes to satisfy people's preferences remains a question, and people's awareness and care about landscape maintenance and water reduction should also be considered before implementing xeriscaping plans to avoid design failures (Hurd et al., 2006; Nazemi et al., 2019; Chen and Xu, 2016).

Some research has been conducted on people's preferences for existing xeric-designed landscapes in different parts of the world, including the U.S. (McCammon et al., 2009), Australia (Bitar, 2004), and Iran (Nazemi et al., 2019), which helps create more sustainable social xeric designs.

Some other methods of sustainable landscape design, including

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Water-sensitive urban design focus on environmental sustainability by integrating urban green spaces and runoff management systems. However, research on people's perceptions and preferences towards these approaches is lacking. While some studies have been conducted on public preferences towards blue-green infrastructure or water-sensitive housing, there is a research gap on people's attitudes towards water-sensitive landscape design (Gunawardena et al., 2020; Wong et al., 2020; Kazemi et al., 2009, 2011; Lamond and Everett, 2019; Wang and Roon, 2021; Iftekhar et al., 2022; Dobbie, 2013). Conducting such research requires the construction of the landscapes, which imposes the costs of implementing various design options before considering people's opinions and choosing the best options based on their opinions. After implementing the plans, for the plan to fully comply with people's preferences, in some cases, it may need full or partial reconstruction of the architecture or revegetation of the plan, which is costly and time consuming.

Kazemi et al. (2022) proposed the evolving concept of low-input landscape design based on the efficient use of inputs, natural resources, and labor force. Low-input landscape design is an approach that can accommodate many sustainable landscape design techniques and methods, including xeriscaping and water sensitive urban design, which help effectively use resources. This concept also pays attention to producing significant outputs in terms of the landscape's social, economic, and environmental aspects during the project's life cycle. Implementing this method with value engineering by Kazemi et al. (2022) resulted in a better-quality park plan and a 62.7% cost reduction over the 20-year life cycle of a demonstration designed and implemented park.

Each landscape design method must be evaluated by the public to be considered from a social sustainability point of view. These evaluations to address people's preferences, perceptions, and level of satisfaction with existing or future landscapes, have been carried out in numerous studies. For example, studies have been conducted on people's preferences for green landscapes (e g., Fernandez-Cañero et al., 2013; Allahyar and Kazemi, 2021). The primary purpose of many of these studies is to develop criteria for landscape management, planning, and monitoring (Muderrisoglu and Gültekin, 2013). In other studies, people's differences in preference concerning age (Howley, 2011; Howley et al., 2012; Muderrisoglu and Gültekin, 2013), level of education (Yu, 1995; Canas et al., 2009; Muderrisoglu and Gültekin, 2013), culture and geography (Herzog et al., 2000; Adevia and Grahna, 2012) and living environment (Van den Berg and Koole, 2006) have been investigated.

Groulx (2010) assessed the effect of computer visualization on public evaluations of future landscapes. He revealed that images calibrated by skilled preparers to precisely depict the actual landscape can be robust tools for planners investigating landscape aesthetic preferences. Allahyar and Kazemi (2021), in a study on the effect of green space factors on the preferences of sick children, concluded that photomontage images are suitable substitutes for real green spaces. Like Allahyar and Kazemi (2021), Liu and Schroth (2019) used computer-generated images to assess people's aesthetic preferences for urban park vegetation and aesthetic factors of coherence, complexity, and legibility. Computer-generated landscape images were also previously used by Yabiku et al. (2008) to evaluate the preferences of residents in Phoenix, Arizona, towards water-wise or xeric landscapes.

People's preferences and perceptions are usually assessed by questionnaires (Bulut and Yilmaz, 2009; Canas et al., 2009; Tveit, 2009; Sevenant and Antrop, 2009; Howley, 2011; Zheng et al., 2011; Yao et al., 2012; Ozkan, 2014). Also, most studies use two-dimensional photographs to depict the landscape scenes to the respondents (Fernandez-Cañero et al., 2013; Muderrisoglu and Gültekin, 2013; Häfner et al., 2017; Allahyar and Kazemi, 2021). However, two-dimensional photos, in some cases, hardly create an accurate perception in people (Chen and Xu, 2016; Chen et al., 2015). In the present study, people's preferences and perceptions of the low-input park design approach were compared with those of the typical conventional park design method. A questionnaire-based interview with 3D image demonstrations was used as the research method. The goal was to provide landscape professionals with knowledge-based planning ideas and assessment method for the future development of the low-input park design approach while keeping people's preferences and perceptions in mind.

The research questions were:

1. Can (and how) people differentiate park design approaches based on the visual characteristics of architecture and planting?
2. Can (and how) people differentiate the park design approaches based on some non-visual characteristics related to maintenance, social sustainability, and people's feelings and experiences?
3. Is the low-input design approach preferred over the common conventional design approach for future park development in the study area?
4. Can integrating questionnaire-based interviews with 3D images be used efficiently in assessing people's preferences and perceptions of future landscape planning scenarios?

Drawing from the research questions stated above, we propose the following hypotheses:

1. People can differentiate park design approaches based on the visual characteristics of architecture and planting.
2. People can differentiate park design approaches based on non-visual characteristics related to maintenance, social sustainability, and people's feelings and experiences.
3. The low-input design approach is preferred over the common conventional design approach for future park development in the study area.
4. Integrating questionnaire-based interviews with 3D images can efficiently assess people's preferences and perceptions of future landscape planning scenarios.

2. Methodology

This study used questionnaire-based interviews with 3D image demonstrations to assess people's preferences and perceptions towards two park design approaches. Images used in landscape assessments may depict present or visual models of future landscapes for planning and designing possibilities (Allahyar and Kazemi, 2021, Groulx, 2010).

2.1. *The study area, site, and the two park design approaches*

The present research was conducted in Mashhad, northeastern Iran (36.2972° N, 59.6067° E). Mashhad, with a population of over 3 million, comprises 13 council areas. The total area of the urban green space in the city, which includes parks, squares, filter islands, and green belts, is approximately 439,564,594 m2. This translates to approximately 26.14 m2 of green space per capita for the residents of Mashhad (Sarcheshmeh et al., 2020). Mashhad climate is arid to semi-arid with an average rainfall of less than 250 mm, mainly distributed from July to September (Kazemi et al., 2018, Kazemi and Hosseinpour, 2022, Hosseinpour et al., 2022).

The study site was a 0.8 ha block of land located northwest of Mashhad, in district 12, in the Elahieh suburb between Amirieh and Aghdasieh boulevards (Fig. 1).

This land was first designed based on the common or conventional park design approaches in Iran (Fig. 2.a). The conventional park design approach was mainly based on the gardenesque European style of garden design, in which aesthetic aspects of design are usually more important than sustainability aspects. The low-input park design prioritizes environmental sustainability more than the conventional park design. By using native plants, minimizing pesticide and toxic material use, using non-potable water, harvesting runoff, using permeable pavements, using pressurized irrigation systems, and water use efficiency techniques. The low-input park can reduce its ecological

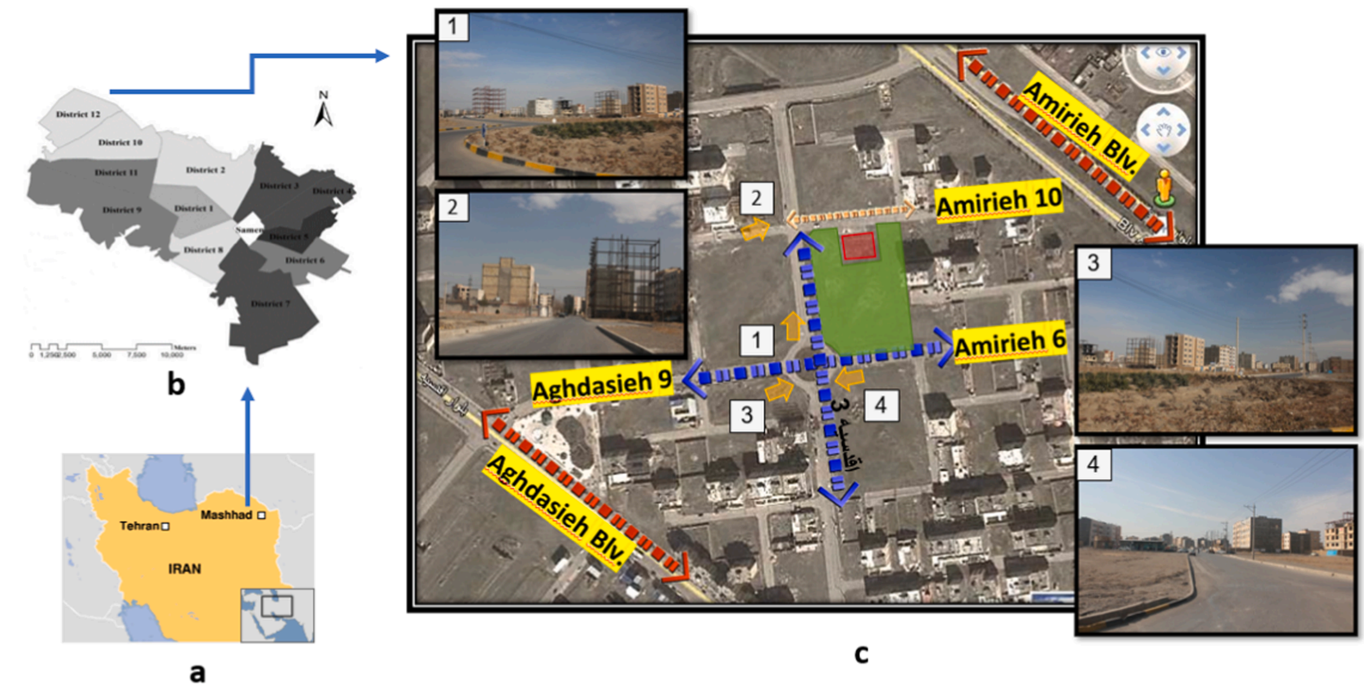


Fig. 1. Location of the studied site (c), in connection with district 12 of Mashhad Municipality (b), Mashhad City, and Iran (a), the site has been shown with the green block in section c in the figure.

footprint, conserve natural resources, and support biodiversity. In contrast, the conventional park design approach may rely more on non-native plants, chemicals, potable water, manual irrigation methods, and exotic turfgrass species, which can be more resource-intensive and negatively impact the local ecosystem. The low-input park design may have lower maintenance requirements than the conventional one, especially if it relies on self-sustaining native plant communities and natural water sources, mulches, and pressurized irrigation systems. The low-input park can also reduce the need for manual watering, weeding, and fertilizing.

In contrast, the conventional park design may require more intensive maintenance activities, such as mowing, pruning, and applying chemicals, to maintain a certain aesthetic or functionality. The cost of implementing and maintaining the low-input park design may vary depending on the availability of native plants, the type of irrigation system, and the extent of permeable pavements. However, in the long run, the low-input park may save costs on water, energy, and chemical inputs, as well as reduce the risk of environmental damage and health impacts associated with conventional park designs. The user experience of the two park design approaches may also differ depending on the factors such as the availability of shade, seating, playgrounds, and other amenities. While the low-input park may prioritize natural and ecological values, it may also limit some activities or features that users may expect from a park. Conversely, the conventional park design approach may offer more variety and control over the park's appearance and function but may also contribute to a less diverse and resilient ecosystem.

The first author established a relatively new concept for sustainable urban landscape design during several years of research on concepts such as xeriscaping and water-sensitive urban design and connected these worldwide concepts to the local climate and available resources in Iran. This relatively new concept, called low-input design, reduces landscaping inputs such as natural resources and labor in the landscape design and management stages and considers increasing tangible outputs of sustainability (Kazemi et al., 2022). The concept considers project management and multi-criteria decision-making methods such as value engineering to quantify the value of the ideas in the design stage to bring profit to the project during the life cycle of the landscape project (Kazemi et al., 2022).

As part of the research and professional collaborations of the first researcher with Mashhad municipality, the selected site was also designed based on a low-input design approach (Fig. 2.b). Research into the value engineering of the project confirmed that constructing the suggested low-input plan compared to the conventional base plan for this park could bring a 62.7% cost reduction over a 20-year life cycle of the project (Kazemi et al., 2022).

A re-design of the same site with the appropriate size provided a fair comparison of this study's two park design approaches. According to zgüner and Kendle (2006), it is critical in landscape and park design approach comparisons that the site size clearly shows the landscape design pattern and that both approaches are designed and compared on the same site.

2.2. 3D park design visualizations

The 0.8 ha block of land, selected as the study site, was designed based on the two landscape design approaches. The approaches were: 1. common or conventional urban park design approach, originally designed by Tahmine Sharg Company in Mashhad, 2. low-input park design approach, designed by the researchers after conducting a value engineering procedure as described in Kazemi et al. (2022). The two-dimensional AutoCAD of the park plans designed based on the two approaches is given in Fig. 2.

The architecture of the two selected park design approaches (conventional vs. low-input) was simulated using the Autodesk 3Ds Max 2021.3.2 software package. The bird-view 3d images of the plans were developed with great care for representativeness and accuracy (i.e., calibrated) as described by Groulex (2010) and were used as simulators in this study. Following evaluations with several industry experts, the images produced met industry standards. The low-input park design and its related base conventional design projects were funded by Mashhad municipality. Therefore, the design stage of the low-input park included several committee approvals of the landscape professionals from the industry, mainly in face-to-face meetings and discussion groups during

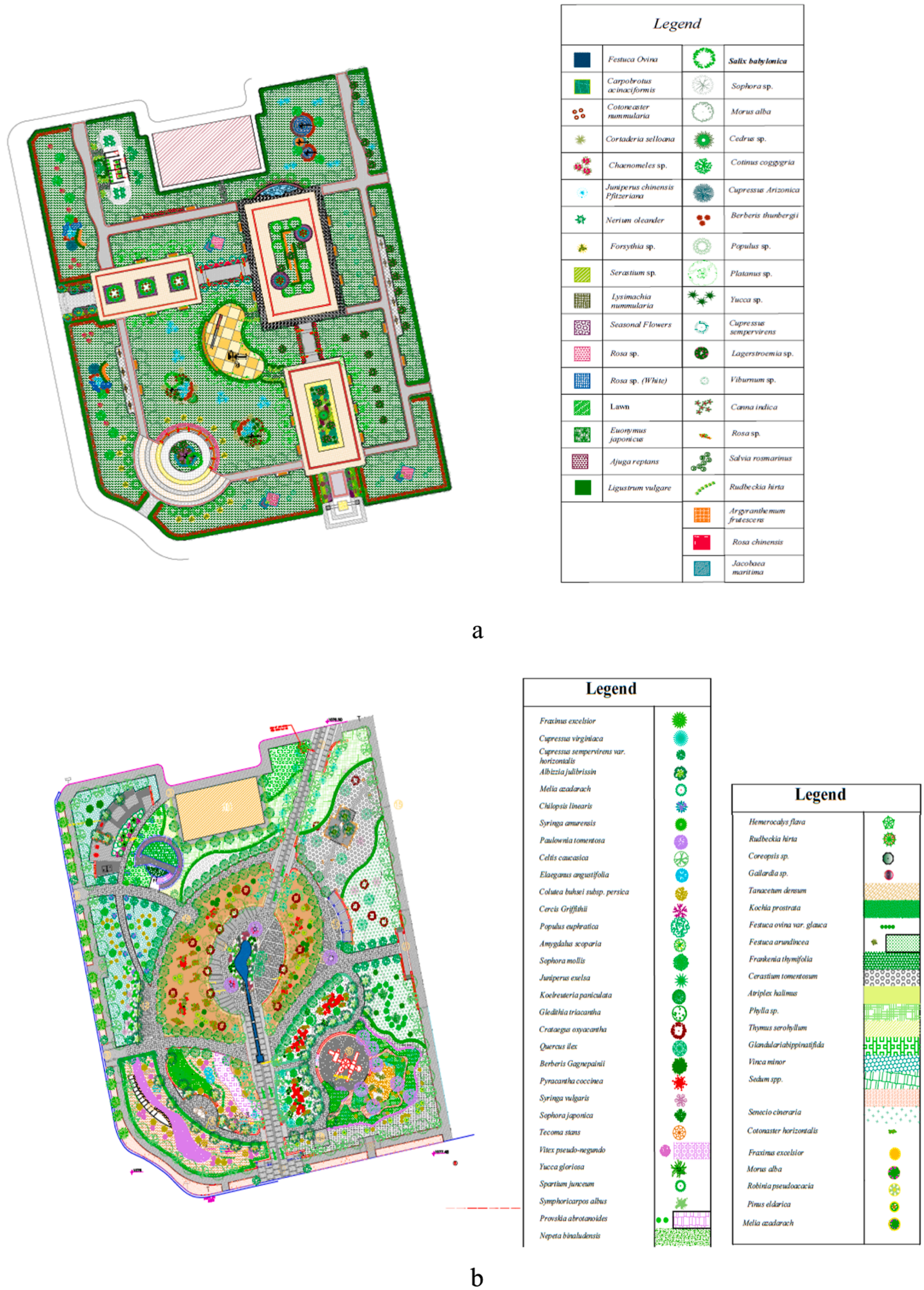
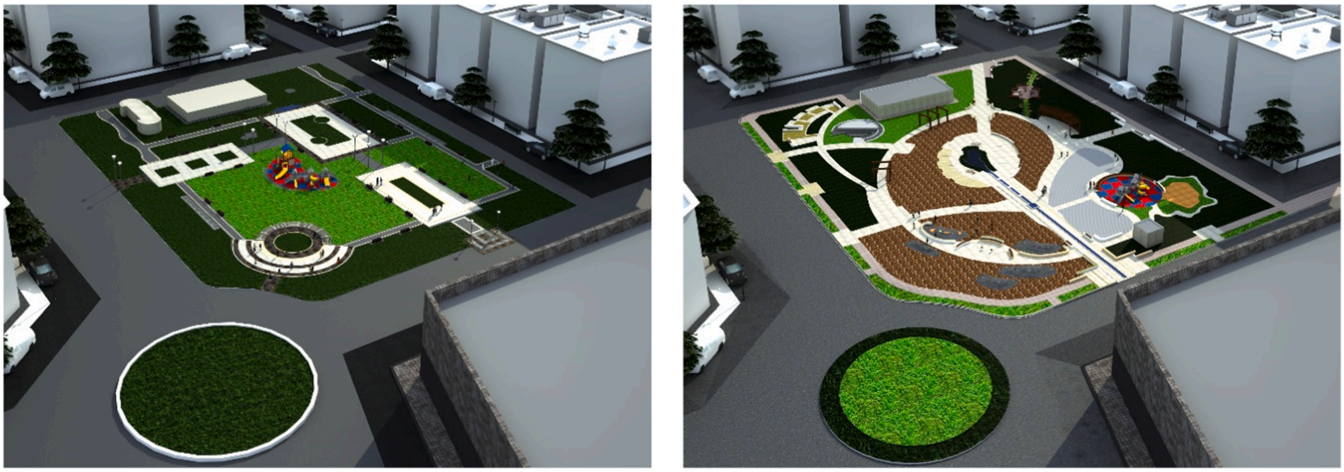


Fig. 2. AutoCAD plans of the urban park based on the two park design approaches, a. the conventional, b. the low-input park design approach.

the step-by-step design process. A group of over ten landscape industry experts approved the 2d and 3d images of the plans in terms of design professionalism and realistic visual view of the created virtual environments to meet their industry standards (Fig. 3).

The planting designs extracted from 3Ds Max 2021.3.2 did not meet the industry standards. Therefore, photoshop software package v.22 was applied to simulate calibrated 3D images of the planting of the study site based on the two park design approaches. The planting symbols were carefully added to 3D images of architectural designs, considering the representativeness and accuracy of the plants to their authentic images



a b

Fig. 3. a) architectural design of the study site based on a. conventional park design, and b. low-input approaches.

after getting expert advice. 3D images from different viewpoints were created and used in this study to give the respondents a better sense of the park landscapes (Fig. 4).

2.3. *Questionnaire design and semi-structured interviews*

In this study, the preferences, and perceptions of 93 respondents familiar with the environmental aspects were examined using simple random sampling and a questionnaire-based interview with 3D image demonstrations of the two park plans (conventional vs low-input). Based

Fig. 4. Planting design of the study site based on conventional park design approach (a, c), and low-input park design approach (b, d), from two viewpoints as examples.

on the suggestion and consultation with the landscape design committee of the parks and gardens organization, as the supporting industry partner for low input park plan, and social scientists and to receive the best representative sampling of respondents to be eligible for this study for the city of Mashhad, and to ensure our research included participants with basic knowledge of the environment, plants, and landscaping, the respondents were selected among the visitors of the only large flower and landscape exhibition center in Mashhad during its show events. It is necessary to note that the flower and landscape exhibition center of Mashhad is the only center in this city with the largest yearly exhibition shows for the public that receive significant public visits. Most city council representatives, landscape consultancies, and plant suppliers will exhibit their products and works and run workshops for people at these important events. Over 200,000 city residents attend the flower and plant exhibition center in Mashhad during its events each year.

Before conducting the survey, we asked the potential respondents a series of questions to confirm their eligibility further. These questions included whether they had worked in a field related to the environment, plants, or landscaping, had a garden or plant collection at home, volunteered for a conservation or environmental organization, participated in a community garden or similar project, read a book or article about sustainable gardening or landscaping, attended a plant or gardening expo or show, designed or helped design a garden or landscaping project, or given advice or recommendations to someone about plants or landscaping. The respondents had to answer "yes" to at least two of these questions to be eligible for our study. Also, the scope of this research covered respondents over 18 years of age.

The study received ethics approval (No.D.1–20.02.1390) from the relevant academics at the Department of social science at Mashhad University. The questionnaire was subjected to content validity by ten scholars and professionals in landscape-related organizations and one statistician. The validity of the questionnaire was also assessed using Principal component analyses (PCA). Principal component analyses (PCA) can evaluate a study's construct validity by identifying the study items' underlying structure (Dacakis et al., 2017). In this study, the five preference and perception variables (indices) were subjected to principal component analysis to conduct construct validity and identify the most efficient and reliable sub-components that explain each of the five factors. The reliability of the questionnaire was further tested using Cronbach's Alpha tests, and the study was considered reliable for the survey after obtaining Cronbach's Alpha$>$ 0.7.

This research allowed us to survey 93 eligible respondents due to the research constraints. Previous studies have used close to such sample size for urban landscape-related studies. For example, Özgüner and Kendle (2006) surveyed 100 residents in each park to compare Sheffield's naturalistic versus designed landscape. Todorova et al. (2004) also investigated the preferences of Sapporo, Japan, towards street flower and tree arrangements. Despite the efforts in selecting the best sampling place for the eligible respondents and taking care of the questionnaire's reliability and validity, the results should still be used with attention to the sample size, and future research should consider a larger sample size as the representative sampling for the entire population of adults in the city of Mashhad.

The park plan information, including their micro-spaces, types of architectural materials, plants, and irrigation systems, was explained in workshop sessions for the respondents/attendees in this research to make them fully familiar with the two park plans. However, respondents were not given information about the names and benefits, or drawbacks of the park design approaches, their aspects of sustainability, their maintenance or labor costs, or their natural resource consumptions.

The respondents were asked to respond to a researcher-designed questionnaire. Such a method has been used by previous researchers (e.g., Allahyar and Kazemi, 2021). The questionnaire was designed to measure people's preferences and perceptions about the low-input design approach compared with the common conventional park design approach using the pairwise comparison questions (Peng, 2019; Khosravi and Hemami, 2019). The respondents were shown calibrated 3D images of the architectural design (e.g., Fig. 3) and planting designs (e.g., Fig. 4) of the two park design approaches on a large digital screen and were given time to answer the questions related to the park design approaches.

People's preferences were asked regarding some visual and aesthetic aspects of the park designs (architecture and planting). Also, people's perceptions regarding some cognitive factors, such as park maintenance and inputs, social sustainability of the parks, and public feelings and psychological experiences in the two park design types, were evaluated using the questionnaire and semi-structured interviews. Image-based questionnaires have previously been used to obtain visual or cognitive factors in landscape studies (e.g., Liu and Schroth, 2019; Muderrisoglu and Gültekin, 2013).

The researchers guided the respondents during their response time. Whenever necessary, the interviewers helped to clarify the contents of the questionnaire, and then the respondents answered it independently. Using this method assisted in making sure the received responses were the results of the respondents' complete understanding of the preference/perception questions about the park design approaches. In some cases, it also gave the researchers the respondents' reasons for their choice of preference or perception.

Respondents determined the degree of their preference for different factors in the two design approaches using pairwise comparison questions with numbers from 0 to 8. The scale was 1–8, with a positive sign for park 1 (designed based on a low-input design approach) and the numbers -1 to -8 for park 2 (designed based on the common and conventional park design approach). The number 8 indicates the highest priority, and the number 1 indicates the lowest priority. Also, the number zero was assigned to cases where the respondents did not differentiate between the two types of parks regarding the questioned item.

The last part of the questionnaire included the respondents' demographic information (age, gender, level of education, job, frequency of visits, and use of green spaces) to create an overview of the statistical population.

As mentioned earlier, the validity of the questionnaire was first assessed using content validity and then evaluated using construct validity. Therefore, in this study, principal component analyses were performed on the five preference and perception factors (indices) to undertake construct validity and to find the most effective and valid sub-factors that explain each of the five factors. The internal reliability was also ascertained by calculating Cronbach's alpha. The indices were planting design (IE=4.28, Var=71.2), architectural design (IE=3.11, Var=77.7), low input and maintenance (IE=4.6, Var=57.5), social sustainability (IE=2.1, Var=51.5), and people's feelings (IE=3.3, Var=54.8) (Table 1). Cronbach's α was over 0.7 for the five preference and perception factors (indices) and their defined sub-factors (Table 1), confirming the indices' reliability and the questionnaire. Landis & Koch (1977) have previously confirmed that a variable is reliable for a study if its Cronbach's α is between 0.6 and 0.8.

2.4. Data analyses

The SPSS V.28 software package was used to analyze the data. Principle component analysis (PCA) was used to evaluate the construct validity of the questionnaire and its factors and to create valid, more prominent factors from the sub-factors. Reliability analyses were performed for all the factors and sub-factors, and when Cronbach's alpha $\geq$ 0.7, the factor or sub-factor was considered reliable in the study.

One-sample T-tests were used to compare the means of the respondents' preferences and perceptions of the five factors (indices) in the two park design approaches. Many studies have used T-tests to compare and examine popular preferences (e.g., Rahnema et al., 2019; Hami and Maruthaveeran, 2018; Xu et al., 2020). The demographic data were described using descriptive statistics. Pearson Correlation was also

Table 1
Principal Component Analysis for construct validity and Cronbach's alpha for the reliability of the five preference and perception factors (indices).

Components/Index	Initial Eigenvalues	Variance (%)	Factor Loadings of Items	Cronbach's α
Planting design	4.28	71.24	Color of trees and shrubs (0.85), the shape of trees and shrubs (0.83), variety of trees and shrubs (0.9), color of ground covers (0.85), the shape of ground covers (0.86), variety of ground covers (0.78)	0.92
Architectural design	3.11	77.7	Type of architectural materials (0.81), beauty of architectural materials (0.88), architectural layout of the spaces (0.9), beauty of lines in architectural design (0.94)	0.9
Low-input and maintenance	4.6	57.5	Low cost of grass (0.68), low cost of pruning trees (0.76), low labor costs (0.83), low need to change cultivation of seasonal flowering plants (0.77), low water consumption (0.77), low fertilizer and chemical pesticides (0.77), more use of native and drought resistant plants (0.69), use of local materials (0.78)	0.89
Social sustainability	2.06	51.54	Creating educational facilities for people in the park (0.76), easier gathering of people in the park (0.76), more diversity and attraction for the visitors (0.76), better remark for people (0.58)	0.7
People's feelings	3.29	54.81	Creating sense of being in nature (0.73), creating less sense of repetition (0.73), creating more sense of mobility and curiosity (0.7), creating more sense of relaxation (0.64), creating a secure environment (0.8), creating a safe environment (0.84)	0.83

used to measure the strength of the relationship between the variables. The tests' assumptions, such as the normality of the data and homogeneity of variances, were checked. The tests were conducted when the assumptions were met.

3. Results

3.1. Demographic characteristics

Based on the demographic data in Table 2, for gender, the table shows that 49.1% of the Mashhad population are women and 50.9% are men. Among the survey respondents, 60.22% were women, and 39.78% were men. The table shows that 31.5% of the Mashhad population are aged 18–35, 17.6% are aged 35–50%, and 15.4% are aged 50 and over. Among the survey respondents, 48.38% were aged 18–35, 38.7% were aged 35–50, and only 12.9% were aged 50 and over. For education, the table shows that 34.7% of the Mashhad population have a high school education, 27.5% have a college education, 20.5% have a bachelor's degree, and 5.7% have a postgraduate degree. Among the survey respondents, only 19.35% had a high school education, 5.37% had a college education, and the majority, including 47.31%, had a bachelor's degree, and 27.95% had a postgraduate degree. For job, Among the survey respondents, 20.43% had a job related to agriculture, and 79.57% had unrelated jobs to agriculture, while only 9.4% of Mashhad's population have been employed in agriculture-related jobs.

3.2. People's perceptions and preferences

In this study, the reliability of the questionnaire survey was tested using Cronbach's alpha, which showed 0.90. A one-sample T-test

Table 2
Demographic characteristics of the respondents.

	Groups	Percentage of Mashhad population[a]	Percentage of respondents
Gender	woman	49.1	60.22
	man	50.9	39.78
Age	18–35	31.5	48.38
	35–50	17.6	38.7
	50 and over	15.4	12.9
Education	High school	34.7	19.35
	College	27.5	5.37
	Bachelor's degree	20.5	47.31
	Postgraduate degree	5.7	27.95
Job	Related to agriculture	9.4	20.43
	Unrelated to agriculture	90.6	79.57

[a] Based on "Iranian Statistical Center. (2020). Statistical yearbook of Iran. Retrieved from https://www.amar.org.ir/english/Statistical-Yearbook-of-Iran"

analysis was used to assess respondents' preferences toward planting and architectural design and their perceptions of low-input and maintenance, social sustainability, and people's feelings about the two park design approaches. There were significant differences in people's preferences between the two park design approaches in terms of architectural design ($t = 8.95$, $p \leq 0.01$), planting design ($t = 7.24$, $p \leq 0.01$), and people's perceptions of social sustainability ($t = 3.62$, $p \leq 0.01$) and people's feelings ($t = 2.33$, $p \leq 0.05$). However, people's perceptions did not significantly differ regarding low-input and maintenance between the two park design approaches ($t = 0.03$, $p = 0.97$). Table 3 shows the one-sample t-test analyses of the factors and sub-factors in the two park design approaches.

Regarding the beauty of color, shape, and variety of trees and plants used in the two designs, 70.66% of respondents preferred a low-input park design approach, 17.66% preferred the original conventional park design approach, and 2.5% did not distinguish between the two design approaches. Regarding the study site's architectural layout, the architectural lines' beauty, and the materials used in the two designs, 79.66% of the respondents preferred the low-input park design, and 17.66% preferred the conventional park design approach. 2.5% of people did not differentiate between the two plans. Also, regarding reducing water consumption, pesticides and reducing labor costs, pruning, and rehabilitation, 39.6% of the park respondents chose the low-input park approach, 48.56% chose the initial conventional plan, and 11.83% of respondents did not differentiate between the two plans. Regarding social sustainability, 40.1% of the respondents preferred the low-input park approach, 44.1% preferred the original conventional design, and 15.6% had no preference. Regarding the people's feelings, 52.85% rated the low-input park, and 34.42% rated the original conventional park design approach as their preferred choice. Also, 12.74% of people needed to differentiate between the two plans.

The average scores given by the respondents show that people preferred four out of the five factors in favor of low-input park design. The low-input architectural design received the highest average score (3.97), followed by planting design (3.34), social sustainability (1.56), and people's feelings (1.03) (Fig. 5). The results, conversely, showed that, from the respondents' point of view, there was no difference in low-input and maintenance conditions, with an average score of (0.01). Most respondents needed more information about the two park design approaches' low input and maintenance differences.

3.3. Effect of demographic characteristics of the respondents on their preference and perceptions towards the low-input park design approach

Independent sample T-tests and ANOVA tests were undertaken to show the mean differences in preferences and perception ratings between groups of demographic data. The results showed no significant differences among the gender groups (men and women), age groups, and education groups in almost all the preference and perception factors when the demographic data of the people who preferred the low-input

Table 3
One sample t-test of the factors (indicators) in the two urban park design approaches.

Index	Items	Std. Deviation	Mean	t	d_f	p
Planting design	Color of trees and shrubs	5.561	3.12	5.35	90	0.00**
	Shape of trees and shrubs	5.185	3.45	6.37	91	0.00**
	Variety of trees and shrubs	4.92	4.02	7.84	91	0.00**
	Color of ground covers	5.62	2.91	4.92	89	0.00**
	Shape of ground covers	5.44	3.1	5.46	91	0.00**
	Variety of ground covers	5.06	3.78	6.98	86	0.00**
Architectural design	Type of architectural materials	4.74	3.76	7.23	82	0.00**
	Beauty of Architectural materials	4.64	4.13	8.58	92	0.00**
	Architectural layout of the spaces	5.073	3.76	7.16	92	0.00**
	Beauty of lines in architectural design	4.73	4.26	8.6	90	0.00**
Low-input and maintenance	Low water consumption	5.53	-0.08	-0.13	88	0.89
	Low fertilizer and chemical pesticides	5.31	-0.1	-0.18	87	0.86
	More use of native and drought resistant plants	5.71	0.88	1.41	83	0.16
	Use of local materials	5.20	0.71	1.21	76	0.23
	Low cost of grass	5.50	0.66	1.14	88	0.26
	Low cost of pruning trees	5.28	-0.23	-0.41	86	0.69
	Low labor costs	5.36	-1.2	-2.12	88	0.04*
	Low need to change cultivation of seasonal flowering plants	5.75	-0.66	-1.06	86	0.29
Social sustainability	Creating educational facilities for people in the park	5.69	0.82	1.36	88	0.18
	Easier gathering of people in the park	5.80	-0.6	-0.99	90	0.32
	More diversity and attraction for the visitors	5.93	1.93	3.09	89	0.00**
	Better remark for people	5.47	3.83	6.61	88	0.00**
People's feelings	Creating sense of being in nature	6.11	0.9	1.38	87	0.17
	Creating less sense of repetition	5.87	1.35	2.17	88	0.03*
	Creating more sense of mobility and curiosity	5.60	2.7	4.58	89	0.00**
	Creating more sense of relaxation	5.9	1.1	1.78	90	0.08
	Creating a secure environment	5.74	-0.15	-0.26	90	0.80
	Creating a safe environment	5.69	0.41	0.69	89	0.50

* *=p ≤ 0.01, * =p ≤ 0.05, the numbers without * * and * shows non-significant differences.

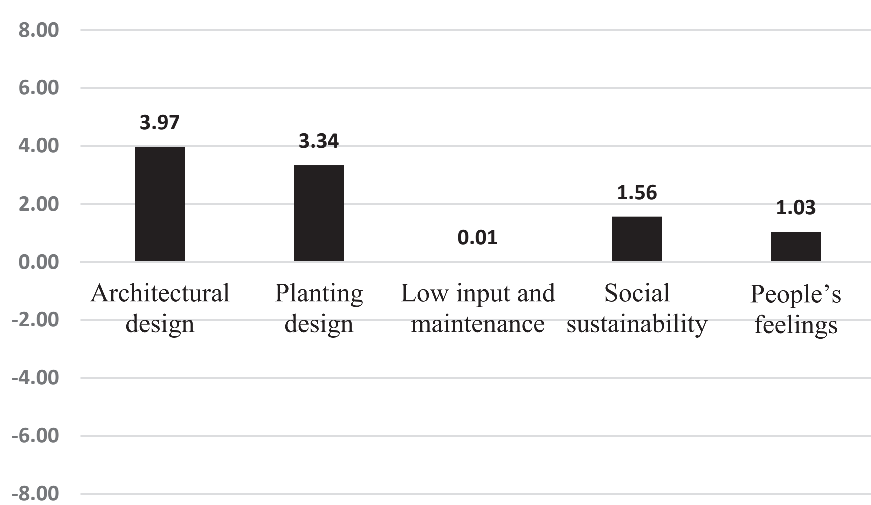


Fig. 5. Average scores of people's preferences and perceptions toward the two park design approaches (score ranges: −8 to +8, positive numbers show preference and perception toward low-input park design, and negative numbers show preference and perception toward conventional park design approach).

park design approach were investigated. There were, however, significant differences in preferences toward the planting design of the low-input park design approach between men and women (p = 0.004). Women (m=4.87, sd=3.04) preferred this planting design approach more than men (m=3.00, sd=2.87). Table 4.

3.4. Correlation between the demographic characteristics of the respondents and their perception and preferences toward low-input park design approach

Pearson correlations were performed between the demographic data and the preferences and perception factors of the respondents who preferred the low-input park design approach.

As seen in Table 5, the people's preference for the low-input park design approach had the strongest significant correlations with its architectural design (r = 0.54) and planting design (r = 0.51). There were also significant positive correlations between the overall preferences of respondents and social sustainability (r = 0.35) and people's feelings (r = 0.36) about the low-input park design approach. Further, there are significant positive correlations between respondents' preferences for the planting design of the low-input park design approach and people's feelings toward this design approach (r = 0.46) and its potential to fulfil social aspects of sustainability (r = 0.44). However, relatively lower negative correlations were found between the planting design perception of this park design approach with gender (r = - 0.3) and education (r = - 0.21). Correlations between the perception of low-input and maintenance characteristics of the low-input park design approach also had significant strong correlations with the perception of

Table 4
Descriptive statistics of the respondents' demographic characteristics regarding their preference and perception ratings of the low-input park design approach.

			n	Mean	Std. Deviation
Gender	Architectural design	woman	56	5.06	2.95
		man	37	4.13	2.67
	Planting design	woman	56	4.87	3.04
		man	37	3.00	2.87
	Low input and maintenance	woman	55	1.77	2.61
		man	37	1.38	2.17
	Social sustainability	woman	56	2.79	2.99
		man	37	2.30	2.49
	People's feelings	woman	56	2.36	3.06
		man	37	1.96	2.49
Age	Architectural design	18–35	45	4.18	2.86
		35–50	36	5.09	2.85
		50 and over	12	5.40	2.84
		Total	93	4.69	2.87
	Planting design	18–35	45	3.77	3.16
		35–50	36	4.34	3.02
		50 and over	12	4.80	3.20
		Total	93	4.12	3.10
	Low input and maintenance	18–35	44	1.59	2.50
		35–50	36	1.93	2.55
		50 and over	12	0.73	1.70
		Total	92	1.61	2.44
	Social sustainability	18–35	45	2.34	2.58
		35–50	36	3.05	3.12
		50 and over	12	2.21	2.60
		Total	93	2.60	2.80
	People's feelings	18–35	45	2.15	2.76
		35–50	36	2.35	3.05
		50 and over	12	1.97	2.67
		Total	93	2.20	2.84
Education	Architectural design	High school	18	5.88	2.63
		College	5	5.10	2.95
		University	44	4.42	3.07
		Postgraduate Education	26	4.23	2.56
		Total	93	4.69	2.87
	Planting design	High school	18	5.16	3.32
		College	5	3.63	3.46
		University	44	4.37	2.94
		Postgraduate Education	26	3.08	3.00
		Total	93	4.12	3.10
	Low input and maintenance	High school	18	1.34	2.35
		College	5	3.32	3.07
		University	43	1.41	2.26
		Postgraduate Education	26	1.82	2.65
		Total	92	1.61	2.44
	Social sustainability	High school	18	2.47	3.07
		College	5	3.17	2.65
		University	44	2.52	2.81
		Postgraduate Education	26	2.71	2.75
		Total	93	2.60	2.80
	People's feelings	High school	18	1.59	2.49
		College	5	2.87	3.85
		University	44	2.41	3.08
		Postgraduate Education	26	2.14	2.50
		Total	93	2.20	2.84

social sustainability ($r = 0.50$) and people's positive feelings and senses ($r = 0.52$) in this park type from the perspective of the respondents. The two cognitive factors of social sustainability and people's feelings toward the low-input park design approach had strong positive significant correlations ($r = 0.61$). The level of education among the respondents had a relatively low significant correlation with architectural design ($r = -0.21$) and planting design ($r = -0.21$) of the low-input park design approach. Also, there were strong positive correlations between gender and education ($r = 0.46$) which is out of the scope of this landscape-related study.

4. Discussion

Examining people's perceptions and attitudes about urban landscapes is one of the research topics of interest and importance in recent years (Rahnema et al., 2019). A successful design is always one that is active and provides an environment to increase people's satisfaction (Montgomery, 2013). Therefore, landscape planners are developing practical and feasible tools to achieve people's preferences and perceptions of future landscapes (Groulex, 2010; Anderson et al., 2018).

This study combined semi-structured interviews and questionnaire surveys of 3D simulated landscape plans to understand people's preferences and perceptions of the two park design approaches. During their evaluation, the respondents had no problem understanding the questions on the visual aspect of architecture and planting design, as well as the cognitive questions regarding the social sustainability and environmental psychology of the two park design approaches. Further, they could distinguish and differentiate the two park design approaches based on the mentioned factors. This finding indicates that the integrated method used in this research has given the respondents a sufficient and appropriate understanding of the factors studied in the parks using the simulated 3D images of the spaces. Therefore, the method can be used as a helpful, practical, and cost-effective planning tool to evaluate visual and cognitive factors in future landscapes. This finding confirms the findings of Groulex (2010) in that calibrated 3D images of future landscapes, if developed with great care for representativeness and accuracy, can be reliable and cost-efficient tools for landscape planning and public involvement. Such landscape planning tools are necessary to avoid failures when new design approaches evolve. Sevenant and Antrop (2009) pointed out the need for empirical studies to examine landscape preferences for different landscape types and their indicators.

This study used the Principal Component Analysis (PCA) technique to find the most valid and influential factors and sub-factors affecting people's preferences and perceptions toward the common versus the low-input park design approaches. This technique assisted in better organizing and interpreting people's opinions in the park design approach. While no research was found to use PCA for public landscape preference studies, previous research has used such techniques in biodiversity (Kazemi et al., 2009) and landscape plant suitability studies (Yang and Wang, 2021).

The respondents preferred the low-input over the common park design approach regarding planting design, architectural design, social sustainability characteristics, and the positive feelings they perceive in this park design type.

The use of common ornamental plants and grasses is usually limited in low-input park design approach, which is based on water-conserving and xeriscaping principles. Previous research has shown that people perceive xeriscapes and many other water-conserving landscapes as landscapes with low color diversity and limited attractiveness (Spinti et al., 2004; Hilaire et al., 2010; Nazemi et al., 2019). Despite this previous research, an attempt was made in this research to design the planting of the low-input park considering the diversity of colors, shapes, and flowering plants. Therefore, it was observed that 70.66% of the respondents in the current research preferred the low-input park covered with native and drought-tolerant plants with various colors, shapes, vegetation density, and long flowering periods. These characteristics were less observed in the planting design of the typical conventional park design in this study, which was mainly based on gardenesque style and covered with a limited variety of green trees and monotonous lawns. Like the results of the present study, Nazemi et al. (2019) found that almost half of their respondents find desert or water-resistant plants attractive. Also, Hilaire et al. (2010) reported that 82% of their respondents believed desert plants could create their favorite green space. This finding differed from the results of Spinti et al.

Table 5
Correlations between demographic variables and average preference and perception scores of the low-input park design approach.

	Architectural design	Planting design	Low input and maintenance	Social sustainability	People's feeling	Gender	Age	Education	Overall Preference
Architectural design	1	0.66**	0.23*	0.45 * *	0.35 * *	-0.16	0.17	-0.21 *	0.54 * *
Planting design		1	0.14	0.44 * *	0.46 * *	-0.3 * *	0.12	-0.21 *	0.51 * *
Low-input and maintenance			1	0.50 * *	0.52 * *	-0.08	-0.06	0.03	0.14
Social sustainability				1	0.61 * *	-0.09	0.04	0.02	0.35 * *
People's feelings					1	-0.07	-0.002	0.06	0.36 * *
Gender						1	0.07	0.46 * *	-0.14
Age							1	-0.08	0.04
Education								1	-0.19
Overall Preference									1

* *, * shows significant correlation at the 0.01 and 0.05 levels.

(2004), who reported that 39% of their respondents were not interested in desert plants because of their grey color. They explained that grey reflects more heat than light green, so the importance of color in popular preferences can be emphasized. The high public preference for the low-input park plan might also be due to its larger plant variety and density compared to that of the conventional park plan. Yao et al. (2012) also found similar results in their study on residential landscapes, in that vegetation density and composition positively affect people's visual landscape preferences.

Flowers are one of the significant planting design features that bring color to the landscape. Nazemi et al. (2019) found that the public preferred xeriscape schemes solely covered with herbaceous flowering plants. Others have made connections between observing flowers and people's feelings and emotional reactions. Haviland-Jones et al. (2005) showed that flowers have a long-term effect on a person's emotional reactions, memory, and social behaviors. Rahnema et al. (2019) also reported that observing flowering plants created a sense of belonging and calm in the respondents. Eder and Öz (2017) found that color is one of the most important aspects of life and impacts people's social life. Color in the human environment affects the mind, soul, and body. For example, light green, light blue, and light grey effectively create a feeling of comfort. Pure white, green, blue, and yellow can create a sense of vitality. And the colors black, dark gray, brown, red, and dark warm can cause fear and sadness in patients (Burton et al., 2015). The relationship between the feelings and perceptions with the visual characteristics found by Eder and Öz (2017) and Burton et al. (2015) confirms our finding that the variety of colors might be a reason for positive feelings people have reported towards the low-input park design approach in their survey.

The architectural design of the parks, like their planting design, can significantly impact attracting visitors. Lines are powerful landscape design elements that connect people to the landscape (Whiting and Jong, 2014) and can create various shapes and forms and control the movement of the eyes and body (Hansen, 2010). Instead of using small zigzags and straight lines, some sources recommend using curve lines (Whiting and Jong, 2014). Research has shown that people prefer curved forms over straight shapes in architecture (Banaei et al., 2017). In this study, 79.66% of people tended towards low-input park design due to its architecture and use of curved lines and various materials. The typical conventional park plan's architectural design was mainly based on straight lines with little visual appeal. Hansen (2010), like the present study, emphasized that the characteristics of lines in the hardscape design of green space determine the emotional and physical responses of individuals. He concluded that curved lines create an informal, natural, calm personality that is more related to nature and asymmetrical balance. Curved lines move the eye slower and add mystery to the space by creating hidden views (Hansen, 2010). Updike (2020) found that some features of the hardscape in outdoor design, such as pattern, size, color, edge, and space frame, affect people's perception of space and cause a sense of security, safety, comfort, interest, and attractiveness. Toscano and Holmes (1990) also emphasized that lines are an essential aspect of nature design and that curved lines create a sense of nature. Our finding confirms the findings of Updike (2020) and Toscano and Holmes (1990) in that there are meaningful relationships between the architectural features of a site and people's feelings and positive senses toward that landscape.

The role of parks in improving social communication has also been proven. In terms of social sustainability also, almost half of the respondents chose the low-input park design plan. According to Miao (2013), the lack of social sustainability and poor perceptions in some countries may be due to the lack of integration of public participation in urban planning. Peter et al. (2010) also expressed that different design approaches in parks led to different uses and expressed the relationships between the readability of architectural design and social interaction in the parks. Like Peter et al. (2010), our findings showed positive relationships between the social sustainability of the parks and their architectural and planting design features. This finding is in line with the findings of the previous researchers in that "the greater the visual beauty of a park, the greater the social connections and people's perceptions and feelings toward the park would be" (Moulay et al., 2017; Montgomery, 2013).

In the current study, people did not perceive differences in the low-input and maintenance characteristics of the two park design approaches. This finding might be promising in the planning stage for this relatively new park design approach because people still require familiarity and information on this sustainable park design approach. Our interview results in this study showed that people's knowledge of the low-input park design concept was relatively low. Our observations and interviews about low-input park design showed people sometimes mistakenly interpreted the low-input landscape design concept as equivalent to the municipalities' low use of resources in park design, no matter how much the outputs, such as aesthetics, amenities, and social performances, could be achieved. Such a wrong interpretation made them unwilling and resistant to accepting the development and implementation of this sustainable concept. The respondents were not given any information about the type and title of the park designs they evaluated during the interviews. Therefore, their evaluations were only the result of people's visual and perceptual preferences for simulated spaces. This approach eliminated possible mistakes such as misunderstanding the concept of "low-input," as explained above. However, such results can also confirm people's little knowledge of the significance of sustainable landscape inputs such as native plants, water, labor, pressurized irrigation systems, and mulches in urban landscaping, which require public awareness, research, and education programs (Kendle and Rose, 2000; Knapp and Huang, 2017).

This study showed that calibrated 3D images and an interview-based questionnaire could provide sufficient and cost-effective tools for people's preference and perception studies, especially for relatively new landscape design methods like the low-input park design approach. Therefore, landscape planners of the city of Mashhad can use the integrated method of semi-structured interviews and questionnaire surveys of 3D simulated landscape plans to evaluate visual and cognitive factors in future landscapes and consider native and drought-tolerant plants with various colors, shapes, vegetation density, and long flowering periods in low-input park design to increase people's satisfaction with the urban landscapes. However, future implementation of this design concept and getting people's preferences and perceptions in the constructed plans may further enhance professional knowledge on future planning of this sustainable landscape design approach.

5. Conclusion

This study showed that if the architecture and planting of the low-input park plans are designed with care and scientific knowledge, it can result in people's strong preferences toward the visual and cognitive factors in the designed space and overall public satisfaction with this sustainable park design approach.

This research provided research-based evidence and practical and cost methods to support future sustainable urban park design strategies and approaches considering people's preferences and perceptions in mind. The integrated method used in the study was effective in giving the respondents a sufficient and appropriate understanding of the factors studied in the parks using simulated 3D images of the spaces. The method can be used as a helpful, practical, and cost-effective planning tool to evaluate visual and cognitive factors in the design stage of future landscapes. The study confirms the findings of previous research that calibrated 3D images of future landscapes, if developed with great care for representativeness and accuracy, can be reliable and cost-efficient tools for landscape planning and public involvement. For more accuracy in such studies, it is recommended that this research be repeated after the implementation of the project.

This research has several strengths, including its focus on people's preferences for new urban design concepts like xeriscape and water-sensitive landscape design, which are both included in the low input park plan. The results of this study could prove valuable in making informed decisions in other areas as well. However, one notable weakness of this research is the relatively small sample size. Due to limited funding, the research team was unable to hold longer workshops to familiarize more people with the park concept. Consequently, the researchers had to use inclusion criteria such as relative awareness to select respondents, which may have led to some bias in the results. To address this limitation, future studies could involve a larger, more diverse sample. Additionally, it would be beneficial to obtain feedback from park visitors after the implementation of the project to assess their actual preferences. Since the project has not yet been fully implemented, further research is needed to complete this aspect of the study.

Ethical approval

The study received ethics approval (No.D.1-20.02.1390) from the relevant academics at the Department of social science at Mashhad University.

Author contribution

F. Kazemi and M. Ebrahimian have contributed to research design, defining the methods, and collecting the data. M. Kazemi and N. Hosseinpour have analyzed and interpreted the data and wrote the manuscript. M. Kazemi has received the industry funding.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

SPSS data and output (Original data)

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Consent to participate

All the authors agreed with the content and that all gave explicit consent to submit the work.

Consent to publish

We give consent to the publisher to publish this work.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2023.128040.

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