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Assessment of an Effective Quantitative Model for Aesthetic Factors in Planting Design Using a Multi-Criteria Decision-Making Method

Çok Kriterli Karar Verme Yöntemi Kullanılarak Bitkisel Tasarımda Estetik Faktörlere Yönelik Etkili Bir Nicel Modelin Değerlendirilmesi

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Abstract
Plants are living materials that are widely used in the discipline of landscape architecture and help the perception of spaces. This study aims to enhance spatial perception in open green spaces by considering aesthetic elements such as color, form, texture, and size in planting design. The study is conducted at Bursa Technical University (BTU) Mimar Sinan Campus. The main criteria such as color, form, texture, and size, which are considered aesthetically important, and the sub-criteria belonging to these criteria, are classified within the scope of the study. The classified criteria groups are evaluated and ranked using the Analytical Hierarchy Process (AHP), a Multi-Criteria Decision-Making (MCDM) method. Results indicate that size is the most critical factor in planting design, with fine-textured materials ranking highest among sub-criteria. The findings offer guidance for creating open green spaces that support educational and recreational activities while adopting a participatory management approach to planting design.

Öz
Bitkiler, peyzaj mimarlığı disiplininde yaygın olarak kullanılan ve mekân algısının oluşumuna katkı sağlayan canlı materyallerdir. Bu çalışma, açık yeşil alanlarda bitkisel tasarımda renk, form, doku ve ölçü gibi estetik öğeleri dikkate alarak mekânsal algının güçlendirilmesini amaçlamaktadır. Araştırma, Bursa Teknik Üniversitesi (BTÜ) Mimar Sinan Yerleşkesi'nde gerçekleştirilmiştir. Çalışma kapsamında estetik açıdan önemli kabul edilen temel ölçütler (renk, form, doku ve ölçü) ile bu ölçütlere bağlı alt ölçütler sınıflandırılmıştır. Oluşturulan ölçüt grupları, Çok Kriterli Karar Verme (ÇKKV) yöntemlerinden biri olan Analitik Hiyerarşi Süreci (AHP) kullanılarak değerlendirilmiş ve önceliklendirilmiştir. Elde edilen bulgular, bitkisel tasarımda ölçü kriterinin en önemli ana kriter olduğunu; alt kriterler arasında ise ince dokulu bitkisel materyallerin en yüksek öncelik değerine sahip olduğunu ortaya koymaktadır. Sonuçlar, eğitim ve rekreasyonel etkinlikleri destekleyen açık yeşil alanların oluşturulmasında ve bitkisel tasarım süreçlerinde katılımcı bir yönetim anlayışının benimsenmesinde yol gösterici niteliktedir.

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INTRODUCTION

Plants, with their aesthetic, ecological, socio-cultural, psychological, hygienic, and functional benefits, are essential living materials that enhance the liveability of urban spaces (Tandoğan & Şişman, 2018). In the discipline of landscape architecture, they are especially used in planting design projects for both aesthetic and functional purposes (Sarı & Karaşah, 2018). Functionally, plants serve various roles, such as visual control, movement control, climate regulation, noise reduction, pollution management, erosion prevention, and improving environmental quality (Pouya, 2019). Aesthetically, plants soften the rigid and sharp lines of surrounding structures, creating contrasting forms and textures that offer unique spatial perceptions. Additionally, their attributes—such as form, size, texture, color, and line—contribute both physical and aesthetic value to urban spaces (Tandoğan & Şişman, 2018).

In landscape design, one of the key elements used to connect people with nature is the dynamic change of seasonal colors (Paraskevopoulou et al., 2018). Color is a vital component of visual perception and evaluation, with approximately 80% of human visual perception derived from color. Thus, vegetation color is an important factor for assessing and measuring the aesthetic value of a landscape (Ma et al., 2020). The use of color can stimulate the senses, heighten awareness of the physical environment, draw attention, and enhance a sense of time through seasonal change (Paraskevopoulou et al. 2018). Plant color plays a significant role in improving the quality of visual landscapes, shaping the emotional perception of landscapes, and emphasizing the characteristics of urban environments (Shen et al., 2022). Colors in landscapes have various effects, such as shaping spatial perception and influencing the sense of warmth or openness. For instance, warm tones like red, yellow, and orange evoke feelings of warmth, energy, and vibrancy, while cool tones like blue, green, and purple create a sense of calmness and a more formal atmosphere. In summer, the use of cool colors in landscape design can evoke feelings of freshness and spatial contraction. Moreover, cool-colored spaces often appear smaller than warm-colored spaces to the human eye (Gao et al., 2020).

Except for color, another key aesthetic parameter in planting design is form. Form is defined as the three-dimensional shape of a plant, or in other words, its external outline or silhouette. It is a design principle that maintains continuity and is perceptible in all seasons. Plant forms can vary greatly, including pyramidal, inverted pyramidal, round, oval, columnar, spreading, weeping, creeping, and irregular shapes (Kösa & Atik, 2013). According to Eroğlu et al. (2005), the visual effects of plant forms on humans are similar to the effects of form in other art disciplines. For instance, columnar plants convey a sense of dynamism, while plants with horizontal branching or weeping branches create a calming and relaxing effect. In a study on the visual evaluation of plant forms, irregular forms are found to have the lowest visual value, while columnar forms elicited the strongest perception. Columnar shapes are described by participants as beautiful, relaxing, and strong (Eroğlu et al., 2005).

The texture of a plant is determined by the density, brightness, or dullness of its branches and leaves. These characteristics classify plants as fine, medium, or coarse-textured. Trees, shrubs, and groundcovers exhibit different textural qualities. The texture of plants can also have psychological effects on people (Eroğlu et al., 2005). Trees with large, unbroken leaves or thick branches are classified as "coarse-textured," whereas those with small or feathery leaves and slender branches are considered "fine-textured." Fine-textured trees appear larger and more distant, while coarse-textured trees seem smaller and closer to the viewer's perspective (Serpa & Muhar, 1996).

Another crucial parameter in the selection of plants for landscaping is their size, which directly influences the scale of the space and forms the framework of the design (Alp et al., 2010). Size refers to the vertical and horizontal volume effect created by plants. Plants vary greatly in size and are dynamic landscape elements that change continuously over time (Kösa & Aksöğüt, 2020). According to Eroğlu et al. (2005), plants should harmonize both with each other and individually,

which is essential for the perception of a composition. In arrangements near structures, plants should neither compete with the building's size nor appear too small in comparison. Filling an area with large trees can make the space seem smaller, while smaller plants can create the impression of a larger area (Serpa & Muhar, 1996). Behe et al. (2005) classified plants into three size categories: small, medium, and large. Small plants typically include groundcovers and herbaceous species, medium-sized plants are often shrubs, and large-scale plants encompass broad-leaved and coniferous species.

All of these parameters, which are aesthetically evaluated in planting design, have different effects on the design of open green spaces. These effects vary depending on how users behaviourally perceive the space. However, the influence of each parameter and its effect on the identity value of open green spaces is typically studied through a single parameter. This study aims to enhance spatial perception in open green spaces by considering aesthetic elements of planting design such as color, form, texture, and size. BTU Mimar Sinan Campus is selected as the study area. In this context, the widely used Analytical Hierarchy Process (AHP), a Multi-Criteria Decision-Making (MCDM) method, are employed to assess the aesthetic factors in planting design. This evaluation is unique in that it provides an aesthetic assessment of open green spaces, adopts a participatory approach, and uses quantitative data through the AHP method. In this context, aesthetic factors from the literature on planting design are researched, and the main criteria, such as color, form, texture, and size, along with their sub-criteria, are objectively ranked according to their importance, based on feedback from stakeholders and experts. The AHP method, known for its accuracy, is used to rank these criteria. While aesthetic factors in planting design have been examined in previous studies, this study contributes to the literature by evaluating four main aesthetic criteria—color, form, texture, and size—affecting spatial perception in open green spaces through a participatory AHP approach.

MATERIAL AND METHOD

Study Area

The study area is located in the Mimar Sinan District of Yıldırım district of Bursa. The campus is built on an area of approximately 102,639 m^2. The campus includes the Faculty of Engineering and Natural Sciences, Faculty of Forestry, Faculty of Maritime Studies, Central Classrooms, Library, Central Research Laboratories, the Rectorate, and other administrative units. In addition, the construction of the Faculty of Architecture within the campus started in November 2024. There is Ankara Yolu Street in the north of the area, Safety Street in the west, and Eflak Street in the south. To the south of the area is Bursa Yüksek İhtisas Hospital, to the west, is the Disaster and Emergency Management Authority, to the north, is the Bursa Provincial Population and Citizenship Directorate, and to the east is a bus parking car (Figure 1).

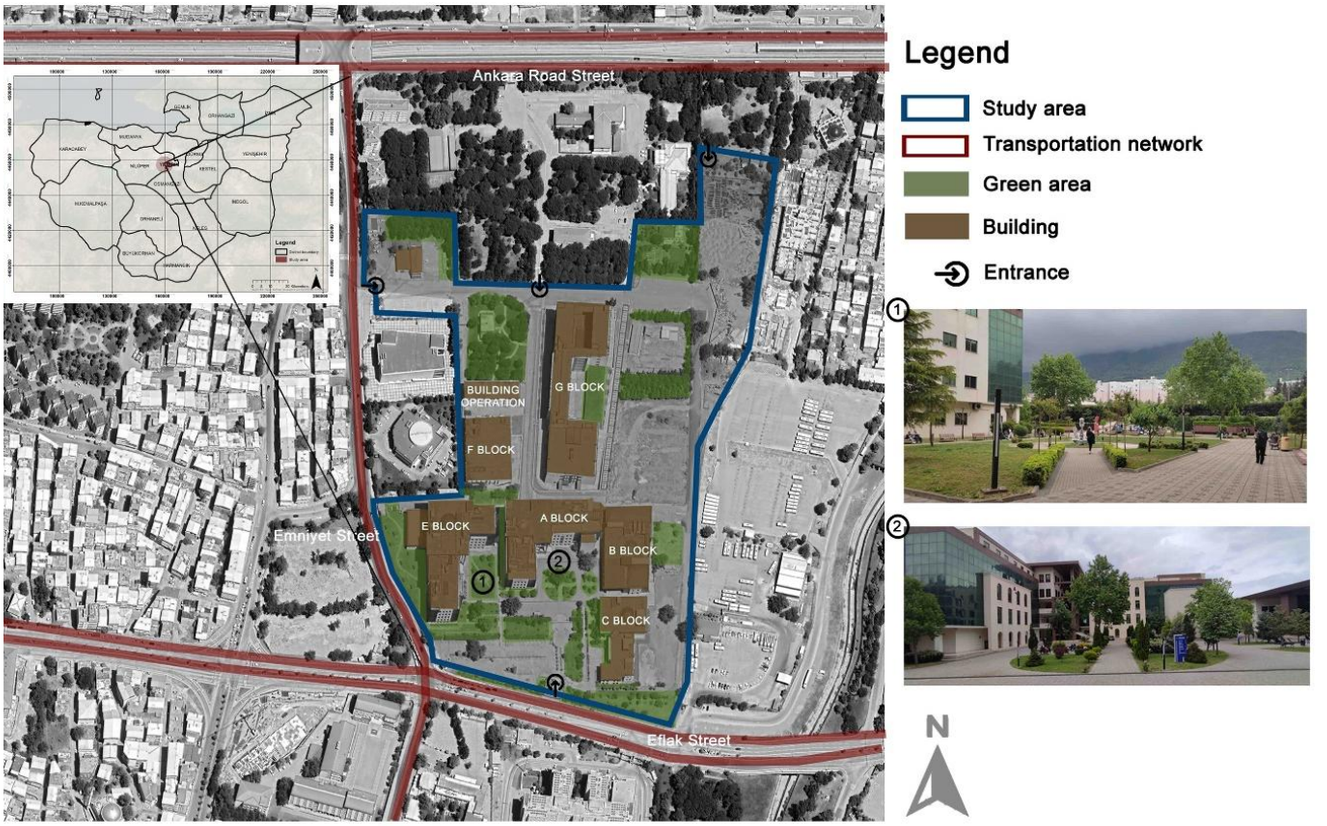


Figure 1. Study area and immediate surroundings

Method

By evaluating the existing literature, a lack of literature on the prioritization of aesthetic factors in plant designs is identified. In this context, the most commonly used main criteria in plant design studies and the sub-criteria under these criteria are determined. Then, a questionnaire is conducted and the weight values of the main and sub-criteria are determined. Within the scope of the analysis obtained in the last stage, the strategies required for planting design are evaluated. Each step is explained in detail below.

Identification Of Aesthetic Criteria in Planting Design

In this study, the definition of planting design in the literature, its principles, and the aesthetic factors considered in planting design are examined, and the aesthetic factors to be worked on within the scope of planting design are determined. Additionally, applied project examples, field studies, and visual space analyses are reviewed. The "main criteria and sub-criteria" headings are selected by examining the aesthetic parameters considered in planting design in various articles and books (Table 1). In many of the studies reviewed, it is found that planting designs often take into account color, form, texture, and size. These topics are therefore chosen as the main criteria for this study. The color criterion is evaluated under four groups. To reduce the number of questions in the questionnaire, the blue/purple and orange/yellow groups are combined into a single category. The form criterion is created based on the study by Kuhns and Rupp (2000), which identified four sub-categories. The texture criterion is classified as "Coarse-textured and Fine-textured" based on the work of Serpa and Muhar (1996). Finally, the size criterion is classified as small, medium, and large according to the study by Behe et al. (2005).

Table 1. Main and sub-criteria in aesthetic planting design

Main criteria	Sub-criteria	References
Color	Blue/Purple Red Orange/Yellow White	(Shen et al., 2022; Gao et al., 2020; Ma et al., 2020; Paraskevopoulou et al., 2018)
Form	Pendulous Column Broad Pyramid	(Kuhns & Rupp, 2000)
Texture	Coarse textured Fine textured	(Serpa & Muhar, 1996)
Size	Small (Herbaceous plant) Medium (Bush) Large (Tree)	(Behe et al., 2005)

Quantification Aesthetic Criteria in Planting Design with AHP

The Analytic Hierarchy Process (AHP) is an MCDM method used in complex decision-making processes. This method allows for the prioritization of criteria by transforming decision problems into a hierarchical structure and enables the objectification of decision-makers subjective evaluations (Saaty, 1980). AHP is used to structure complex problems, compare and rank alternatives, support group decision-making processes, and ensure consistency in the decision-making process (Saaty, 1994). Additionally, it provides a numerical scale to measure both quantitative and qualitative performances. This scale ranges from 1/9 for "least important" to 1 for "equally important" and up to 9 for "absolutely more important," covering the entire comparison process (Perçin, 2006). Due to its simple and flexible structure, and its ability to combine qualitative and quantitative data, AHP is used by various professional groups (Saaty & Vargas, 2001).

The AHP method consists of four main stages. First, the decision problem is structured into a hierarchical model. Then, pairwise comparisons are made, resulting in judgment matrices. In the third stage, local priorities and the consistency of the comparisons are assessed. In the final stage, the overall priorities are determined (Carli et al., 2018). In this study, AHP is chosen due to its simplicity, flexibility, and objective approach. Before applying the AHP method, the aim of the study and the main and sub-criteria to be prioritized are determined. A questionnaire is then conducted, involving forest engineers, architects, and landscape architects students and academians. Of the participants, 180 were Landscape Architecture students, representing 72% of the total sample. Of these Landscape Architecture students, 140 were female (56%) and 40 were male (16%). Twenty were Forestry Engineering students, constituting 8% of the total participants; 8 were female (3.2%) and 12 were male (4.8%). Thirty were Architecture students, representing 12% of the total sample; 15 were female (6%) and 15 were male (6%). Finally, 20 academic staff members (8%) participated in the survey; 12 were female (4.8%) and 8 were male (3.2%). The reliability rate for the sample calculation is set at 95%, with 250 participants completing the questionnaire. Generally, the sample size is not fixed, so Equation 1 is used; according to this formula, approximately 384 surveys would be needed for the population of landscape architects in Türkiye. However, AHP is based on expert opinions, so a very large sample is not necessary, and the analysis can be conducted using only experienced experts in the field (Tsyganok et al., 2012). In this context, the maximum number of participants that could be reached within the scope of the survey was achieved. Furthermore, previous studies have shown that AHP analysis can be conducted with sample sizes of 5, 7, 18, and 25 participants (Kil et al., 2016).

$n = Z^2 x\ p\ x\ q\ /\ d^2$ (Equation 1)

n = Required sample size, *p* = Probability of the event occurring (usually taken as 0.5), *q*= 1 – p, *d*= Margin of error (typically 0.05)

The questionnaire is designed to assess the aesthetic factors in plant design, and the criteria are queried using a pairwise comparison method. In the questionnaire form, participants are asked which of the color, form, texture, and size components, listed under the "main criteria" heading in Table 1, are more important. Six questions are asked for the main criteria and sixteen questions for the sub-criteria, making a total of 22 questions in the questionnaire. The questionnaire lasted approximately 5 minutes (Table 2). The clarity and comprehensibility of the questionnaire are important factors in increasing the consistency ratio (CTR). Therefore, all questions are directed to the relevant expert groups and completed through face-to-face interviews. The questionnaire data are organized using Microsoft Office Excel, and the geometric averages for each item are calculated using Expert Choice 11 software. According to Carli et al. (2018), for the study to be considered valid, the consistency ratio (CR) must be below 0.10.

Table 2. Questions regarding main and sub-criteria within the scope of the study

Questions	A	B	Questions	A	B
1.Question	Color	Form	**12.Question**	Orange/Yellow	White
2.Question	Color	Texture	**13.Question**	Pendulous	Column
3.Question	Color	Size	**14.Question**	Pendulous	Broad
4.Question	Form	Texture	**15.Question**	Pendulous	Pyramid
5.Question	Form	Size	**16.Question**	Column	Broad
6.Question	Texture	Size	**17.Question**	Column	Pyramid
7.Question	Blue/Purple	Red	**18.Question**	Broad	Pyramid
8.Question	Blue/Purple	Orange/Yellow	**19.Question**	Coarse	Fine
9.Question	Blue/Purple	White	**20.Question**	Small	Medium
10.Question	Red	Orange/Yellow	**21.Question**	Small	Large
11.Question	Red	White	**22.Question**	Medium	Large

Design Proposals

In the final stage of the study, based on shareholder opinions and the priorities identified in the quantitative AHP analysis, recommendations are developed to guide aesthetic plant design and enhance the spatial perception and identity value of open green spaces.

RESULT AND DISCUSSION

Prioritization Criteria of Aesthetics in Planting Design

In this study, all criteria are ranked according to their priorities. According to the results, the ranking between criteria is respectively size (0.27), texture (0,26), form (0,24), and color (0.23) (Figure 2). The CTR ratio among criteria is calculated as “0,0013”.

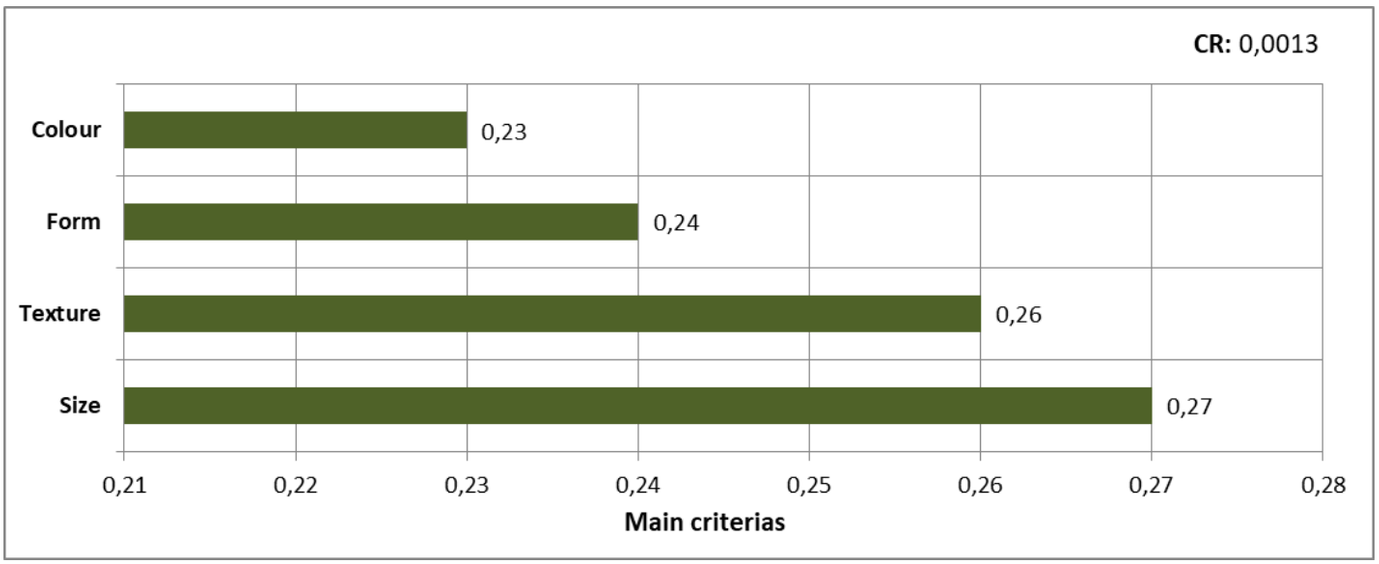


Figure 2. Priority rankings of color, form, texture, and size criteria

Prioritization Sub-Criteria of Aesthetics ın Planting Design

According to the results obtained from AHP analysis, the most important sub-criteria under color is white (0.0644). The least important sub-criteria is found to be blue/purple (0.0529). The most important sub-criteria under the form is the pyramid (0.0672). The least important sub-criteria is found to be pendulous (0.0528). The most important sub-criteria under texture is fine textured (0.1352). The least important sub-criteria is found to be coarse textured (0.1248). The most important sub-criteria under size is large tree (0.1053). The least important sub-criteria is found to be small herbaceous plants (0.0621) (Figure 3).

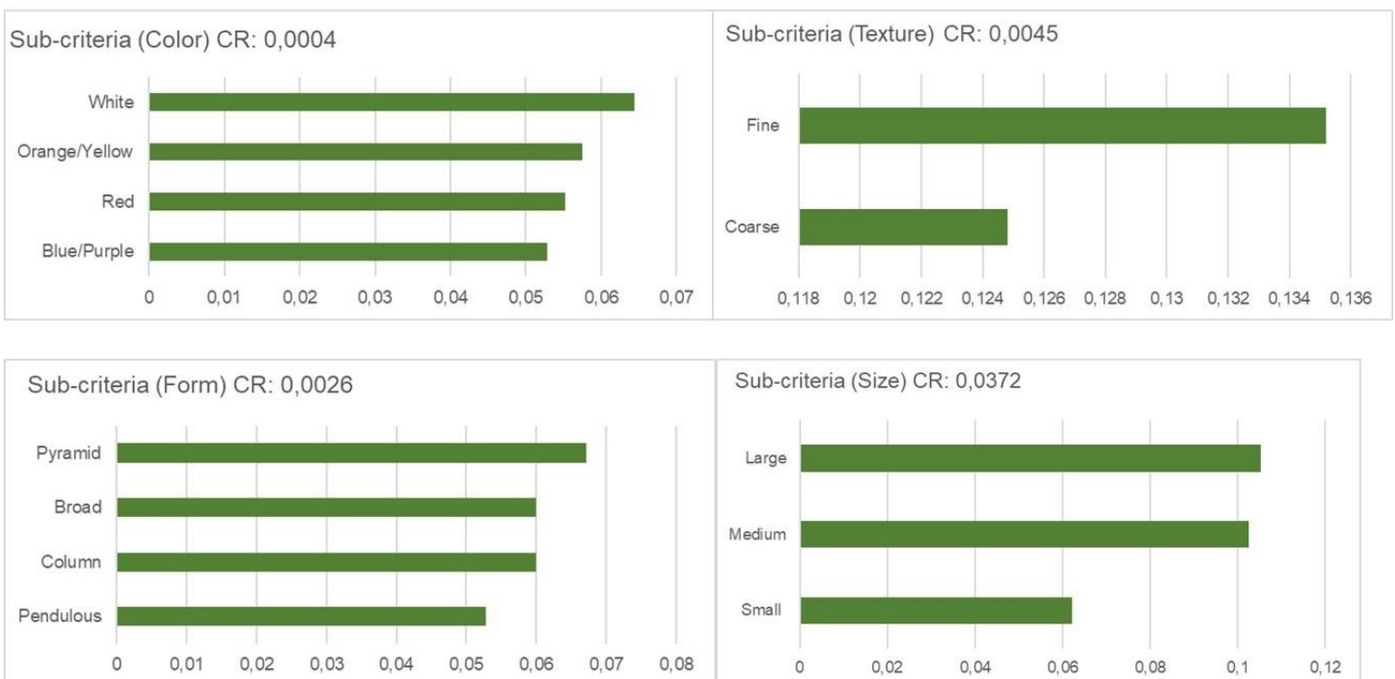


Figure 3. Weight values of sub-criteria of planting designs made for aesthetic purposes

In the study area, when ranking in order of importance among all sub-criteria in planting designs, the 3 most important sub-criteria are respectively fine-textured (0.1352), coarse-textured (0.1248), and large (tree) (0.1053). This situation showed that there is a need to develop strategies for these three criteria in planting design. The 3 least important sub-criteria are respectively pendulous (0.0528), blue/purple color (0.0529), and red color (0.0552) (Table 3).

Table 3. Quantification of sub-criteria of planting designs made for aesthetic purposes

Main criteria	Priority Value	CR	Sub-criteria	Priority Value	CR
Color	0.23	0.0013	Blue/Purple	0.0529	0.0004
			Red	0.0552	
			Orange/Yellow	0.0575	
			White	0.0644	
Form	0.24		Pendulous	0.0528	0.0026
			Column	0.06	
			Broad	0.06	
			Pyramid	0.0672	
Texture	0.26		Coarse textured	0.1248	0.0045
			Fine textured	0.1352	
Size	0.27		Small (Herbaceous plant)	0.0621	0.0372
			Medium (Bush)	0.1026	
			Large (Tree)	0.1053	

In this study, the main and sub-criteria commonly used in aesthetic plant design were weighted using the AHP method. The results indicate that plant size is the most influential factor among the main criteria, whereas plant color has the lowest relative importance. This finding suggests that users tend to prioritize spatial and structural characteristics over purely visual attributes, likely due to the stronger functional and perceptual impact of larger vegetation elements within the landscape. At the sub-criteria level, fine-textured plant species under the texture parameter were identified as the most preferred, while pendulous forms under the form criterion exhibited the lowest importance. The preference for fine-textured vegetation may be associated with its ability to create more visually coherent and aesthetically refined environments, whereas pendulous forms may be perceived as less dominant or less effective in defining spatial structure. Based on these findings, the planting design of the BTU Mimar Sinan Campus was re-evaluated, and plant species native to the Marmara region, including Bursa, were recommended in accordance with the weighted criteria (Aksoy & Erken, 2022). This approach not only supports aesthetic preferences identified through AHP but also enhances ecological compatibility and sustainability by prioritizing locally adapted species.

The prominence of plant size identified in this study is consistent with previous research emphasizing its fundamental role in landscape perception and design. According to Nemutlu (2014), plant size represents one of the most dominant characteristics when multiple design criteria are considered, largely because users tend to respond first to the overall visual mass and external appearance of vegetation. Similarly, Eren and Var (2016) highlight that trees and shrubs are primarily distinguished by their dimensional attributes, with tall trees exceeding 5–8 meters in height and forming a strong vertical structure, whereas shrubs remain relatively low and multi-stemmed. In addition, the dynamic nature of plant size, as noted by Kösa and Aksöğüt (2020), further reinforces its importance, as plants continuously change in scale over time, thereby altering spatial perception and landscape character. These findings collectively support the results of the present study, where plant size emerged as the most influential criterion in the AHP analysis. From a design perspective, the dominance of size suggests that larger plant species play a critical role not only in visual hierarchy but also in shaping spatial definition, user perception, and potentially microclimatic conditions through shading. Accordingly, for the BTU Mimar Sinan Campus, planting strategies can prioritize size characteristics to enhance both aesthetic quality and

functional performance. In this context, large plant species identified as suitable are presented in Table 4 and can be effectively integrated into the proposed design schemes.

Table 4. Planting design features of tree species that can be suggested within the scope of plant design proposed for BTU Mimar Sinan Campus (TUBİVES, 2004)

Plants species	Leaf Color	Spring coloration	Autumn coloration	Form	Texture
Abies nordmanniana (STEV.) SPACH	Dark green	Dark green	Dark green	Pyramid	Coarse
Acer campestre L.	Light green	Light green	Yellow	Round	Medium
Acer platanoides L.	Light green	Light green	Yellow-orange	Round	Medium
Carpinus betulus L.	Light green	Light green	Yellow	Column	Medium
Celtis australis L.	Light green	Light green	Yellow	Round	Medium
Cercis siliquastrum L.	Light green	Pink	Light green	Broad	Fine
Crataegus monogyna JACQ.	Light green	White	Yellow	Broad	Fine
Elaeagnus angustifolia L.	Silver green	Silver green	Silver green	Umbrella	Medium
Fraxinus ornus L.	Light green	White	Yellow	Round	Medium
Gleditsia triancanthos L.	Light green	Light green	Yellow	Broad	Fine
Pinus pinea L.	Dark green	Dark green	Dark green	Round	Coarse
Platanus orientalis L.	Light green	Light green	Yellow	Broad	Coarse
Populus alba L.	Silver green	Silver green	Yellow	Round	Medium
Populus tremula L.	Light green	Light green	Yellow	Round	Fine
Taxus baccata L.	Dark green	Dark green	Dark green	Broad	Coarse
Tilia argentea DESF. EX DC.	Light green	Light green	Yellow	Round	Coarse

When developing planting designs, species selection should not rely on a single parameter; rather, it should be based on the combined evaluation of multiple sub-criteria with high relative importance. The AHP results of this study clearly indicate that attributes such as fine texture, large size, structured forms (e.g., pyramid or broad canopy), and light-colored surfaces (e.g., white tones) play a dominant role in user preferences. Therefore, plant species that simultaneously satisfy these criteria are more likely to contribute to both visual quality and spatial coherence. In this context, species such as *Populus tremula* L. and *Fraxinus ornus* L. can be considered suitable due to their fine-textured foliage, light-colored bark, broad canopy forms, and their capacity to reach heights exceeding 10 m, thereby providing strong visual impact and spatial definition. Similarly, *Tilia tomentosa* L., *Populus alba* L., and *Acer saccharinum* L. stand out with their light-toned foliage and medium-to-large size (8–10 m), which enhances visual continuity and aesthetic perception within the landscape. In addition, *Abies nordmanniana* (Stev.) Spach, characterized by its evergreen structure and pyramidal form, represents a valuable option for introducing vertical emphasis and year-round visual stability. Beyond their aesthetic contributions, these species may also enhance functional performance—particularly in terms of shading and microclimatic regulation—due to their size and canopy structure. Accordingly, integrating such species into the green spaces between Blocks A and E (Figure 4) can support a design approach that is both aesthetically consistent with user preferences and functionally effective.



Figure 4. Planting design proposal between Blocks A and E (Artificial Intelligence (AI))

According to the AHP results, texture emerges as the second most important criterion following plant size, highlighting its significant role in shaping user preferences. At the sub-criteria level, fine-textured plants are identified as the most influential category, not only within the texture parameter but also across all evaluated sub-criteria, whereas coarse-textured plants rank second. This finding indicates a strong user tendency toward finer vegetation structures, suggesting that visual subtlety and detail may play a key role in aesthetic perception. This result is consistent with the findings of Gülgün et al. (2013), who demonstrated that different plant textures evoke distinct psychological responses. In particular, transitions from coarse- to fine-textured vegetation contribute to a stronger perception of depth and spatial layering, thereby enhancing visual complexity and landscape legibility. Furthermore, fine-textured plants, characterized by delicate leaves and branching patterns, are often perceived as more refined and visually appealing. In contrast, coarse-textured species—typically represented by evergreen plants with darker and denser foliage—tend to create heavier and more dominant visual effects. The consistency between the AHP results and existing literature suggests that fine texture is not only an aesthetic preference but also a key factor in improving spatial perception and visual quality. From a design perspective, prioritizing fine-textured plant species can therefore enhance both the perceived depth and coherence of landscape compositions. Accordingly, for the BTU Mimar Sinan Campus, plant selection should emphasize fine-textured species. Tree species suitable for such applications are presented in Table 4, while shrub species that can support fine-textured planting compositions are listed in Table 5.

Table 5. Planting design features of shrub species that can be suggested within the scope of plant design proposed for BTU Mimar Sinan Campus (TUBİVES, 2004)

Plants species	Leaf Color	Spring coloration	Autumn coloration	Form	Texture
Arbutus unedo L.	Light green	Light green	Red	Round	Coarse
Calluna vulgaris (L.) HULL	Light green	Purple	Purple	Broad	Fine
Cornus mas L.	Light green	Yellow	Yellow	Broad	Fine
Cotinus coggyria SCOP.	Light green	Light green	Red/ Yellow	Round	Medium
Erica manipuliflora SALISB.	Light green	Pink	Purple	Broad	Fine
Hypericum calycinum L.	Light green	Yellow	Light green	Broad	Coarse
Jasminum fruticans L.	Light green	Yellow	Light green	Creeping	Medium
Laurus nobilis L.	Dark green	Dark green	Dark green	Column	Coarse
Ligustrum vulgare L.	Light green	Light green	Light green	Round	Medium
Myrtus communis L.	Light green	Light green	Light green	Round	Medium
Philadelphus coronarius L.	Light green	White	Yellow	Round	Medium
Pyracantha coccinea ROEMER	Dark green	Dark green	Red	Round	Coarse
Rosa canina communis L.	Light green	White	Red	Creeping	Medium
Spartium junceum L.	Light green	Yellow	Yellow	Round	Fine
Vaccinium myrtillus L.	Light green	White	Yellow	Creeping	Medium
Viburnum opulus L.	Light green	White	Yellow	Round	Medium
Vitex agnus-castus L.	Light green	Purple	Purple	Broad	Medium

When selecting shrub species, preference should be given to plants that simultaneously satisfy the most highly weighted sub-criteria identified through the AHP analysis, particularly fine texture, structured forms (e.g., columnar or broad shapes), and light or warm color tones such as white, orange, and yellow. This multi-criteria approach ensures that plant selection is not arbitrary but directly aligned with user preferences and perceptual priorities. In this context, species such as *Laurus nobilis* L., *Cornus mas* L., *Philadelphus coronarius* L., Vaccinium myrtillus L., and *Viburnum opulus* L. can be considered suitable due to their compatibility with the identified criteria, including their textural qualities, form characteristics, and seasonal color attributes. These species have the potential to enhance visual coherence and aesthetic richness while supporting spatial definition within planting compositions. From a spatial perspective, implementing these shrub species in the green areas between Blocks A and B (Figure 5) is particularly appropriate, as these zones represent areas of high pedestrian intensity and collective use. In such contexts, plant composition plays a critical role in shaping user experience, guiding movement, and reinforcing visual continuity. Therefore, integrating fine-textured and structurally defined shrubs in these high-use areas can contribute to both aesthetic quality and functional landscape performance.



Figure 5. Planting design proposal between Blocks A and B (Artificial Intelligence (AI))

Following texture, form emerges as the next most important criterion in the AHP analysis, indicating that plant morphology plays a significant role in shaping user preferences. Among the sub-criteria, pyramid-shaped plants are identified as the most influential, suggesting a strong preference for structured and geometrically defined forms within the landscape. This tendency may be explained by the ability of such forms to create clear visual hierarchy and spatial organization. This finding is consistent with previous studies. For instance, Meral et al. (2018) reported that pyramid-shaped plant groups have the highest visual impact according to user evaluations. Similarly, Var (2024) emphasized that columnar and pyramidal forms can generate strong focal points in landscape design, effectively guiding user attention and enhancing visual stimulation. However, these forms may also evoke different emotional responses depending on their scale and spatial context. As noted by Var (2024), large pyramidal or conical trees, when used in isolation or without compositional balance, may create feelings of loneliness or visual heaviness. The consistency between the AHP results and the literature suggests that plant form is not only a visual attribute but also a key design element influencing spatial perception and user experience. Therefore, pyramid and columnar forms should be carefully integrated into planting compositions to achieve both visual emphasis and spatial balance. In this context, the plant materials presented in Table 4 can be effectively utilized to support structured and visually coherent design schemes.

In the analysis, color is identified as the least influential criterion among the evaluated parameters, indicating that users assign relatively lower importance to chromatic attributes compared to structural characteristics such as size, texture, and form. However, among the color-related sub-criteria, white emerges as the most significant, suggesting a preference for lighter and more neutral tones. This finding may be explained by the perceptual and psychological effects of color in landscape environments. Previous studies have shown that color influences emotional responses, but its impact is often

secondary to spatial and structural features. For instance, a cross-sectional survey of over 600 UK residents by Harries et al. (2024) demonstrated that cool colors such as blue and white are associated with low-arousal emotional states, including relaxation and calmness, whereas warm colors like orange are linked to higher arousal states such as excitement. Similarly, Zhang et al. (2023) reported that bright and highly saturated colors tend to elicit stronger emotional responses compared to darker and less saturated tones, with red being the most stimulating color when brightness and saturation are controlled. The relatively low importance of color observed in this study may therefore suggest that, while color contributes to emotional experience, users prioritize spatial clarity, form, and physical presence over purely visual or chromatic qualities in plant selection. From a design perspective, this implies that color can consider as a complementary rather than a primary criterion. In this context, the preference for white tones may be advantageous, as lighter colors can enhance visual brightness, improve perceptual clarity, and contribute to a sense of openness and calmness within the landscape.

In the AHP analysis, blue and purple are identified as the least preferred color categories, indicating a relatively low user preference for these tones in plant selection. While their lower ranking may partially relate to their limited visual dominance in planting compositions, this finding can also be explained through their psychological effects. Previous research has shown that different colors evoke distinct emotional responses. Zhang et al. (2024) demonstrated that warm colors, particularly orange, produce strong energizing effects, whereas cool colors such as blue are generally associated with relaxation. However, the same study also revealed that these effects are highly sensitive to color combinations. For instance, the relaxing effect of blue decreases when mixed with higher proportions of orange, and the addition of purple to blue compositions reduces their overall capacity to promote relaxation. These findings suggest that cool colors, although calming, may be less visually dominant or impactful in complex planting arrangements, which may contribute to their lower preference in the present study. The consistency between the AHP results and the literature indicates that color plays a secondary yet context-dependent role in landscape perception. Accordingly, although blue and purple tones are less preferred, they should not be entirely excluded from design compositions. Instead, color should be strategically integrated as a complementary element to support overall visual balance. For the BTU Mimar Sinan Campus, plant materials featuring white, yellow/orange, and red tones are recommended, as these colors provide stronger visual impact and align more closely with user preferences. At the same time, limited use of cooler tones may help introduce contrast and visual diversity when carefully combined within the planting scheme.

This study has some limitations. First, to avoid increasing the number of questions, the grouped sub-criteria could be separated into distinct headings, which would provide clearer results. Additionally, the study by Sarı and Karaşah (2018) suggests that key criteria such as emphasis-focus, rhythm-repetition, balance, dominance, and unity should also be considered in plant design. To help participants respond more effectively, visual aids could be used, which would enhance the accuracy and clarity of the survey. Then, the gender of the respondents may influence the results. It is important to further explore how gender could affect the findings. Finally, including other user groups of the campus in the study would support the participation of a wider range of individuals in the process.

CONCLUSION

This study prioritized the most commonly used color, size, texture, and form characteristics in plant design using AHP. According to the results, the size criterion was the most preferred by users, while color was the least preferred criterion in plant design. Among the sub-criteria, fine-textured plants were the most preferred, whereas pendulous form plants were the least preferred. The prominence of the size criterion may be associated with its strong influence on spatial perception, particularly in terms of defining enclosure, scale, and visual dominance within open green spaces. Similarly, the preference for fine-textured plants may be related to their contribution to visual continuity and perceived order,

which can enhance users' comfort and aesthetic experience. In contrast, color may have been perceived as a more temporary or seasonal attribute, thus playing a less decisive role in users' preferences.

In addition, these preferences may also be shaped by contextual and cultural factors, such as users' familiarity with certain plant types, educational background, and the spatial characteristics of the study area. Considering that the study was conducted at the BTU Mimar Sinan Campus, user tendencies may reflect both the environmental context of the campus and the design expectations of its users. Based on these findings, plant recommendations have been developed for the BTU Mimar Sinan Campus. These results could provide guidance for future plant design projects. Furthermore, adopting a participatory approach may support not only the aesthetic quality of campus landscapes but also their educational, recreational, and social functions.

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