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Beyond Technical Specs: Using AHP to Prioritize User Needs in Turkish Basketball Arena Designs

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ABSTRACT

Basketball arenas are crucial spaces that must meet specific standards to ensure the sustainability of the sport and the quality of play. While Post-Occupancy Evaluation (POE) assesses these standards, it often assumes that all performance indicators are equally important, potentially leading to a gap between design intent and actual user experience. This study aims to bridge this gap by using the Analytic Hierarchy Process (AHP) to prioritize evaluation criteria for Turkish professional basketball arenas designed for national and international matches, regional/local competitions, and training programs. Existing studies and reports indicate that basketball arenas in Turkey often fall short in meeting necessary physical requirements and exhibit performance deficiencies. To address this gap, this study identifies factors determining arena performance, categorized as technical, functional, and behavioral based on Preiser's framework. These criteria were further categorized according to different spaces within the arena, including general use areas, administrative spaces, and athlete-specific areas. A panel of expert sports facility design professionals provided judgments about the relative importance of these criteria using pairwise comparisons. The AHP method was then employed to calculate priority weights for each criterion. The results reveal the relative importance of different criteria for each space. For example, in general use areas, "furniture suitability/sufficiency" and "provision of ergonomic conditions for the disabled" ranked highest. In administrative spaces, "fire protection" and "accessibility" were deemed most important, while in athlete-specific areas, "visual and auditory privacy" and "security" took precedence. This study demonstrates the potential of AHP for developing a systematic and reliable framework for qualitative evaluations that measure user satisfaction. AHP-based evaluation models offer a valuable tool for architects, facility managers, and decision-makers to assess architectural design quality, prioritize design criteria, and support user-centered design processes.

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1. Introduction

Basketball arenas are dynamic spaces that significantly impact various stakeholders, from athletes and spectators to local communities and economies (Propheter, 2012). These arenas play a pivotal role in sports, entertainment, and economic development, hosting a wide array of events such as basketball games, concerts, and other gatherings, attracting large crowds and contributing to the local economy (Propheter, 2012). Beyond their sporting function, they are essential for hosting events that foster community engagement and enrich cultural experiences (Davidson & McNeill, 2011). The sensory experience within these arenas can significantly influence consumer behavior and team loyalty, underscoring the importance of creating an engaging atmosphere for spectators (Ogiso et al., 2019).

Ensuring the success of these multifaceted spaces requires a deep understanding of user needs and expectations (Bengi & Toprakli, 2020; Wong & Aziz, 2021; Hassanain et al., 2021; Kumaraguruparan et al., 2022). Research has emphasized the importance of incorporating user feedback and prioritizing user-centered design principles in architectural projects (Bengi & Toprakli, 2021; Kumaraguruparan et al., 2022; Wong & Aziz, 2021). However, while Post-Occupancy Evaluation (POE) studies provide valuable insights, a gap often exists between the intended design and the actual user experience (Hassanain et al., 2021). This gap can be attributed to the complexities of integrating multiple criteria and stakeholder perspectives (Toprakli, 2011). Studies have explored user expectations in various building types, such as mosques (Bengi & Toprakli, 2021; Hassanain et al., 2021), courtrooms (Toprakli, 2019a), dormitories (Toprakli, 2019b), and even office spaces during the pandemic (Kumaraguruparan et al., 2022), highlighting the importance of addressing specific user needs to enhance the overall building experience. Research has also explored the impact of different materials and spatial design on users' emotional responses, particularly for young people (Wong & Aziz, 2021), emphasizing the importance of considering psychological factors in architectural design.

Maintaining standards is crucial for the sustainability of the sport and the quality of play, but technical, functional, and behavioral issues can arise in basketball arenas. These challenges necessitate a proactive approach to understanding and addressing potential problems. Similar to other building types, evaluating basketball arenas requires a systematic approach that considers all relevant aspects. Studies have shown that the design and acoustics of arenas significantly impact the overall experience for both players and spectators, highlighting the need for careful planning and consideration of these factors (Smith, 1990). Additionally, the economic implications of investing in sports facilities like basketball arenas require thorough evaluation to assess their long-term benefits and sustainability (Propheter & Hatch, 2014).

This research focuses on professional basketball arenas in Turkey designed for a range of events, from national and international matches to regional competitions and training programs. While these arenas often feature large seating capacities and specialized facilities, existing studies, administrative reports, and media coverage suggest they frequently fall short of meeting necessary physical requirements and exhibit performance deficiencies (T.C. Kalkınma Bakanlığı, 2014; Sunay, 2003). These challenges include limitations in multi-functionality, thermal comfort issues, accessibility problems (Url-1), flooring concerns (Url-2), negative impacts of court advertising (Url-3), and technical difficulties with electrical systems, roofs, and equipment (Url-4). Despite the critical role these arenas play in Turkish basketball, there is limited research on systematically evaluating and prioritizing user needs in their design. This study aims to address this gap by proposing a comprehensive framework, using the Analytic Hierarchy Process (AHP), to guide the evaluation and design of Turkish basketball arenas that better meet the needs of athletes, spectators, and other stakeholders.

Table 1 Basketball halls with a capacity of 5000 or more in Turkey

Basketball hall	Construction year	City	Capacity
Sinan Erdem Sports Hall	2010	İstanbul	16000
Ülker Spor Event and Sports Hall	2012	İstanbul	12687
Antalya Sports Hall	2016	Antalya	10000
Konya Metropolitan Municipality Sports and Congress Centre	2014	Konya	10000
Halkapınar Sports Hall	2005	İzmir	10000
Ankara Sports Hall	2010	Ankara	10000
Hayri Gür Sports Hall	2011	Trabzon	7500
Kadir Has Convention Centre Sports Hall	2008	Kayseri	6363
Servet Tazegül Sports Hall	2013	Mersin	6000
Seyrantepe Sports Hall	?	Diyarbakir	6000
Tofaş Sports Hall	2014	Bursa	5750
Karataş Şahinbey Sports Hall	2010	Gaziantep	5500
11 April Sports Hall	?	Şanliurfa	5000
Mamak Metropolitan Municipality Hidayet Türkoğlu Sports Hall	?	Ankara	5000
Şehit Polis Recep Topaloğlu Sports Hall	2012	Kocaeli	5000
Mustafa Kemal Atatürk Karşıyaka Sports Hall	2005	İzmir	5000
Sakarya Sports Hall	2013	Sakarya	5000

To bridge the gap in current evaluation practices and address the multifaceted challenges of designing successful basketball arenas, this research aims to develop a comprehensive framework for evaluating these professional arenas using the Analytic Hierarchy Process (AHP). This approach, as highlighted in previous research (Onur & Altuntas, 2022; Ranasinghe & De Silva, 2016), can effectively prioritize criteria based on their relative importance, considering the diverse needs and perspectives of stakeholders. The goal is to prioritize various technical, functional, and behavioral criteria based on their relative importance, ultimately contributing to the creation of high-quality spaces that enhance the experience for athletes, spectators, and the wider community.

To achieve this goal, the research will pursue the following objectives:

- **Identify and categorize relevant evaluation criteria:** Based on Preiser's framework and existing literature on basketball arena design and user satisfaction, identify a comprehensive set of technical, functional, and behavioral criteria relevant to professional basketball arenas. These criteria will be further categorized according to the specific spaces within the arena, such as general use areas, administrative spaces, athlete-specific areas, and competition official-specific areas.
- **Establish a hierarchical structure:** Develop a hierarchical structure for the identified criteria, reflecting their interrelationships and dependencies within the context of basketball arena evaluation.
- **Elicit expert judgments:** Engage a panel of experts, including sports scientists, facility managers, and architects experienced in sports facility design, to provide pairwise comparisons and judgments on the relative importance of the evaluation criteria.
- **Calculate criteria weights using AHP:** Apply the AHP methodology to analyze the expert judgments and calculate the weights or priorities of each criterion, reflecting their relative significance in the overall evaluation framework.
- **Validate and interpret the results:** Analyze the consistency of the expert judgments and validate the AHP results. Interpret the findings in the context of existing literature and best practices in basketball arena design and user satisfaction.
- **Develop recommendations for future design and evaluation:** Based on the research findings, provide recommendations for architects, facility managers, and decision-makers to improve the design, evaluation, and user experience of professional basketball arenas.

2. Literature Review

2.1 Challenges and Issues in Basketball Arena Design

Sports facilities are unique building types with specific technical, functional, and behavioral requirements based on the sport they accommodate. Sports arenas, in particular, play a vital role in communities, providing spaces for exercise, entertainment, and social gathering (Huang et al., 2022a). The quality of the indoor environment in these facilities significantly impacts occupant health, comfort, and performance.

Recent research highlights the importance of several key factors in sports arena design:

- **Thermal Comfort:** The thermal environment directly influences occupants' physiological responses, including heart rate, blood pressure, skin temperature, and thermal sensation (Huang et al., 2022a). Designers must consider the varying thermal needs of athletes during competition and spectators (Huang et al., 2022a).
- **Lighting:** Indoor sports arenas require careful light control to minimize glare and visual discomfort. Artificial lighting is often prioritized over daylight to ensure optimal visibility and performance (Wang et al., 2024).
- **Indoor Air Quality (IAQ):** Air temperature, air velocity, and indoor air pollutants significantly affect the performance and well-being of athletes and spectators (Huang et al., 2022b; Ni et al., 2023).
- **Roof Design:** The morphological characteristics of roof systems impact the overall performance of the arena, influencing lighting, acoustics, and thermal comfort (Wang et al., 2024).

In addition to these factors, recent studies on indoor basketball arenas emphasize:

- **Flexibility and Adaptability:** Modular design principles are crucial to allow for reconfiguration of seating arrangements and the creation of additional training spaces or event areas (Umezinwa et al., 2024).
- **Sustainability:** Sustainable design practices are increasingly important in basketball arena design, considering energy efficiency, material selection, and waste reduction.
- **Stakeholder Engagement:** Involving stakeholders in the design process can lead to more inclusive and responsive basketball arenas that better meet community needs (Umezinwa et al., 2024).

The design and construction of basketball arenas must also consider historical influences and adapt to the evolving needs of fans and stakeholders (Downs & Seifried, 2021). This necessitates a multidisciplinary approach encompassing technology, architecture, sports science, and urban planning to create safe, efficient, and engaging environments.

2.1.1 Design Guidelines and Evaluation Practices

Governing bodies like FIBA play a crucial role in guiding basketball arena design, especially for facilities hosting international competitions (FIBA, 2009). FIBA's design guide provides comprehensive recommendations on various aspects, including:

- Arena classification
- Site selection
- Space planning
- Technical specifications for flooring and equipment
- Court dimensions
- Seating capacity

- Facility operation, maintenance, and safety
- Accessibility standards
- Technological requirements

While design guidelines provide a valuable framework, the literature on basketball arena performance evaluation remains limited. Existing practices often focus on specific aspects, such as:

- **Post-Occupancy Evaluations (POE):** These studies assess building systems, energy efficiency, environmental impact, and user feedback (Preiser et al., 2004; Zimring et al., 2006).
- **User Satisfaction Surveys:** These collect data from athletes and spectators on their experiences with seating comfort, accessibility, amenities, and overall atmosphere (Wakefield & Sloan, 1995; Kim & Trail, 2004).

Although these methods offer valuable insights, they frequently lack a comprehensive framework that integrates multiple criteria and considers their complex interrelationships. This gap highlights the need for a more holistic approach, such as the Analytic Hierarchy Process (AHP), to effectively evaluate and prioritize different aspects of arena design and performance.

2.2 The Analytic Hierarchy Process (AHP) in Architectural Design and User Satisfaction

Decision-making in complex situations often involves multiple, sometimes conflicting, criteria. Multi-Criteria Decision Making (MCDM) methods have emerged to address this challenge, providing structured frameworks for evaluating alternatives and prioritizing factors based on their relative importance (Saaty, 2008). The Analytic Hierarchy Process (AHP), developed in the late 1970s, is a prominent MCDM method that has gained widespread recognition and application across various fields (Saaty, 2008).

2.2.1 AHP: Key Features and Advantages

AHP relies on pairwise comparisons and expert judgments to establish priority scales (Saaty, 2008). By breaking down complex problems into a hierarchy of goals, criteria, sub-criteria, and alternatives, AHP enables a comprehensive evaluation process (Montequín et al., 2020). Key advantages of AHP include:

- **Systematic and Structured Approach:** AHP provides a clear, logical framework for analyzing decision problems and handling subjective judgments.
- **Flexibility and Adaptability:** AHP can be applied to a wide range of decision-making contexts and integrated with other methods (Önder & Önder, 2018).
- **Transparency and Accountability:** The pairwise comparison process and weight calculations are transparent, allowing for easy understanding and verification of the results.
- **Integration of Diverse Perspectives:** AHP facilitates the inclusion of multiple stakeholders with varying perspectives, promoting consensus-building (Sipahi & Timor, 2010).

These features make AHP particularly suitable for scenarios involving subjective criteria, conflicting objectives, and multiple decision-makers.

2.2.2 Applications in Architectural Design and User Satisfaction

AHP's versatility has led to its successful application in various architectural design and user satisfaction assessment contexts. Key examples include:

- **Evaluating Design Alternatives:** AHP enables the comparison of different design options based on multiple criteria, such as aesthetics, functionality, cost, and environmental impact, helping designers and stakeholders make informed choices (Opricovic & Tzeng, 2004; Lee & Chan, 2008).
- **Prioritizing User Needs:** AHP can be used to identify and prioritize the needs and preferences of building occupants, providing valuable insights for guiding design decisions and ensuring the final building meets user requirements (Preiser et al., 2004; Ouf & Hassanain, 2016).
- **Post-Occupancy Evaluation:** AHP can enhance POE studies by systematically analyzing and prioritizing user feedback on various building aspects, leading to targeted improvements (Preiser et al., 2004; Zimring et al., 2006).

Studies by Ranasinghe and De Silva (2016) and Onur and Altuntas (2022) further demonstrate AHP's effectiveness in architectural design evaluations.

2.2.3 Advantages of AHP in Arena Evaluation

In the context of basketball arena evaluation, AHP offers significant advantages over traditional single-criterion evaluations or simple user satisfaction surveys:

- **Comprehensive Assessment:** AHP allows for the simultaneous consideration of multiple criteria, providing a more holistic view of arena performance.
- **Prioritization of Criteria:** AHP enables the ranking of criteria based on their relative importance, highlighting the most critical factors.
- **Integration of Stakeholder Perspectives:** AHP facilitates the inclusion of diverse viewpoints from athletes, spectators, facility managers, and other stakeholders, leading to more informed and balanced decisions.

These advantages make AHP a valuable tool for evaluating and improving basketball arena designs, promoting user-centered approaches, and enhancing the overall experience for all stakeholders.

Decision-making has evolved into a mathematical science, recognizing the importance of criteria and sub-criteria (Figuera et al., 2005; Saaty, 2008). The intangible nature of decision-making criteria and the need for hierarchical ranking of alternatives have

led to the development of Multi-Criteria Decision Making (MCDM) methods (Saaty, 2008). The Analytic Hierarchy Process (AHP), a prominent MCDM method, effectively ranks both objective and subjective judgments, enabling consensus despite individual expert opinions (Saaty, 2008). Its flexibility allows integration with other methods, and its ease of use and understandability make it preferable for large-scale decision-making problems (Önder & Önder, 2018).

AHP, initially developed in the late 1970s, is based on pairwise comparisons and expert judgments to establish priority scales (Saaty, 2008). It is a recognized method for multi-criteria decision-making, allowing for the analysis of complex situations and aiding in making informed decisions (Ho & Ma, 2018). AHP's simplicity, ease of use, and flexibility have led to its widespread application in diverse areas, including construction management, information technology outsourcing, medical applications, supplier selection, and watershed management (Darko et al., 2018; Udo, 2000; Sobrie et al., 2016; Yavuz & Baycan, 2013).

AHP's systematic method for weighting decision criteria and its ability to handle conflicting objectives make it suitable for scenarios involving multiple decision-makers with varying perspectives. It has also been integrated with other decision-making tools like SWOT analysis to enhance participatory decision-making processes (Sipahi & Timor, 2010).

The application of AHP involves structuring decision problems hierarchically into goals, criteria, sub-criteria, and alternatives, enabling a comprehensive evaluation process (Montequín et al., 2020). By utilizing pairwise comparisons and mathematical calculations, AHP assists in prioritizing factors and alternatives, aiding decision-makers in selecting the most suitable option (Mimović & Krstić, 2016). AHP has also been used in conjunction with other methods like Data Envelopment Analysis (DEA) to evaluate the performance of institutions.

The Analytic Hierarchy Process (AHP) stands out as a valuable decision-making tool due to its structured approach, flexibility, and ability to handle complex decision problems effectively. Its widespread application across various domains underscores its significance in aiding decision-makers in reaching well-informed and rational decisions.

3. Methodology

This study focuses on professional basketball arenas, designed to host national and international matches, regional/local competitions, and training programs (FIBA, 2009). These arenas typically include various spaces, such as general use areas, administrative spaces, athlete-specific areas, and competition official-specific areas (See Figure 1).

The study employed the Analytic Hierarchy Process (AHP) to determine the priority relationships among evaluation criteria. Drawing on Preiser's framework (1995), we categorized evaluation criteria into three aspects: technical, functional, and behavioral, grouping them according to the arena spaces (See Table 2).

An expert panel consisting of a sports scientist, a facility manager, and an architect with prior experience in designing sports facilities provided their insights through pairwise comparison forms. A geometric mean was calculated to synthesize individual priorities into a single unified priority, as recommended in AHP for multiple expert responses. This approach ensured the utilization of expert experience while defining the priority levels of evaluation criteria for each space within the arenas.

3.1 The Analytic Hierarchy Process (AHP): A Detailed Explanation

The Analytic Hierarchy Process (AHP) is a structured technique for dealing with complex decisions involving multiple criteria and subjective judgments. It provides a systematic framework for breaking down a problem into a hierarchy of levels, comparing the relative importance of elements at each level, and synthesizing these comparisons to derive overall priorities.

The AHP process involves the following steps:

1. **Problem Definition and Hierarchical Structure:** Clearly define the decision problem and identify the overall goal. Decompose the problem into a hierarchy with different levels, typically consisting of the goal, criteria, sub-criteria (if applicable), and alternatives.
2. **Pairwise Comparisons and Judgment Elicitation:** For each level of the hierarchy, conduct pairwise comparisons between the elements to determine their relative importance with respect to the element in the level above. Experts use a standardized scale (e.g., Saaty's 1-9 scale) to express their judgments on the relative importance of each pair of elements.
3. **Comparison Matrices:** Organize the pairwise comparison judgments into square matrices, where each entry represents the relative importance of one element over another.
4. **Calculating Weights:** Apply eigenvector analysis to each comparison matrix to derive the relative weights of the elements within that level. These weights represent the relative importance of each element in achieving the goal or criterion in the level above.
5. **Consistency Check:** AHP incorporates a consistency ratio to assess the logical consistency of the expert judgments. Inconsistent judgments may indicate errors or biases in the decision-making process and may require further review or revision.
6. **Synthesizing Results and Prioritization:** Aggregate the relative weights of elements at each level through a hierarchical synthesis process to obtain the overall priorities of the alternatives with respect to the overall goal.

This structured approach enables AHP to effectively handle complex decision-making problems, considering multiple factors and perspectives. AHP has been widely used in building evaluation studies to assess criteria across various stages of the building lifecycle, from planning and construction to operation and use. These studies recognize the diverse nature of evaluation criteria in areas such as urban landscaping, ecology, and different building

types. AHP helps to prioritize and understand the relationships between these criteria through a systematic ranking process.

Several studies have gone beyond simply evaluating criteria to develop comprehensive AHP-based evaluation models. For example, Haifang et al. (2017) created an AHP-based model to evaluate the landscape quality of university campuses. Lai (2013) investigated the impact of lighting, air conditioning, fire safety, acoustics, internet access, and hygiene on user satisfaction in student dormitories. The study measured the gap between expected and perceived satisfaction levels among dormitory residents.

3.2 Description of the Research Model

This study employed a mixed-methods approach, combining expert judgment with the AHP methodology. The research model is centered around the following components:

3.2.1 Expert Panel Selection

To ensure the validity and reliability of the AHP analysis, a panel of experts with relevant knowledge and experience in Turkish basketball arena design and user experience was carefully selected. The panel included three experts, each representing a distinct perspective:

1. **Architect (Design Office):** This expert has direct experience designing basketball arenas and is familiar with the planning and design processes.
2. **Architect (Public Institution):** This expert works within a government organization involved in sports facility construction in Turkey. They have expertise in the programming and regulatory aspects of basketball arena design.
3. **Sports Manager:** This expert has extensive experience in managing basketball facilities and interacts regularly with athletes, spectators, competition officials, and federations, providing a valuable user-focused perspective.

These experts were chosen for their in-depth understanding of the technical, functional, and behavioral aspects of basketball arena design and management (Table 2). The selection of three experts aimed to capture diverse perspectives on building design and use while maintaining a manageable scope for the AHP process, which relies on pairwise comparisons. While AHP studies sometimes involve larger expert panels, research has shown that a smaller number of experts can still provide robust results, especially when carefully chosen to represent key stakeholder groups (Eryuruk, et al. 2022; Kamaruzzaman, et al. 2018). This study assumes that each expert reflects the general viewpoint of their professional group.

All experts participated voluntarily, and data was collected through in-person interviews, allowing for open and collaborative discussions. No conflicts of interest existed between the experts and the researchers. The research was conducted ethically respected expert anonymity and data privacy and following ethical guidelines for research with human subjects.

Table 2 Expert panel

Expert	Expertise	Education	Experience
Expert 1	Architect (in design office)	PhD	15+ years
Expert 2	Architect (in public institution)	Graduate	15+ years
Expert 3	Sports manager	PhD	20+ years

3.2.2 Selection Areas for Evaluation

This study focuses on professional basketball arenas designed for basketball-specific use, excluding facilities with multiple sports or entertainment uses. Within these arenas, the evaluation criteria were categorized according to the following space types:

- **General Use Areas:** These areas are accessible to the general public and include spaces like the reception, tribunes, cafe/restaurant, first aid unit, and wet areas.
- **Administrative Areas:** These areas are primarily used for management and administrative functions, encompassing spaces such as management offices, archives, storage, VIP areas, and the media unit.
- **Athlete and Competition Official Specific Areas:** These areas cater to the specific needs of athletes and competition officials, including changing rooms, wet areas, first aid rooms, doping control rooms, referee rooms, observer rooms, statistician rooms, and guest team coach rooms.

This categorization allowed for a nuanced understanding of different user groups' varying priorities and requirements within the basketball arena.

3.2.3 Evaluation Criteria for Basketball Arenas

This study utilizes a comprehensive set of evaluation criteria categorized into three main aspects based on Preiser's framework (1995): technical, functional, and behavioral. To tailor the AHP framework to the specific context of Turkish basketball arenas, a two-step adaptation process was employed:

1. **Literature Review and Expert Consultations:** A thorough review of relevant Post-Occupancy Evaluation (POE) literature and semi-structured interviews with the expert panel were conducted. This identified a

preliminary set of criteria relevant to Turkish basketball arena design and user satisfaction.

2. **Contextualization of Criteria:** The preliminary criteria were then carefully categorized according to the different functional spaces within a basketball arena: general use areas, administrative spaces, athlete-specific areas, and competition official-specific areas. This ensured the AHP framework reflected the diverse needs and priorities of users across these distinct spaces.

This approach allowed for a nuanced understanding of the varying needs and priorities of diverse user groups. The following criteria were identified:

Technical Criteria: These address the physical and environmental conditions, ensuring a safe, comfortable, and high-performing arena for all users:

- **Thermal Comfort:** Temperature, humidity, air movement, and radiant heat.
- **Air Quality:** Ventilation, filtration, and control of pollutants and odors.
- **Lighting:** Illuminance levels, uniformity, glare control, and color rendering.
- **Acoustics:** Noise control, sound insulation, and reverberation time management.
- **Maintenance and Repair:** Ease of maintenance, material durability, and building systems accessibility.
- **Fire Protection:** Fire safety systems, evacuation routes, and fire-resistant materials.
- **Safety and Security:** Accident prevention, crowd control, emergency preparedness, and security systems.
- **Accessibility:** Compliance with accessibility standards for people with disabilities (ramps, elevators, accessible seating, etc.).

Functional Criteria: These evaluate usability and functionality, ensuring the arena effectively meets the needs of diverse users:

- **Flexibility/Adaptability:** Ability to accommodate various events with adaptable seating and multi-functional spaces.
- **Furniture Suitability/Sufficiency:** Comfortable, ergonomic, and sufficient seating and furniture for diverse users.
- **Ergonomics for People with Disabilities:** Provision of accessible facilities and amenities that meet the specific needs of disabled users.
- **Visual Comfort:** Aesthetics, color schemes, views, and overall visual appeal of the arena.

Behavioral Criteria: These assess the arena's impact on user behavior and experience, ensuring a positive and engaging environment:

- **Interpersonal Communication:** Facilitation of easy interaction between spectators, athletes, staff, etc.
- **Personal Space:** Availability of adequate personal space and privacy for users.
- **Visual and Auditory Privacy:** Prevention of unwanted noise and visual distractions.
- **Wayfinding:** Clear signage and spatial organization for easy navigation.
- **Security and Safety Perception:** Design and operations that foster a feeling of safety and security.

Table 3 Evaluation criteria according to spaces in level 1 basketball halls

		General Use Areas	Administrative Areas	Athlete and Competition Official Specific Areas
Technical criteria	Thermal comfort	*	*	*
	Air quality	*	*	*
	Lighting	*	*	*
	Noise	*	*	*
	Maintenance and repair	*	*	*
	Fire protection	*	*	*
	Accident protection	*	*	*
	Accessibility	*	*	*
Functional criteria	Functionality		*	*
	Furniture suitability/Sufficiency	*	*	*
	Provision of ergonomic conditions for disabled	*	*	*
	Visual comfort	*	*	*
Behavioral criteria	Communication	*	*	
	Personal space		*	
	Privacy		*	*
	Wayfinding	*	*	*
	Security and safety perception	*	*	*

3.2.4 Hierarchical Structure of the AHP Model

This study utilizes a hierarchical structure for the AHP process, reflecting the interrelationships and dependencies among the evaluation criteria. The hierarchy is based on the criteria and spaces presented in this chapter.

The decision tree (See Figures 1, 2, and 3) depicts the hierarchical structure:

- **Level 1:** The overall goal of evaluating professional basketball arenas.
- **Level 2:** The three main evaluation aspects (technical, functional, and behavioral) serve as criteria for achieving the overall goal.
- **Level 3:** Within each evaluation aspect (technical, functional, and behavioral), specific criteria are categorized according to the different spaces within the basketball arena (general use areas, administrative areas, athlete and competition official specific areas).
- **Level 4:** Each criterion is further broken down into sub-criteria, representing specific aspects of the criteria relevant to the evaluation.

This hierarchical structure allows for a systematic and comprehensive evaluation of basketball arenas, considering the interplay of various factors across different spaces.

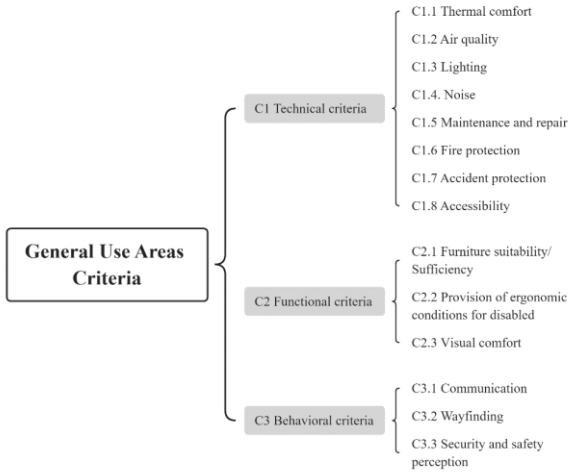

Figure 1 Hierarchical structure of evaluation criteria in general use areas

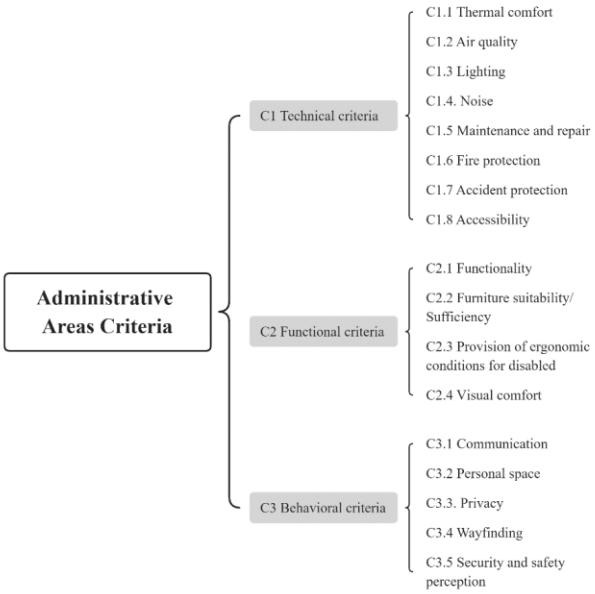

Figure 2 Hierarchical structure of evaluation criteria in administrative areas

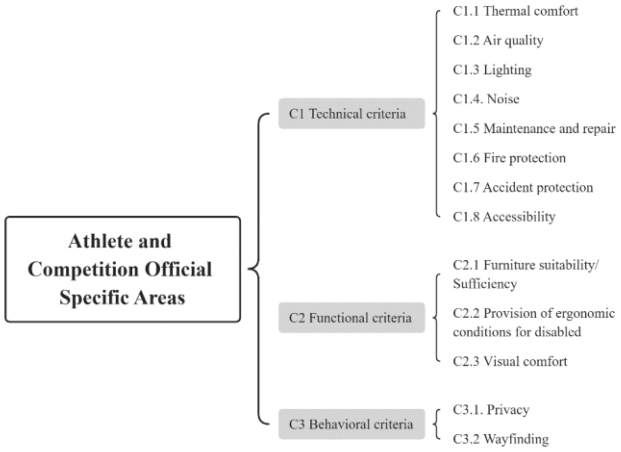

Figure 3 Hierarchical structure of evaluation criteria in areas specialised to athletes and competition officials

3.3 Data Collection

Data collection for this study involved a combination of methods:

- **Literature Review and Design Guideline Review:** To ensure that the evaluation criteria were comprehensive and relevant to current best practices in basketball arena design, a thorough review of existing literature and design guidelines was conducted for the determination of criteria.

- **Pairwise Comparison Surveys:** The primary data collection method was through pairwise comparison surveys administered to the expert panel. These surveys utilized Saaty's 1-9 scale to elicit judgments on the relative importance of each pair of evaluation criteria within each level of the hierarchy. Interviews were conducted in-person to ensure a collaborative and open environment where participants could freely express their views without undue influence.

The collected data was analyzed using Microsoft Excel to calculate the weights and priorities of the evaluation criteria. The software also assisted in checking the consistency of expert judgments and ensuring the validity of the results.

4. Findings

4.1 Prioritization of Evaluation Criteria

Expert opinions were gathered using pairwise comparison surveys and analyzed using the Microsoft Excel. To synthesize the priorities from multiple experts, the geometric mean was calculated, as recommended for AHP with multiple expert responses. This approach ensured the utilization of expert experience while defining the priority levels of evaluation criteria for each space within the arenas.
To ensure the accuracy of the priorities, it was confirmed that their sum equaled "1."

The priorities of the evaluation criteria are presented in the following tables:

- **Table 4:** Prioritization of Evaluation Criteria in General Use Areas
- **Table 5:** Priorities of Evaluation Criteria in Administrative Spaces
- **Table 6:** Priorities of Evaluation Criteria in Athlete and Competition Official Specific Areas

Table 4 Prioritisation of evaluation criteria in general use areas

General Use Areas		
Criteria		Priority (Weight)
Technical criteria	Thermal comfort	0,024
	Air quality	0,031
	Lighting	0,027
	Noise	0,019

General Use Areas		
Criteria		Priority (Weight)
	Maintenance and repair	0,013
	Fire protection	0,039
	Accident protection	0,043
	Accessibility	0,029
Functional criteria	Furniture suitability/Sufficiency	0,131
	Provision of ergonomic conditions for disabled	0,203
	Visual comfort	0,094
Behavioral criteria	Communication	0,053
	Wayfinding	0,062
	Security and safety perception	0,090

Table 5 Priorities of evaluation criteria in administrative spaces

Administrative Areas		
Criteria		Priority (Weight)
Technical criteria	Thermal comfort	0,049
	Air quality	0,061
	Lighting	0,044
	Noise	0,027
	Maintenance and repair	0,028
	Fire protection	0,083
	Accident protection	0,065
	Accessibility	0,055
Functional criteria	Functionality	0,077
	Furniture suitability/Sufficiency	0,067
	Provision of ergonomic conditions for disabled	0,119
	Visual Comfort	0,055
Behavioral criteria	Communication	0,031
	Personal space	0,034
	Privacy	0,039
	Wayfinding	0,033
	Security and safety perception	0,051

Table 6 Priorities of evaluation criteria in athlete and competition official specific areas

Athlete and Competition Official Specific Areas		
Criteria		Priority (Weight)
Technical criteria	Thermal comfort	0,043
	Air quality	0,047
	Lighting	0,036
	Noise	0,035
	Maintenance and repair	0,026
	Fire protection	0,067

Athlete and Competition Official Specific Areas		
Criteria		Priority (Weight)
	Accident protection	0,070
	Accessibility	0,044
Functional criteria	Furniture suitability/Sufficiency	0,083
	Provision of ergonomic conditions for disabled	0,118
	Visual comfort	0,073
Behavioral criteria	Privacy	0,085
	Wayfinding	0,067

4.2. Visualizing the Results

To enhance understanding and communication, the results of the AHP analysis were visualized using a line graph (Figure 4, 5 and 6). The graph depicts the importance weights of evaluation criteria according to the different spaces within the basketball arenas.

The visualization reveals several key insights:

- **Accessibility as a Leading Priority:** The provision of criteria specific to disabled people in general use areas is by far the leading indicator, indicating that accessibility is a critical consideration for this space.
- **Accessibility in Administrative Spaces:** Provision of criteria specific to persons with disabilities is also presented as the most important indicator in administrative spaces, suggesting a strong emphasis on accessibility in these areas.
- **More Balanced Priorities in Other Spaces:** In administrative spaces and in areas specialized for athletes and competition officials, the importance weights of other indicators tended to be more evenly distributed compared to general use areas, highlighting a broader range of priorities in these spaces.

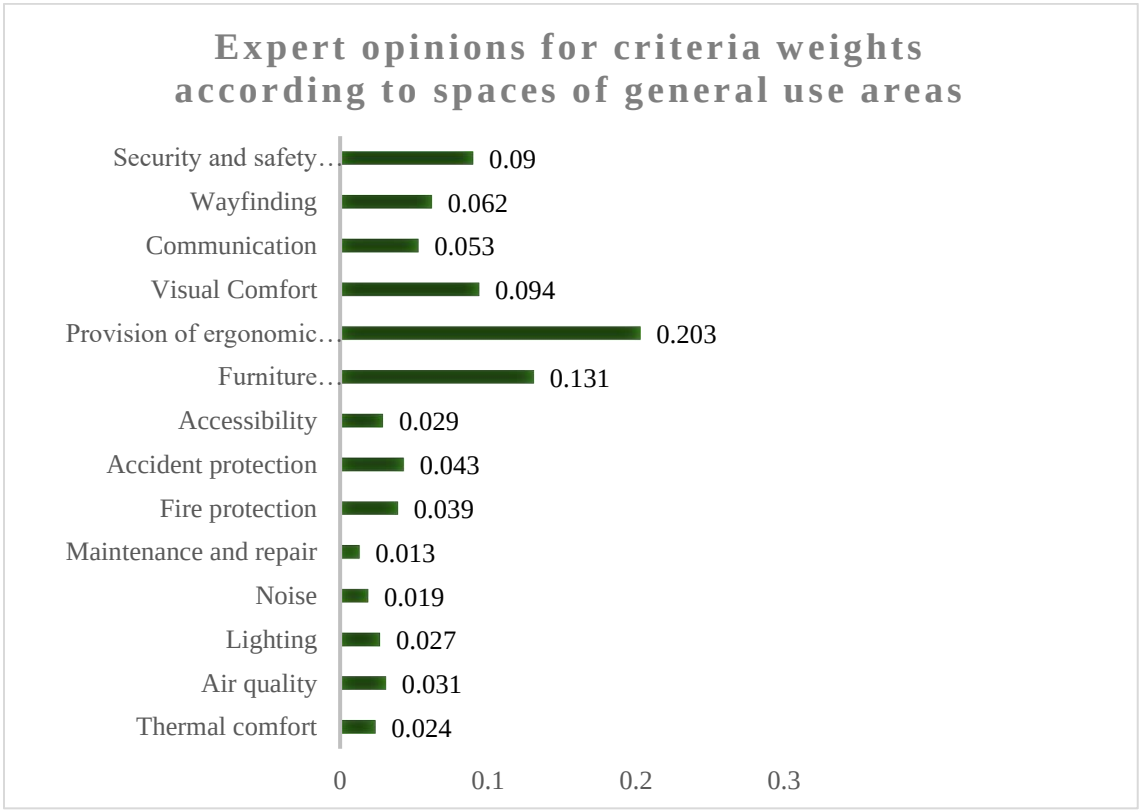

Figure 4 Criteria weights of general use areas in basketball halls

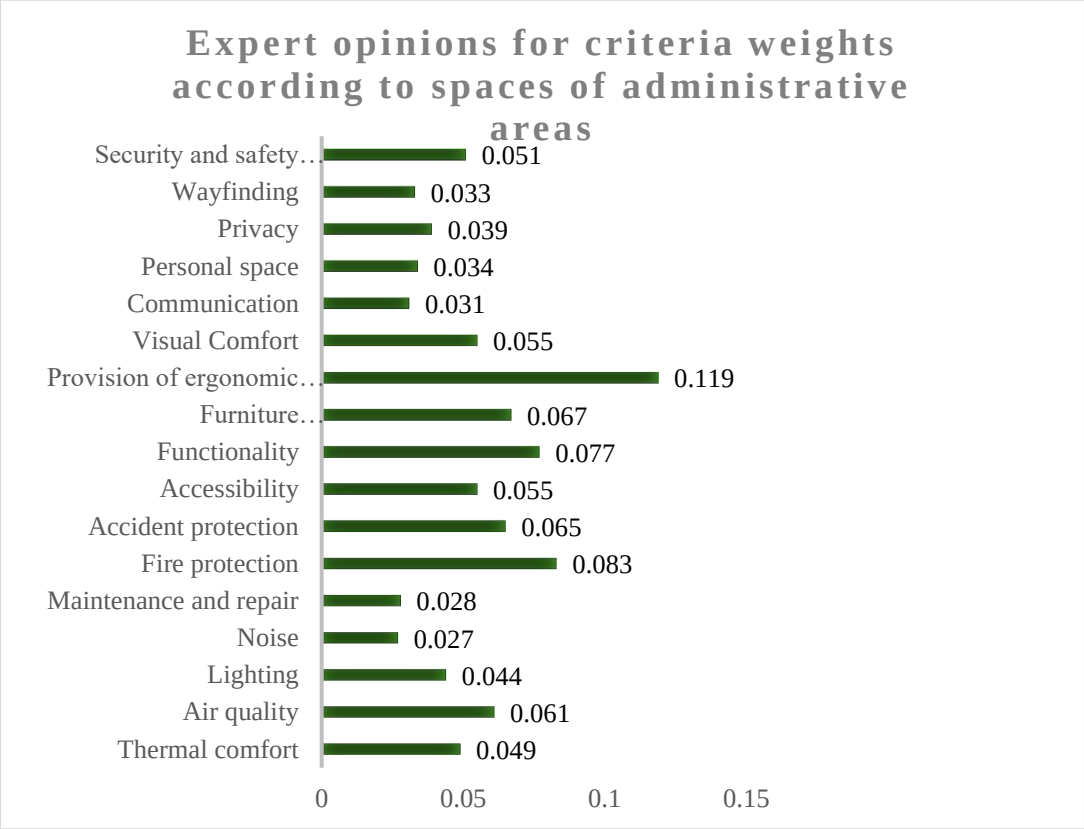

Figure 5 Criteria weights of administrative areas in basketball halls

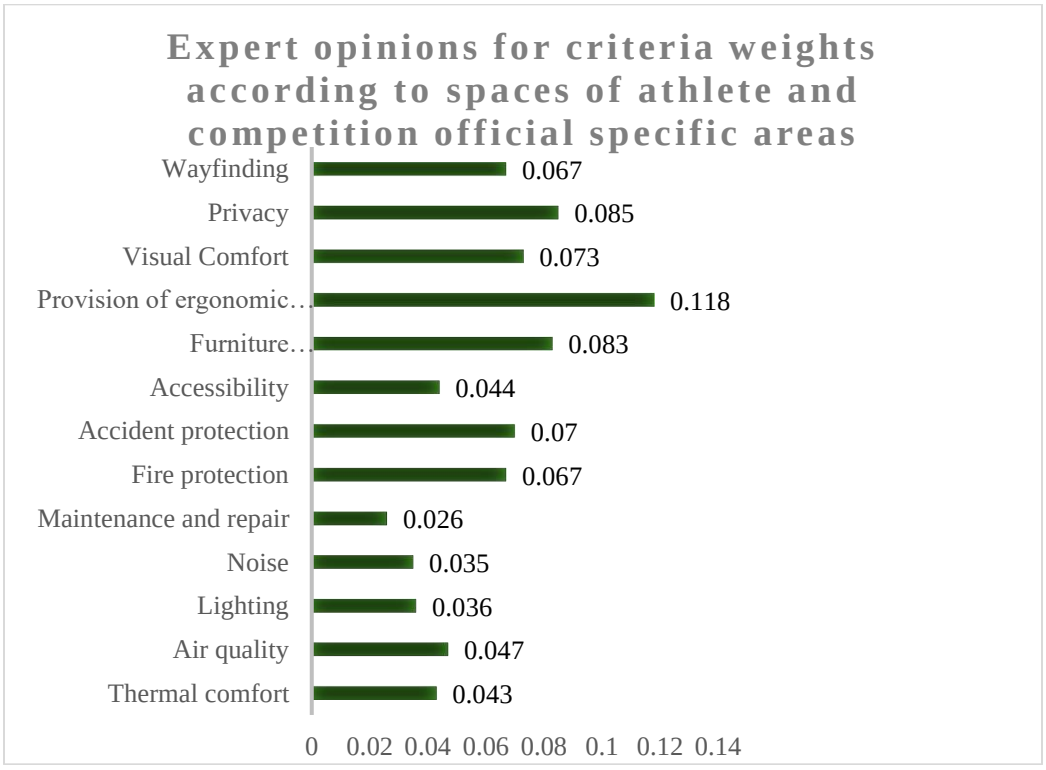

Figure 6 Criteria weights of athlete and competition official specific areas in basketball halls

5. Discussion

The findings of this study highlight the critical role of user needs and safety measures in evaluating professional basketball arenas. The AHP method, by integrating diverse stakeholder perspectives, facilitates comprehensive and objective assessments, promoting user-centered design and informed decision-making.

5.1 Key Findings and Implications

The AHP analysis revealed a clear priority hierarchy of evaluation criteria for different spaces within professional basketball arenas. For example, "furniture suitability/sufficiency" and "provision of ergonomic conditions for the disabled" emerged as top priorities for general use areas. "Fire protection" and "accessibility" were deemed most important for administrative spaces, while "visual and auditory privacy" and "security" held the highest priority for athlete-specific areas.

These findings have several significant implications for the design, evaluation, and management of basketball arenas:

- **User Comfort and Accessibility:** The high weight assigned to criteria related to user comfort and accessibility underlines the importance of creating inclusive and accessible spaces for all individuals. This suggests a need for careful attention to seating design, circulation spaces, and amenities that cater to diverse user needs, including those with disabilities.
- **Safety and Security:** The strong emphasis on fire protection, security systems, and safety perception underscores the critical role of safety and security in the design and operation of basketball arenas. This finding suggests the need for robust safety protocols, advanced security systems, and clear communication strategies to ensure the well-being of all occupants.
- **Specialized Needs:** The prioritization of visual and auditory privacy, accessibility, and communication systems for athlete-specific and competition official-specific areas emphasizes the importance of creating dedicated spaces that cater to the unique needs of these user groups. This implies a need for careful design considerations that balance functionality with privacy and ensure optimal conditions for athletic performance and event management.

These findings offer valuable insights for architects, facility managers, and decision-makers, allowing them to develop more effective strategies for designing, evaluating, and operating basketball arenas that meet the needs and expectations of all stakeholders.

5.2 Interpretation in Context

This study's findings align with the growing emphasis on user-centered design and the importance of creating inclusive and accessible spaces for all individuals. The prioritization of criteria related to comfort, accessibility, and safety resonates with current trends in sports facility design, which increasingly focus on enhancing the spectator experience, promoting inclusivity, and ensuring the well-being of all occupants.

Furthermore, the emphasis on functionality and privacy for athletes and competition officials reflects the recognition of their specific needs and the importance of creating dedicated spaces that optimize performance and facilitate efficient event management. This aligns with best practices in sports facility design, which advocate for a clear separation of spaces and specialized facilities that cater to the unique requirements of different user groups.

5.3 Strengths and Limitations of AHP in the Study

The Analytic Hierarchy Process (AHP) offers several advantages that make it suitable for evaluating complex, multi-criteria problems like basketball arena design:

- **Systematic and Structured Approach:** AHP provides a clear and logical framework for breaking down complex decision problems into a hierarchy, enabling a systematic evaluation of multiple criteria. This was particularly valuable in this study, as it allowed us to consider a wide range of technical, functional, and behavioral aspects of arena design in a structured and transparent manner.
- **Flexibility and Adaptability:** AHP is highly adaptable to different contexts and user needs, making it suitable for evaluating diverse building types and design challenges. In this study, the framework was successfully adapted to the specific context of Turkish basketball arenas by incorporating criteria relevant to local practices and user preferences.
- **Transparency and Accountability:** The pairwise comparison process and the calculation of criteria weights are transparent and readily verifiable, promoting accountability and facilitating stakeholder understanding. This transparency was crucial in this study, as it allowed us to clearly communicate the rationale behind the prioritization of criteria to the expert panel and other stakeholders.
- **Integration of Diverse Perspectives:** AHP facilitates the inclusion of multiple stakeholders and their varying viewpoints, promoting a more holistic and balanced evaluation. This was particularly important in this study, as it allowed us to capture the perspectives of architects, facility managers, and sports managers, ensuring a more comprehensive understanding of user needs in Turkish basketball arenas.

5.3.1 Limitations and Mitigation Strategies

While AHP offers numerous advantages, it's essential to acknowledge its limitations and the steps taken to mitigate them in this study:

- **Subjectivity of Judgments:** AHP relies on subjective judgments from experts, which can introduce potential biases or inconsistencies. To mitigate this, we carefully selected experts with diverse backgrounds and expertise, ensuring a range of

perspectives was represented. Additionally, we clearly communicated the importance of considering the needs of their respective professional groups during the pairwise comparison process.

- **Rank Reversal Issue:** AHP can sometimes exhibit rank reversal, where the addition or removal of criteria can alter the ranking of alternatives, potentially leading to counterintuitive results. This was not observed in our study, as the set of criteria was predetermined through a thorough literature review and validated by expert consultations, preventing any alterations to the criteria set that might have led to rank reversal. However, it is a limitation to consider in future AHP-based evaluations with dynamic criteria sets.
- **Time and Effort Required:** Conducting pairwise comparisons and calculating weights can be time-consuming, especially when dealing with many criteria. To address this, we limited the number of experts to three, which allowed for a manageable number of comparisons while still capturing diverse viewpoints. Additionally, we used Microsoft Excel to streamline the calculation process, ensuring efficiency and accuracy.

In this study, we actively addressed the inherent strengths and limitations of AHP. To minimize the impact of subjective judgments, we reminded experts participating in the fieldwork to reflect the viewpoints of their respective professional groups. To further facilitate the pairwise comparison process, given the numerous criteria, the expert panel was limited to three individuals. Calculations were performed using Microsoft Excel to streamline the process. This approach resulted in a transparent, logical, and structured prioritization of criteria. The diverse viewpoints of the decision-makers are clearly presented, and the consistency of the data has been carefully evaluated.

6. Conclusion

This study successfully demonstrates the applicability of the Analytic Hierarchy Process (AHP) to evaluate professional basketball arenas. A hierarchical framework of evaluation criteria was developed through a comprehensive literature review and expert consultations with sports facility designers. This framework encompassed technical, functional, and behavioral aspects relevant to different spaces within the arena. The AHP analysis revealed the relative importance of these criteria, highlighting the prioritization of user comfort, accessibility, safety, and functionality in Turkish basketball arena design and evaluation.

6.1 Key Findings

The study's findings provide a nuanced understanding of the relative importance of various factors within different basketball arena spaces:

- **General Use Areas:** Fire protection, accident prevention, and air quality emerged as top priorities within the technical criteria. Ensuring ergonomic conditions for people with disabilities was a key functional requirement, while security was identified as the most important behavioral aspect.
- **Administrative Areas:** Fire protection, accident prevention, and air quality were again highly prioritized under technical criteria. Flexibility and adaptability emerged as a crucial functional criterion, while security remained a significant behavioral concern.
- **Athlete- and Competition Official-Specific Areas:** Similar to the other areas, fire protection, accident prevention, and air quality were deemed essential technical criteria. Visual comfort was identified as a highly important functional requirement for these specialized spaces, and security was once again a top priority in the behavioral aspect.

Across all spaces, fire and accident prevention, air quality, and security emerged as high-priority considerations for successful Turkish basketball arena performance. These findings suggest that prioritizing these criteria in design and evaluation processes can significantly contribute to meeting user needs and improving the overall performance of these facilities. This study also highlights the potential for developing building-type-specific evaluation methods based on the data and framework presented.

While previous research has recognized user comfort, safety, and accessibility as important considerations in sports facility evaluations, this study provides a more nuanced understanding of their relative importance within different areas of a basketball arena. The findings can assist architects, facility managers, and decision-makers in gaining a deeper understanding of user needs and preferences, leading to the development of basketball arenas that are not only functional and aesthetically pleasing but also cater to the comfort, safety, and overall experience of all occupants.

6.2 Contributions and Future Research

This research makes several key contributions to the field of sports facility design and evaluation:

- **Development of a Comprehensive Evaluation Framework:** The study presents a structured and holistic framework for evaluating professional basketball arenas, considering multiple criteria and stakeholder perspectives. This framework can be adapted and expanded for use in other sports facility contexts.
- **Application of AHP in a Novel Context:** The study successfully demonstrates the application of AHP in sports facility evaluation, highlighting its versatility and effectiveness in addressing complex decision-making problems in architectural design.
- **Insights into User Priorities:** The findings reveal valuable insights into the priorities and preferences of diverse user groups within basketball arenas, informing future design and management strategies to better meet the needs of athletes, spectators, staff, and other stakeholders.

Several avenues for future research can build upon the findings of this study:

- **Expanding the Scope of Evaluation Criteria:** The current framework can be expanded to include additional criteria related to environmental sustainability, technological integration, economic considerations, and long-term operational costs.
- **Exploring Alternative MCDM Methods:** Comparative studies could explore the application of other MCDM methods, such as TOPSIS or PROMETHEE, in basketball arena evaluation, comparing their effectiveness and results with the AHP approach.
- **Developing User-Friendly AHP Tools:** Creating software tools or web-based applications that facilitate the implementation of AHP for basketball arena evaluation could encourage wider adoption of this method among practitioners and stakeholders in the design and management of these facilities.
- **Conducting Longitudinal Studies:** Longitudinal studies could track the performance and user satisfaction of basketball arenas over time, providing valuable data on the long-term effectiveness of design decisions and the impact of ongoing maintenance and management practices.
- **Investigating Cultural and Regional Variations:** Future research could investigate how cultural factors and regional differences influence user preferences and priorities in basketball arena design and evaluation across different countries and contexts.

By addressing these potential areas of improvement, future research can further enhance the understanding and application of AHP in sports facility evaluation, ultimately contributing to the design and development of optimal spaces for athletic performance, spectator enjoyment, and community engagement.

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