

Factors Affecting the Development of Football Stadium Architecture in the Temperate and Humid Climate of Iran

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Abstract

Purpose: Paying attention to the architecture of football stadiums is considered a significant issue in sports, which has yet to receive less attention in Iran. Considering the presence of teams from northern Iran in the premier league and the specific climatic conditions they face, this research aims to investigate the Factors affecting the development of football stadium architecture in Iran's temperate and humid climate.

Method: This research was conducted using a qualitative approach based on phenomenology. Colaizzi's method (1978) was employed to explore the interview data. The study's target population consisted of university faculty members in art and architecture, engineers in sports facilities construction and equipment, and university faculty members in sports management, totalling 18 individuals. The data collection tool was semi-structured interviews. Validity and reliability criteria were used, including credibility, transferability, dependability, and confirmability. (study Community and sample, sampling method, research method, instruments or questionnaires).

Results: According to the results obtained from the participants' information, the factors influencing the development of football stadium architecture consist of 104 sub-themes categorized into eight main themes. Based on the designers' priorities and the significance of their sub-indicators, these themes include site, climate, moisture control, design regulations, safety, structure, design ideas, and sustainability.

Conclusion: Therefore, designers and relevant managers must pay special attention to the construction of stadiums, which are considered significant and monumental structures in the urban landscape. Considering the eight identified factors in this research, they should be designed with principles and foresight.

Keywords: Design, Football, Sustainable Structure, Architecture, Stadium Construction

Introduction

sustainable strategies and innovative architectural solutions can be found to meet the changing needs of buildings over time, in line with the current requirements of owners and users. It is desirable to replace single-function and static objects with compatible alternatives that demonstrate new spatial, structural, and programmatic design strategies (Hudec & Rollová, 2016). In this regard, the design of sports facilities is a creative endeavour that begins with thinking and ends with presenting a beautiful, efficient, and authentic product. When an architect thinks about creating a place and examines the dimensions, site location, local and climatic conditions, and technical facilities before design, they take into account the individual and collective needs of the users of that place, considering their mental and physical well-being, individual activities, and social and cultural needs, and offer appropriate solutions and designs to create a suitable, beautiful, efficient, and safe space (VazifehdanMolla Shahi et al, 2021).

Creating beauty and innovation in any field is the heritage of creative and innovative human beings. One of the areas in which humans have been able to express their artistry is the construction of sports venues and spaces that harmonize with the natural aesthetics, stadiums that, alongside their beauty, adhere to all engineering principles in various aspects such as location, urban sustainable development, safety, aesthetics, and even external landscaping (Dempsey et al, 2012). The utilization of architectural art in the construction of stadiums, which are constantly visited by different sections of society, is considered a characteristic of civilized communities, and neglecting public needs in the construction of sports facilities is not only a waste of national capital but also a detriment to society, and its compensation will not be easy (Backman & Svensson, 2023).

Furthermore, emphasizing sports and physical

spaces, including sports venues, is essential for maintaining health and physical and mental growth. They play a fundamental role in improving the quality of life and meeting the desirable living standards of citizens. Designing a stadium aligning with this goal serves as a covered space while evoking a sense of an open and accessible environment for players and spectators. The stadium is essentially a place to "witness an event." Therefore, the design of stadium spaces is closely related to the concepts of "watching" and "event." Strategically designing stadiums while adhering to design principles and regulations can not only have a direct and constructive impact on its hosts in terms of psychological aspects but also attract more spectators, create a significant source of income, and ultimately be considered a unique added value in sports affairs (Ghorbani, 2020). Football stadiums are essential centres for fans, players, and the sports industry worldwide. With the rapid development of technology and the need for sustainable performance and providing a unique experience for fans and players, the development of football stadium architecture has become a significant challenge.

Therefore, the main problem of the present research is to identify the factors affecting the development of football stadium architecture. Essentially, the construction of new sports spaces requires scientific and precise studies on location determination, and neglecting this issue will not only result in the inefficiency of the constructed spaces but also waste budget, time, and energy and hurt the quality of sports programs and healthy recreational activities in the future society (Minti, 2019). Nowadays, due to economic problems and the need for maximum efficiency and productivity, the construction of sports facilities and spaces must consider essential and critical factors such as construction criteria, design, location, and proximity to achieve desirable goals during the construction process, and the spatial distribution of these facilities should be based on established standards and comply with

existing regulations, just like any other location (Tabesh et al, 2020).

With the advancement of technology and innovation in the present era, the experience of attending football stadiums can also be improved. Intelligent technologies, virtual reality, and other tools can make the experience of fans and players more unique and dynamic (Rogers et al, 2017). Furthermore, considering climate change and the need for environmental preservation, the development of football stadium architecture also requires sustainability and environmental protection (Kellison et al, 2015). Using sustainable construction methods and materials, energy efficiency, water and wastewater management, and other similar solutions can effectively reduce negative environmental impacts and improve the sustainability of stadiums (Kucukvar et al, 2021). As places for gathering fans and participating in games, football stadiums should create a desirable user experience and close interaction for them (Cho et al, 2019). Welfare facilities, easy access, physical and digital security, recreational spaces, and diverse services can enhance the user experience. Therefore, research in this field can contribute to a better understanding of the needs and preferences of fans and players and provide optimal architectural designs to improve the user experience. The study's results by Soltanhoseini et al. (2021) showed that the critical factors for the success of sports projects were managerial, environmental, project characteristics, and organizational factors, respectively. Generally, it can be acknowledged that the success of sports projects depends on multiple factors that require coordination, and project management should establish connections between these factors with insight and capabilities (Soltanhoseini et al, 2021). Spremić et al. (2024), After examining the fire resistance of the steel structure of the stadium roof, it has been concluded that the stadium structure, benches or seats should be made of non-flammable materials, and people should

not be carrying flammable items. Additionally, the separation of the upper floor area from the seating area using a fire-rated glass wall can prevent the effect of fire on the roof terrace (Spremić et al, 2024). Xue et al. (2024), Article titled Development of membrane structures in China presents the development of membrane structures in China. Noteworthy among these are the incorporation of membrane structures in building facades, suspended ceilings for indoor spaces, and the utilization of ETFT membrane structures. Furthermore, applications of air-supported membrane structures are explored, especially in the areas of sports facilities and environmental protection. Finally, 8 issues for the future research and development of membrane structures are pointed out in the conclusion part (Xue et al, 2024). VazifehdanMolla Shahi et al. (2021) stated in their research that the factors related to aesthetics, safety, sustainable urban development, equipment, urban geography, culture, location, foresight, coherence and unity, and symbolism constitute the framework for the construction and design of sports facilities in the country (VazifehdanMolla Shahi et al, 2021). Stockhusen et al. (2024) describes some of the challenges and design solutions in the field of temporary stadiums, with portable and reusable structures, using the case study of the first stadium 974. "Modular and Iterative Design "The design based on a highly iterative network of identical structural frames enables the use of standardized components such as pre-fabricated tribune units, aisle platforms, and containerized modules (Stockhusen et al. 2024). Feizabadi et al. (2015) This article, with the title "The Application of Retractable Tensile Membrane Structures in the Optimal Design of Roofs for Sports Stadiums", after analysis, proposes this roof structure for large spans and concludes that the use of this system, in addition to meeting the technical and engineering parameters of a covering structure, is very useful and beneficial from the perspective of aesthetics,

environmental considerations, and also during the occurrence of natural disasters due to the reduction in weight and the lighter structure, as well as the high flexibility (Feizabadi et al. 2015). Babaian et al. (2022) mentioned in their research that having open spaces, having green spaces, quick evacuation capability, flexibility in usage, the number of entrances and exits of the sports facility, adjacency of open spaces, adjacency of green spaces, dispersion of sports facilities, the population density of the region, and the proportion between the urban population and the number of sports facilities are far from the desirable state (Babaeian et al. 2022).

The current research aims to provide a more comprehensive and in-depth analysis compared to previous studies, by focusing on a specific domain - the factors influencing the development of the architectural aspect of stadiums. Additionally, this research attempts to examine these influential factors from the initial stage of site selection to the final phase of construction, within the specific climatic conditions. Research on developing football stadium architecture has the potential to yield significant results and advancements, benefiting architects, engineers, managers, and other stakeholders involved in stadium design and construction. These studies contribute to improving architectural standards, technology integration, and sustainability practices within the sports industry while creating spaces that facilitate social, cultural, and sports interactions. This research focuses on the development of football stadium architecture in the northern regions of Iran, considering the unique weather conditions faced by teams in the Iranian Premier League. By addressing these factors, the research aims to enhance the quality and functionality of stadiums in these geographical areas. The findings provide valuable insights for designing stadiums tailored to the local climate and offering optimal experiences for players and spectators. This research contributes to the ongoing

advancement of stadium design, supporting the demand for sustainable and innovative sports facilities and benefiting both the sports industry and the communities they serve. Therefore, the central question of the study is as follows:

What factors affect the development of football stadium architecture in Iran's temperate and humid climate?

Materials and methods

The present research is considered to be applied in terms of its objective and was conducted using a qualitative descriptive approach. This research aimed to identify the factors influencing the development of football stadium architecture. For this purpose, the phenomenological approach was used, and Colaizzi's method (1978) was employed to explore the interview data. The phenomenological approach deals with revealing the nature of meaning hidden in experiences. The researcher's goal is to understand the meaning of the experience in the same way that the person experienced it. Therefore, according to the nature of the research and the use of the descriptive phenomenology method According to the subject of the study, Colaizzi's method was chosen as the most practical method of descriptive phenomenology. The study's target population consisted of university faculty members in art and architecture, engineers in sports facilities construction and equipment, and university faculty members in sports management. Ultimately, 18 individuals from the mentioned groups were chosen as participants in the research. The sampling method was purposive, selecting individuals directly connected to the research topic. People who have experienced the research subject or had a direct relationship with it were used to select samples. Therefore, the participants' lives, work, scientific experience, the complete satisfaction of the people attending the interview, and their ability to conduct the interview and narrate the content were the

criteria for entering and selecting the samples in the research. The requirements for people leaving the study were the lack of desire to continue working with the researcher and the insufficient and incomplete information received by those participating. The data collection tool was a semi-structured interview with open-ended questions. The average duration of the interviews was 35 minutes.

Seven approaches to Colaizzi's method were used in this research. Colaizzi's method has seven stages, which are:

1. A detailed study of all the descriptions and essential findings of the interviewees is needed.
2. Extraction of effective phrases and sentences related to the desired phenomenon.
3. Giving meaning to the vital words and sentences extracted from the interview.
4. Orderly Making and ordering the interviewees' descriptions and common concepts in unique categories.
5. Converting all the quoted opinions into complete descriptions.
6. Converting the comprehensive descriptions of the phenomenon into a shortened, accurate description.
7. final validation.

All interviews were listened to multiple times, and the content was transcribed verbatim in a Word document. The coding process was then carried out using version 20 of MAXQDA software. Considering ethical principles in the current research, the objectives and necessity of the study were explained to the research participants before starting the interviews. Then, the participants participated with their consent and initial familiarity with the topic under study. Before beginning the interview, people were asked to allow the interview process to be recorded entirely. If in any interview, the people did not allow the interview to be recorded, With their permission,

the interview process was implemented with pen on paper. Out of 18 interviews conducted, 15 interviews were recorded, and three were written on paper. In the following, the participants were permitted to withdraw from the interview at any time during the interview process. However, participants remained during the interview and all the interviews were completed. Also, all the interviews were done by setting a previous time in a place away from the crowd and without the interference and participation of others.

Criteria such as credibility, transferability, dependability, and confirmability were utilized to establish validity and reliability in the qualitative research method. To enhance credibility, the interview transcripts and the coding method were shared with some of the participants and a few professors in sports management, and their feedback was incorporated. A detailed report of all research stages and the sample's demographic characteristics were provided for transferability. An intra-subject agreement method was employed to examine the devolving of two coders. Was used. Two expert coders in the field of sports management, familiar with the coding method, coded the interviews, and an agreement percentage of 83% was obtained. Since this percentage is above 60%, the reliability of the research was confirmed. For confirmability, several experts in the relevant field who were not involved in the research process reviewed all research stages, and their opinions were considered.

Result

According to the results obtained from the participants' input in the research, the Factors affecting the development of football stadium architecture in the temperate and humid climate of Iran, include 104 sub-themes organized into 8 main themes: site, climate, moisture control, design regulations, safety, structure, design ideas, and sustainability. Table 1 presents the factors affecting the development of football

stadium architecture based on the designers' themes.
prioritization and the importance of their sub-

Table 1. Factors affecting the development of football stadium architecture in the temperate and humid climate of Iran

Main Theme	Sub-theme
Site	Future traffic planning around the site and street width
	Consideration of visual buffers around the site
	Consideration of access buffers around the site
	Consideration of acoustic buffers around the site
	Alignment of sports facilities with the shape of the land
	Easy access to public transportation around the stadium
	Absence of industrial spaces around the stadium (smoke)
	Distance from residential areas around the site (shadow)(noise)(light)
	Absence of high-rise buildings around the site
	Integration of the site into a recreational area for residents and visitors of the city
Climate	Integration of the stadium site at the end of the network
	Building orientation along the longitudinal axis in the north-south direction
	Building orientation with a maximum deviation of 15 degrees, preferably towards the west
	Increasing the number of covered spaces, overlapping with spectator stands
	Construction of windbreakers on the western side of the stadium
	Optimal placement of spectator seating on the western side
	Ensuring lighting for sideline areas using light fixtures on the roof structure
	Controlling shadows in the stadium and maintaining appropriate temperatures
	Temperature control through heated and cooled seating
	Placement of different types of stadium roofs based on climate conditions
Moisture control	Planting trees around the site to improve climatic comfort conditions
	Avoiding the placement of water features or vegetation in wind-exposed areas
	Controlling the moisture of plants or water features through airflow in the spaces between dense vegetation and buildings
	Using absorbent materials in the landscaping of the building's surroundings
	Preventing water accumulation in sun-exposed areas
	Utilizing covered gutters for irrigation purposes
Design regulations	Preventing direct sunlight exposure on plants located inside the building
	Ensuring proper ventilation in the kitchen, bathroom, and laundry room areas
	One parking space per every four spectators
	Separate seating and standing areas
	Seats with backrests
	Seating and standing space width of 0.5 meters per person
	Any opening or rotation directed outward
	Artificial turf with an average slope of 8 per cent
	Fixed individual seats
	An overhead bridge for emergency services over the trench
Provision of equivalent space for people with disabilities, equivalent to one per cent of the total space	
Safety	Considering the width of the aisle with appropriate rotation for wheelchair accessibility marked passage with a width of 40 centimetres between seat rows
	Adjusting the height of platforms
	Differentiating the colour of emergency doors from the surrounding area
	Installing a fence (metal or security glass) around the stadium
	Securing the level difference between sloped surfaces and adjacent ground with poles
	The material of sloped surfaces should be polished
	Placing emergency exits around the field
	Defining escape routes in the spectator stands
	Direct visibility from emergency doors to the central position and the competition field
	Incorporating escape stairs around the circulation area
Placing the police room and stadium control room next to each other	
Structure	Separating the entrance for spectators from the exit
	Defining the stadium exit with a tree-like pattern
	Stadium lightweight and strengthening construction
	Space-frame structures (tubular spatial frames)
	Tensile membrane structures (fibreglass membrane with PTFE coating)
	Green building materials (ETFE foil panels)
Semi-transparent roofs with polycarbonate sheets over spectator lobbies and stands	
Shell structures	
Cable and tension structures	

	<ul style="list-style-type: none"> Combination of steel structures with precast concrete <ul style="list-style-type: none"> Truss beams Open and retractable roofs Frames, arches, and giant cupolas Reduction of steel usage with large bubble shapes and honeycomb structures underneath <ul style="list-style-type: none"> Diagrid structures Pneumatic or inflatable structures Reinforced plate structures Stressed roofs (with different shapes and sections) Congress roofs (conical wavy surfaces) Lamella roofs Folded geometry roofs Geodesic dome roofs Shodler domes Zeiss domes Stroudham domes Gear-driven spherical domes Constructing stadiums using transport containers and modular steel elements <ul style="list-style-type: none"> Using durable materials for separation and reassembly
Ideas	<ul style="list-style-type: none"> Incorporating impactful (iconic) spatial design in the quality of the urban environment <ul style="list-style-type: none"> Placement of sports reporting room in the central spectator position Stadium layout designed in an oval, U-shape, semi-circular end geometry, corners and sides with curved arc geometry, horseshoe-shaped around the transverse axis (cross-section) Determining the dimensions of the stadium field based on spectator sightlines <ul style="list-style-type: none"> Linear seat gradient for spectators' comfort Installation of alternating wave breakers in each block <ul style="list-style-type: none"> Elevating the first row above ground level Ensuring sightline distances between spectators in football matches <ul style="list-style-type: none"> Temporary stadium design Flexibility in capacity (changing stadium capacity) Incorporating steeper angled supports in two levels to increase capacity <ul style="list-style-type: none"> Flexibility in changing the stadium's usage The stadium accommodates various purposes (concerts, fitness, swimming, etc.) <ul style="list-style-type: none"> Neutral background in the spectator stands with black and white seats Access to seats from circulation areas, at the back of the stands Adequate views of the city or nature through the circulation space around the stadium <ul style="list-style-type: none"> Utilizing high-tech styles in the facade
Sustainability	<ul style="list-style-type: none"> Large dimensions and geometry of tree canopies around the site (providing shade) <ul style="list-style-type: none"> Green hedges Utilizing water resources (rainwater collection) <ul style="list-style-type: none"> Power supply through solar systems Designing appropriate vegetative cover Incorporating principles of local architecture Using native and local plants around the site Utilizing materials and products that are recyclable and returnable to the natural cycle <ul style="list-style-type: none"> Installation of bases and trellises on facades Living walls (oxygen-producing)

In Figure 1, the final research pattern is depicted.

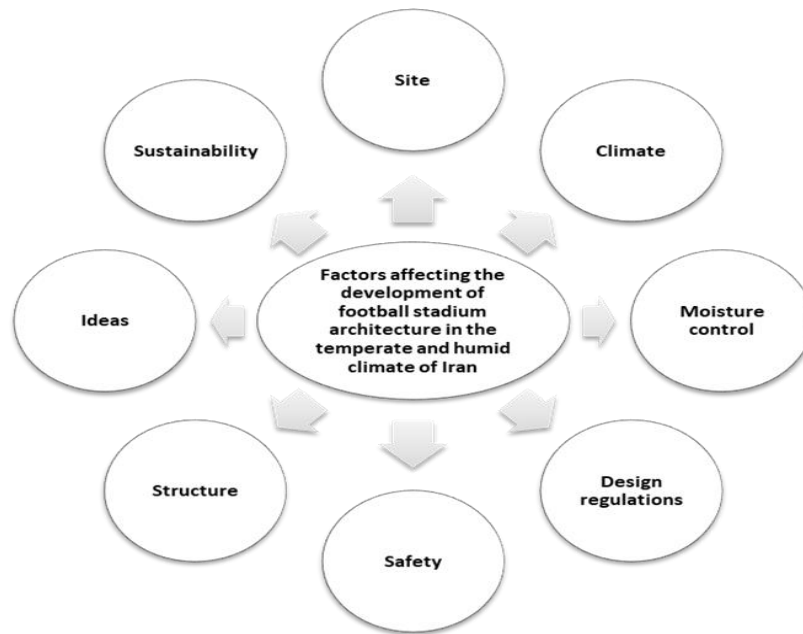


Figure 1, the final model of the research

Discussion

The development of stadiums in Iran is one of the critical goals of the government and sports-related institutions. Given the large population of Iran and the significant interest of people in sports, there is a growing need for modern and suitable stadiums to host increasing sports events. Sports stadiums, recognized as monumental city structures, should be prominent buildings. In developing football stadium architecture in Iran's temperate and humid climate, attention can be given to the following priorities presented by designers: site, climate (moisture control), design regulations (safety), structure, and design ideas and sustainability.

The first crucial criterion in stadium design is the project site. Attention should be paid to the area, the shape of the land, and its location in a way that adequately addresses the project's needs. The project site should be well-placed without disrupting the stadium's operation and surrounding environment. For example, a stadium can be located at the end of the urban network, away from residential areas and tall buildings. It can also be situated near

recreational areas such as a lake or natural surroundings, allowing direct connectivity with nature through surrounding circulation spaces. Overall, future planning should consider traffic and the width of the streets surrounding the site.

The second identified theme is climate. Weather significantly influences the design and architecture of football stadiums. Factors like climate, temperature, sunlight, drainage, and wind must be carefully considered. Stadiums need to withstand harsh weather conditions, offer comfort to spectators, ensure good visibility, and prevent flooding. Measures such as roofing, shading devices, ventilation systems, and drainage systems are implemented to create an optimal environment for players and spectators, regardless of the prevailing weather conditions. In sports facilities, in addition to the need for visual quality and natural light throughout the day, there is a need to protect against adverse weather conditions. Considering that the climate in the present study is moderate and humid, the roof structure of the building is considered crucial due to the high precipitation in these areas. Nowadays, stadium roofs are designed to allow for easy opening and closing, providing flexibility in different weather conditions.

This type of roof comprises precast elements and components that can be opened and closed. The main problem with these types of roofs is the creation of a shadow in the middle of the field when the roof is closed, which affects the visual quality. Semi-transparent space roofs with polycarbonate panels can be used to solve this issue. The orientation of the sports fields should also be designed to avoid direct sunlight in players' eyes during the game. Therefore, the longer axis of the field should be aligned north-south or with a maximum deviation of 15 degrees to the sides, preferably towards the west. Windbreakers can be constructed to prevent the influence of disruptive winds.

Moisture control is another aspect related to the climate. For this purpose, proper ventilation of the stadium should be maintained continuously. Additionally, to prevent increased moisture, water should be avoided from remaining in the site area that faces the sun, and sufficient attention should be given to controlling the humidity of plants exposed to sunlight.

The next following identified theme is design regulations. Safety rules in football stadium design prioritize structural integrity, evacuation routes, fire safety, crowd management, accessibility, security, and regular maintenance. These measures ensure the well-being of players, spectators, and staff, encompassing aspects such as load-bearing capacity, clear exit paths, fire-resistant materials, crowd control strategies, accessibility features, security systems, and routine inspections. Experts in the field have established design regulations, and they are nearly the same worldwide for all stadiums. Attention to these regulations is essential to designing a stadium with appropriate functionality and physical and mental comfort. The identified themes in this section help improve the design process.

The safety of the stadium structure, part of the design regulations, is paramount. Buildings that can cause significant damage, such as stadiums or any covered space accommodating 300

people under one roof, are essential in their location and earthquake-resistant design. Considering that our country is located in a seismically active zone, attention to this matter and appropriate planning in terms of design, construction methods, and seismic strengthening are a priority. In addition to structural design, other measures can be considered to enhance stadium safety, such as increasing the number of emergency exits, separating spectator entrances from exits, and incorporating escape stairs.

The next aspect is the study of stadium structures, which is usually based on the design requirements and dimensions of the stadium. Generally, stadium structures are designed as large and complex structures to withstand the stadium's weight. Structural technology has advanced significantly, and new structures have entered the market. These structures, through a combination of architecture, can tolerate higher loads, reduce human hazards during natural disasters, and improve environmental sustainability (by reducing the consumption of materials such as steel and concrete) and visual aesthetics. One type of such roof is retractable roofs for large-span coverings. Dome structures can also be used partially in the spectator stands area with a curved shape. It seems necessary to comply with these points in the construction and design of football stadiums in the humid regions of Iran.

The next following identified theme is design regulations. design ideas. The design of a sports stadium, as a monumental structure in the city, should be created to stand out and attract attention. These ideas are shaped based on the designer's perspective and prioritization, taking into account the site's surroundings, climate, design regulations, and safety and considering the structural weight for its stylization, which has various types. It can design the building as temporary or, in other words, flexible and multipurpose. Additionally, the designer can showcase innovative structures in the façade

and roof using high-tech styles.

The last identified theme is sustainability. The main goal is to balance human interactions and the environment. These issues are rising with the increasing population, global warming, and climate change. One of the most critical objectives for humanity is to prevent and address them through sustainable structures. In urban environments, where space on the ground is limited but vertical spaces are abundant, vertical greening helps integrate structure and nature. On the other hand, the building facade is permanently influenced by its surrounding environment, such as sunlight, snow, wind, and acid rain, which can lead to the deterioration of facades. A living wall system contributes to air purification and oxygen supply. It plays a vital role in reducing summer and winter energy consumption, noise pollution, and harmful radiation, significantly reducing air pollution. It seems necessary to comply with these points in the construction and design of football stadiums in the humid regions of Iran.

To summarize, this research focuses on the factors influencing the development of football stadium architecture in Iran's temperate and humid climate. The study highlights the significance of considering site conditions, climate, moisture control, design regulations, safety measures, structural aspects, design ideas, and sustainability principles in the design and construction of stadiums. By incorporating these factors and prioritizing user experience, architects can create remarkable and functional stadiums that contribute to the urban landscape and meet the needs of players and spectators. Additionally, the research underscores the importance of sustainable construction practices and environmental preservation in the context of football stadium architecture, ensuring long-term viability and reducing negative environmental impacts.

Therefore, it is necessary for relevant managers and designers involved in designing, constructing, and developing football stadiums

in the northern region of the country to pay sufficient attention to the factors influencing the architectural development of stadiums. They should engage in future-oriented planning to address the current existing problems. The identified concepts in this study can significantly assist them in this regard.

Conclusion

The present research helps to take a step forward in the development of stadiums in the country's temperate and humid climate. This research helps managers and draws their attention to the appropriate selection of the site before building it, which is very important, as making the wrong choice will incur huge costs. Additionally, the research is very helpful in guiding the selection of appropriate structures for the temperate and humid climate, as well as providing solutions for ensuring sustainability.

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