

A Content Analysis of Immersive Spatial Design Components in Sports Recreational Spaces

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ABSTRACT

Many modern sports facilities are built for durability and basic function, but this often leaves them feeling sterile and uninviting, a problem that may be quietly undermining public motivation to stay active. This paper looks at immersive technologies that offer a way to bring these spaces back to life. Specifically, it examines the components of immersive spatial design and how they might be used to boost physical activity and athletic performance. Recreational sports venues have traditionally leaned toward plain, low-maintenance layouts, and this can contribute to mental fatigue and a drop in motivation among both serious athletes and casual users. To explore this, eight international immersive sports projects spanning 2010 to 2026 were examined through a qualitative content analysis, organized around four components: physical object, content, interaction, and environment. Each of these was assessed for its role in shaping physical interaction, spatial realism, and psychological focus. The analysis suggests that expressive, dynamic visuals projected across three-dimensional surfaces, paired with automated or touch-free tracking and deliberately controlled lighting, do a great deal to enhance immersion, concentration, and motivation among athletes. In effect, immersive spatial design turns passive concrete structures into environments that respond to the people using them, closing the gap between purely functional urban infrastructure and the sensory expectations audiences now bring with them. The paper concludes that bringing these components together offers a workable path toward modernizing public sports venues, one that can deepen psychological flow and support long-term public health engagement for future generations.

Keywords: Immersive Spatial Design, Sports recreational spaces



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1 INTRODUCTION

Public sports and recreational spaces are important for community health and social life. These areas give people a place to stay physically active, hang out, and improve their overall well-being. However, to make these sports spaces successful, the physical environment itself needs to be engaging. This is where immersive spatial design comes into play. Immersive spatial design is an approach that uses multi-sensory elements such as interactive lighting, unique sensory, dynamic layouts, and controlled sound environments to turn a normal, empty area into a lively and responsive experience. Combining sports spaces with immersive spatial design is crucial because the environment directly affects how a person feels and performs.

Right now, many sports facilities are built only for basic function and high durability to prevent wear and tear. While this makes them easy to maintain, it also makes the courts or skateparks look blank, boring, and uninviting. When a space feels completely empty and plain, athletes and casual users can easily lose motivation or feel stressed by the boring, repetitive nature of their training. According to (Koohsari et al., 2024), the design of the built environment is a key factor in how people interact with a space and how much effort they put into physical activities. Therefore, by adding immersive elements, we can make sports spaces feel "alive" and exciting. This changes them from boring concrete structures into emotional and engaging hubs that support the mental well-being of the whole community.

1.1 Research Objective

The objective of this study is to examine how immersive spatial design can be applied to improve public sports and recreational spaces. By using content analysis, this research systematically analyses the main components of immersive spatial design, including physical surfaces, visual content, interactive elements, and the surrounding environment. By exploring these design variables, the research identifies practical ways to optimize plain and sterile facilities and to provide design solutions that help users focus better on their training, enjoy their workouts, and have a more engaging experience during physical activities.

1.2 Problem Statement

At present, there is a significant lack of research exploring how immersive spatial design can be applied to sports spaces. While immersive design such as using interactive lighting, responsive sound, and dynamic visuals is growing in other fields such as contemporary art galleries, where multi-sensory technologies such as VR and MR have already been shown to deepen visitor engagement and interactivity in immersive exhibitions (Asmi et al., 2025), commercial retail, where creative, designed store environments are used to shape the retail experience and organisational identity (Kent, 2007), and digital entertainment venues, and is beginning to reshape education and training through shared immersive spaces used for learning and skills development (Koivula, 2025), its potential to improve sports and recreational spaces remains heavily understudied.

As a result, many designers and local councils do not realize how important these sensory elements are for encouraging public physical activity. Because of this research gap, most current public sports facilities, such as basketball courts and skateparks, are built with a very basic approach. They focus too much on being highly durable and easy to maintain, rather than focusing on the actual experience of the human being using the space. This makes these public areas feel sterile, inactive, and uninviting. Past research by (Koohsari et al., 2024) has already proven that the quality of a sports environment directly affects how often people visit and use it. Without immersive elements, standard plain sports spaces miss a huge opportunity to create a state of "flow", a psychological state where athletes feel completely focused, motivated, and deeply connected to their activity. Ultimately, if sports facilities remain plain and boring, they fail to reduce user stress or provide the mental and emotional boost that communities need for long-term health and sports participation.

2 LITERATURE REVIEW

This literature review explores the key components of immersive spatial design such as the physical layout, sensory elements, and interactive technology and how they can be used to improve public sports and recreational spaces.

2.1 Immersive Spatial Design to Enhance Athlete Motivation

Immersive spatial design is a design approach that transforms a physical space into an active, responsive environment by engaging human senses. Instead of relying on static walls and floors, it

integrates multi-sensory components such as interactive lighting, dynamic visual projections, texture materials, and controlled soundscapes. This view builds on earlier design theory, which argued that a spatial environment should be understood through several interacting dimensions, its physical, conceptual, perceptual, and behavioural aspects rather than as a single static backdrop (Trumbo, 1997). When applied to architecture, this design method shifts the focus from purely functional structures to the emotional and psychological experience of the people using space, making the environment feel "alive" even when it is physically empty.

Using immersive spatial design is a powerful way to make sports spaces more exciting. By adding design elements that react to human movement or alter the overall atmosphere, a simple court can be transformed into an inspiring environment. This approach helps athletes feel more spirited and reduces the "mental fatigue" or boredom that comes from training in a dull, grey area. Research by (Yao & Xiao, 2026) suggests that evaluating sports architecture through user perception is vital for creating successful venues. When a facility feels vibrant and interactive, it allows athletes to easily enter a state of deep focus, commonly known as "flow," where they become completely absorbed in and highly motivated by their activity. This strong connection between the person and the space ultimately helps build a stronger community identity and makes public facilities much more popular and frequently used (Salimi, 2024).

2.1.1 Sports Recreational Spaces

Public sports spaces like basketball courts, futsal courts, and skateparks are usually built with a focus on function and durability. However, when these spaces are too plain, they can feel "empty" or boring, which often leads to higher stress levels for athletes and lower motivation for the community to stay active. According to (Koohsari et al., 2024), the way a built environment is designed directly affects modern sports science and how people engage in physical activity. This is supported by empirical survey evidence as well: a study of 721 users across nine waterfront sports complexes in China found that built-environment factors such as accessibility, safety, and opportunities for social interaction significantly predicted user satisfaction, an effect partly explained by users' sense of place attachment (Zhang et al., 2025). This concern is not limited to the sensory qualities of a space; how sports facilities are planned and located also shapes whether communities use them, since accessibility, service radius, and surrounding urban infrastructure all influence residents' willingness to visit a facility (Yuan et al., 2019). Even where a facility is conveniently located, its external appearance still matters to younger users' research on interactive façade design for youth sports centres suggests that visually engaging, technology integrated building exteriors can play a role similar to interior sensory design in attracting and retaining young people (Nur Atiqah et al., 2025). If a space feels inactive, it loses its value as a community hub. Therefore, modern sports architecture needs to move beyond just being a "place to play" and become an "experiential space" that supports mental health and social connection.

2.2 Components of Immersive Spatial Design

Based on the framework of interactive and immersive environments, there are four main components that make a space feel "immersive": the physical object (the space), the content (visuals/atmosphere), the interaction (the connection between the user and the space), and the environment (sound). These elements work together to turn a boring facility into a meaningful experience (Hyora et al., 2013). A similar componential logic has been used elsewhere to break down immersive three-dimensional environments for instance, identifying the object, content, interaction, and environment elements that support cultural-heritage preservation in immersive virtual reality (Firoz Khan et al., 2025), suggesting that this four-part structure travels well across different immersive design domains, not only sport.

2.2.1 The Physical Object

In this study, the object refers to the physical surfaces of the sports recreational area, such as the floor of a basketball court, the walls of a skatepark, or the ceiling of an indoor gym. Unlike flat screens, these 3D surfaces allow for creative manipulation of perspective. When these surfaces are designed with interesting patterns or textures, they can change how an athlete perceives the size and energy of the space, making it feel more immersive and less sterile (Yao & Xiao, 2026). This three-dimensional quality is not incidental: research on underwater rugby, one of the few sports that unfolds fully in three dimensions, shows that immersive three-dimensional physical experiences can meaningfully broaden a person's spatial and perceptual awareness, reinforcing why the sports surface should be treated as a three-dimensional object rather than a flat backdrop (Özdamar, 2025).

2.2.2 The Content

Content refers to the visual imagery, colours, and textures used within the sports space. Expressive content leverages texture, materiality, and the seamless blending of real images with computer-generated graphics to create a vivid sense of realism. This can make the object appear as if it has truly transformed, enhancing the audience's sense of presence. Non-expressive content, by contrast, lacks these qualities and may not evoke the same level of engagement or immersion. The richness and realism of the content are key factors in sustaining the audience's interest and emotional response (Hyora et al., 2013). For example, using vibrant colours or digital projections can visually transform a concrete floor into a dynamic surface. High-quality visual content helps in reducing stress by creating a more "natural" or "energetic" feeling. Studies show that the richness and realism of the design content are key factors in keeping a user's interest and emotional response high.

2.2.3 The Interaction

Interaction is the component that connects the physical action of the athlete with the digital response of the space, transforming a passive court into an active partner. According to (Edmonds et al., 2006), interactive spaces can react to human presence through movement, weight, or speed, which alters the environment in real time. In a sports setting, this means floor patterns can light up as a skater rolls past, or colors can shift when a basketball hits the backboard. This creates a state of "embodied interaction," where the human body interacts naturally with a smart environment (Dourish P, 2001). This active feedback gives athletes a sense of control and playfulness, which breaks the boredom of repetitive training, reduces everyday mental fatigue, and gives them a reason to stay active longer (Erickson, 1993). This pattern is echoed outside sport as well: a study of interactive projection mapping used to enhance youth engagement with the traditional Kuda Kepang performance in Malaysia similarly found that responsive, motion visual elements increased participants' attention and enjoyment, supporting the broader claim that it is interactivity itself, not the specific setting that, drives sustained engagement (Nordin & Che Din, 2025).

2.2.4 The Environment

The environment includes external atmospheric factors, and in this study, the distinction between indoor and outdoor settings plays a crucial role in the effectiveness of the sports space. By controlling the spatial environment such as utilizing indoor facilities or leveraging natural outdoor landscapes the perception of a space can be completely altered. For athletes, choosing the right environment can block out distracting city chaos, help them enter a state of deep concentration, and reduce everyday stress. Proper environmental spatial design ensures that both indoor and outdoor elements remain distinct and motivating, providing a powerful energy boost that allows the athlete to stay highly focused and inspired during their daily training sessions (Koohsari et al., 2024).

3 METHODOLOGY

3.1 Research Design

This research uses a qualitative content analysis approach to examine the immersive spatial design components that can improve engagement in sports recreational spaces. The research focuses on four main elements: object, content, interaction, and environment, based on the framework adapted from (Hyora et al., 2013). According to (Krippendorff, 2019), content analysis is a systematic way to make valid conclusions from data within a specific context. This method allows the researcher to identify themes and patterns in qualitative data, helping to organize complex design information and clarify how specific immersive components affect the way athletes experience a space (Bengtsson, 2016).

By analysing eight selected case studies of existing sports, the research maps out how physical spaces (object), visual graphics (content), responsive systems (interaction), and landscapes (environment) work together to reduce stress and build a more energetic public space for the community.

The components of immersive spatial design in this study are adapted from the spatial and experiential frameworks of (Svabo et al., 2013) and (Globa et al., 2022), which include physical object, content, interaction, and environment.

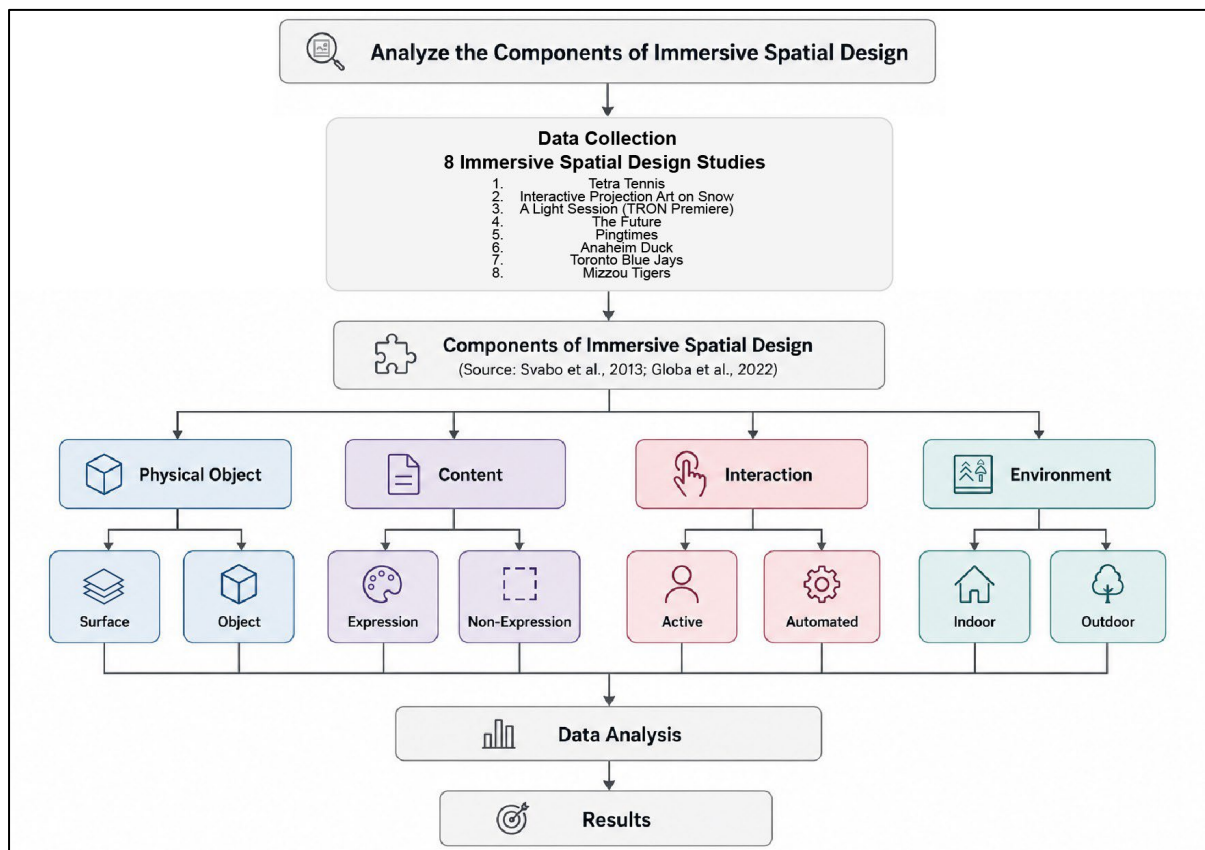
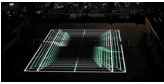


Figure 1 Framework of study
(Source: Svabo et al., 2013 and Globa et al., 2022)

4 SAMPLE OF IMMERSIVE SPATIAL DESIGN

These immersive spatial design works were selected based on their availability on YouTube and Vimeo to demonstrate how these technologies are applied within sports recreational spaces. The selection focuses on international projects, showcasing how global immersive spatial designs are incorporated to attract and engage visitors. These selected sports cases span from as early as 2010 to the most recent developments in 2026.

Table 1 Selection Sample of Immersive Spatial Design Based on Recreational Sports that is available on the YouTube and Vimeo Platform.

No	Code	Immersive Spatial Design Project	Production	Year/Places	Theme/Sports	Platform
1	ISD 1	Tetra Tennis 	1024 Production	2010 French Master in (Paris,Bercy)	Tennis	Vimeo
2	ISD 2	Interactive Projection on Snow 	ENESS	2010 Melbourne Australia	Skiing	Youtube
3	ISD 3	A Light Session (TRON Premiere) 	ENESS	2010 Melbourne Museum	Skateboardin g	Vimeo
4	ISD 4	The Future 	Obsura Digital	2010 Unknown	Basketball	Vimeo
5	ISD 5	Pingtimes 	VVVV	2013 Bucharest Romania	Ping Pong	Vimeo
6	ISD 6	Anaheim Duck 	Quince Imaging	2024 Honda Center, Anaheim (California).	Ice Hockey	Youtube
7	ISD 7	Toronto Blue Jays 	Quince Imaging:	2026 Rogers Centre, Toronto (Canada).	Baseball	Youtube
8	ISD 8	Mizzou Tigers 	Quince Imaging	2023 Mizzou University (Missouri)	Basketball	Youtube

5 DATA ANALYSIS

Table 2 Analysis of Components of Immersive Spatial Design
Components of Immersive Spatial Design

Code	Physical Object		Content		Interaction		Environment	
	Surface	Object	Expressions	Non-Expression	Active	Automated	Indoor	Outdoor
ISD 1	(/) Physical Court		(/) 3D visual container for tennis court.		(/) Body tracking movement.		(/)	
ISD 2	(/) Physical Snow Terrain		(/) Digital patterns and light objects scaled by slope distance		(/) Tracking object near the terrain			(/)
ISD 3	(/) Physical Mini Skate Ramp		(/) Visual aesthetic placed within comfortable FOV.		(/) Hands-free interaction via motion sensors.			(/)
ISD 4	(/) Physical basketball court		(/) 2D/3D content containers with hierarchical visual layers.		(/) Adaptive system that responds to the court environment.		(/)	
ISD 5	(/) Physical Ping pong table		(/) 3D visual container for ball tracking.		(/) Physical impact of the ball used as a natural input method.		(/)	
ISD 6	(/) Physical ice rink edges.		(/) Team branding toolbars and large-scale stadium UI			(/) Big spanning across massive arena volumes.	(/)	
ISD 7	(/) Physical field turf.		(/) Field-scale 3D visual container and spectator reticles.			(/) Event-triggered transitions between immersion levels.	(/)	
ISD 8	(/) Physical wood court surface.		(/) 3D visual containers for player intros and virtual tiger effects.			(/) Scaled visual objects based on viewer distance	(/)	

(Adapted from Svabo et al., 2013 and Globa et al., 2022, which includes physical object, content, interaction, and environment)

6 RESULTS

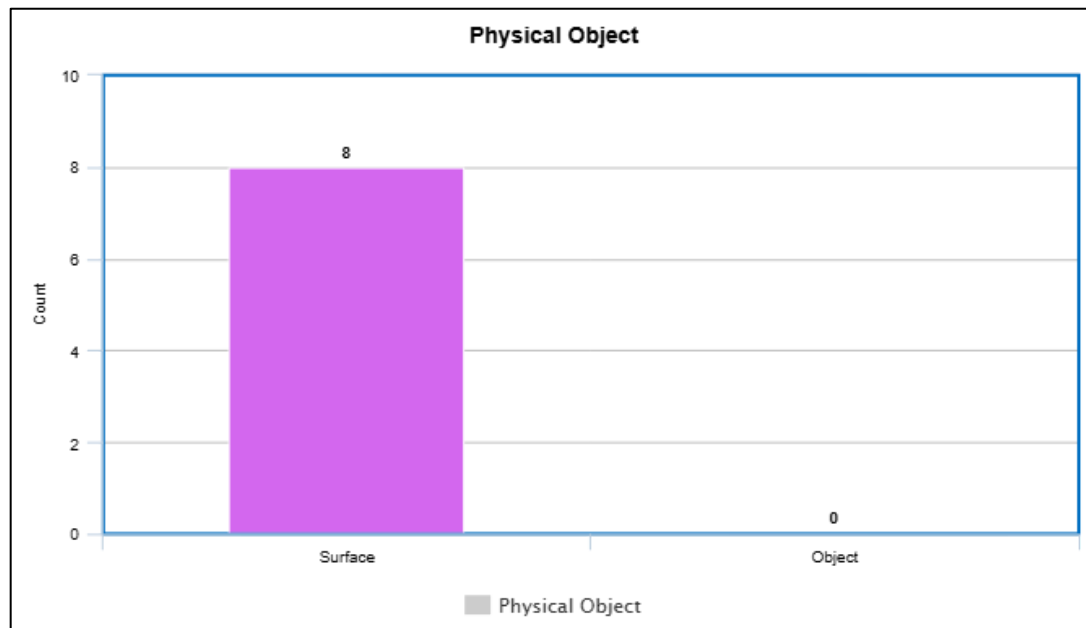


Figure 2 Results of Physical Object in Immersive Spatial Design

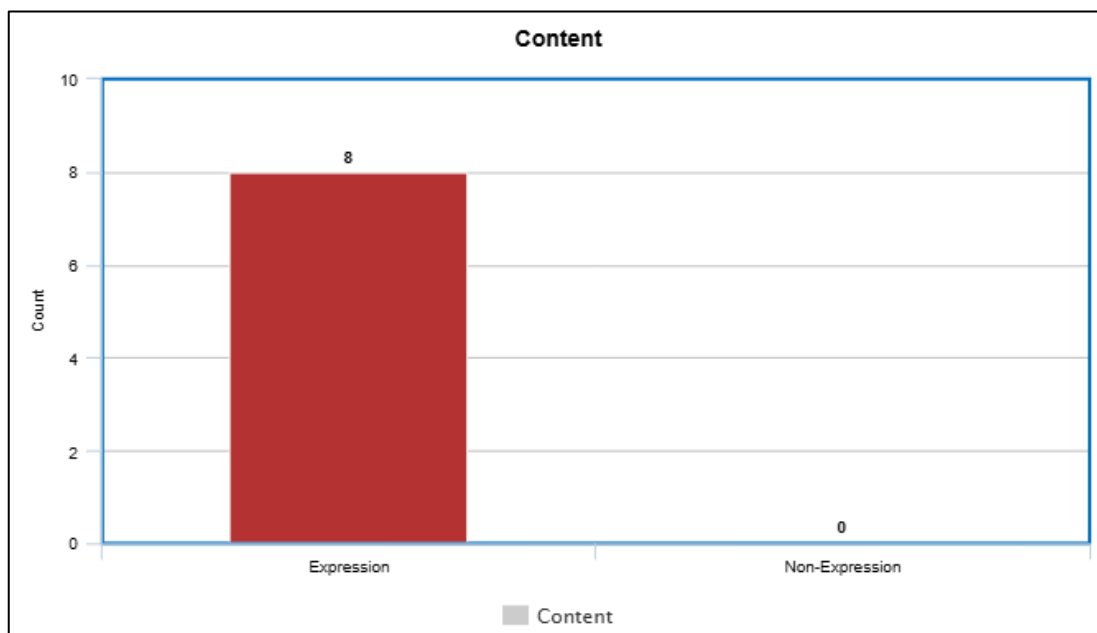


Figure 3 Results of Content in Immersive Spatial Design

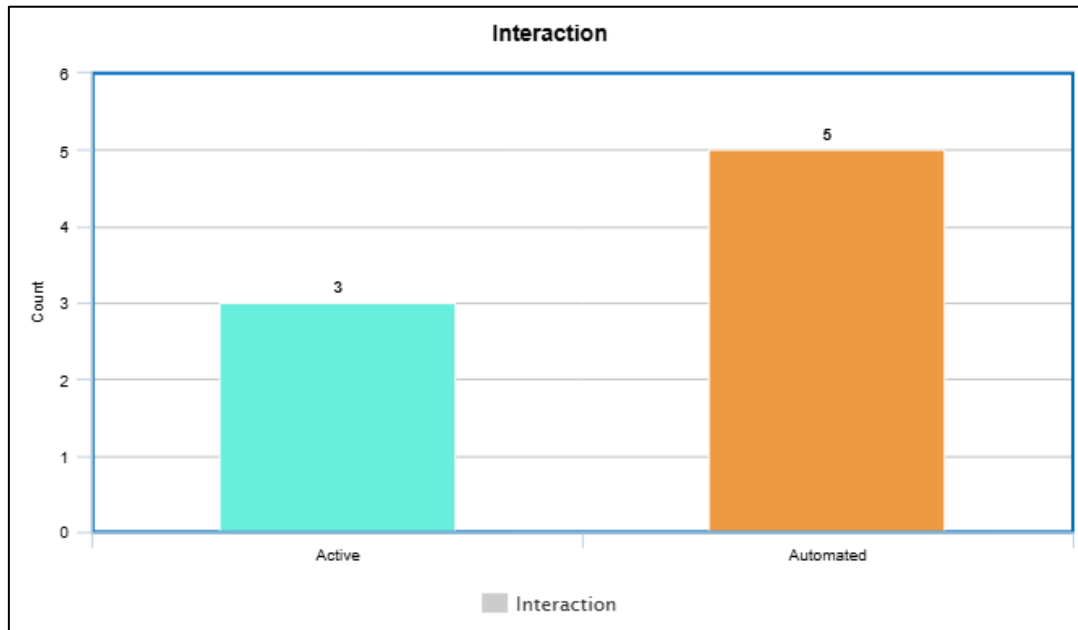


Figure 4 Results of Interaction in Immersive Spatial Design

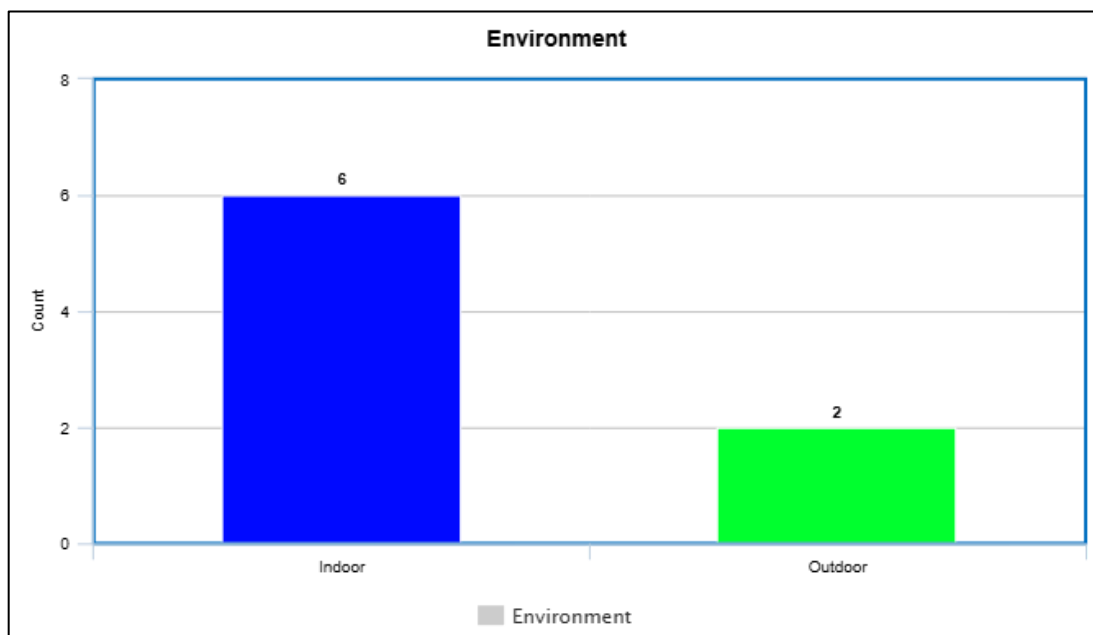


Figure 5 Results of Environment in Immersive Spatial Design

7 FINDINGS

The analysis of the eight immersive sports case studies shows several consistent design patterns across the selected projects. All the examples make use of three-dimensional physical surfaces, including wooden courts, skate ramps, and snow-covered terrain, as projection areas. These physical elements help create a more convincing spatial experience because the projected visuals respond to the existing shapes and structures, making the environment feel more immersive. In addition, every project incorporates animated digital content and real-time visuals rather than static displays, helping to maintain user interest throughout the experience. This finding is consistent with projection mapping research, which suggests that as the technology has become more widely adopted in commercial, artistic, and urban environments, similar visual approaches have been repeatedly applied across different settings (Korola, 2014). The sports environments examined in this study appear to follow the same direction by emphasizing visually engaging and dynamic content. In terms of interaction, the projects combine both touch-based and motion-based systems, although 62.5% rely on contactless interaction, allowing users to move more freely while interacting with the environment. Most of the installations also operate in controlled, low-light conditions to improve projection quality and reduce visual distractions. Overall, the findings suggest that combining suitable physical surfaces, dynamic visuals, responsive interaction, and appropriate lighting contribute to a more engaging sports environment and enhances the overall user experience (Salimi, 2024; Xiao & Zong, 2026).

CONCLUSIONS

This study shows that interactive design can improve ordinary sports facilities by making them more engaging and enjoyable for the community. Spaces that combine digital visuals, suitable lighting, and interactive technology are more effective at encouraging users to stay active and involved. Among the design components identified, animated visuals and real-time interaction appear to have the greatest influence on creating a more engaging sports experience. In addition, controlled lighting and sound can help users stay focused, reduce distractions, and support better concentration during physical activities. Overall, adding these interactive elements to standard sports courts and skateparks can make the spaces more appealing, especially to younger users, while encouraging regular physical activity and supporting community well-being.

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AUTHOR CONTRIBUTIONS

All authors played equal contributions towards the production of this paper.

CONFLICT OF INTEREST

There is no conflict of interest.

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