The Application of AR Game Scenarios in Urban Gamification: Opportunities, Challenges, and the Future

Zixuan Wang[a]
College of Architecture and Landscape of Peking University, Peking University, Beijing, China

Keywords: AR Game Scenarios, Urban Gamification, Location-Based Games, Multi-Stakeholder, Public Participation.

Abstract: Against the backdrop of the accelerating urbanization process and the vigorous development of digital technologies, urban gamification, as an innovative approach to enhancing urban vitality and enriching residents' living experiences, has received extensive attention. The rise of Augmented Reality (AR) technology has brought new opportunities to urban gamification, enabling players to interact with virtual elements in the real urban environment and creating unique gaming experiences. However, the application of AR game scenarios in urban gamification is still in the exploratory stage, facing numerous uncertainties and challenges. This study focuses on the application of AR game scenarios in urban gamification, conducting an in-depth analysis of its theoretical foundation, practical applications, advantages, challenges, and development strategies. Using the case analysis method, multiple typical AR game cases are selected for in-depth dissection, demonstrating the actual performance of AR game scenarios in urban gamification from different perspectives. The study finds that AR game scenarios have significant advantages in enhancing the fun of urban spaces, promoting social interaction, and facilitating cultural dissemination, but they also face many challenges. Based on this, the study proposes targeted development strategies such as increasing investment in technological innovation, promoting the diversification of game content, and innovating cooperation and promotion models, with the hope of effectively improving the quality of residents' lives.

1 INTRODUCTION

With the rapid development of urbanization, cities are actively exploring innovative development models in the process of pursuing sustainable development and improving the quality of residents' lives (Bagratuni, Silberer, Planning, 2025). The integration of the gamification concept and AR technology has opened up a new path for urban development. AR games like "Pokémon GO", relying on AR and LBS technologies, have attracted global players to capture virtual Pokémon in the real world, demonstrating the potential of AR game scenarios in urban gamification. However, the development in this field is still not mature at present, with problems such as technical bottlenecks and insufficient content innovation. Therefore, in-depth research on its application is of great significance (Vo, 2024).

Foreign research on AR games started relatively early and has achieved fruitful results in terms of technical improvement and user experience optimization. Mikael Bagratuni and others, by studying the impact of different immersive media formats (such as VR, video, and photos) on user acceptance (Kounavis, Kasimati & Zamani, 2012), have deeply explored the mechanism of how technology affects user experience, providing a theoretical reference for the technical improvement of AR games and the optimization of user experience. Their research methods and the research ideas on immersion are helpful for improving AR game technology and enhancing users' immersive experience in the game. Tony Liao and Lee Humphreys (Liao & Humphreys, 2015), through the study of the Layar application, analyzed the practices of users using AR technology in public spaces and proposed that users can change their perception and interaction with space by creating content, which provides design strategies and ideas for enhancing the social interactivity of AR games. Domestic research focuses on innovation by combining local culture with market demands. Bruno Marques, Jacqueline

[a] https://orcid.org/0009-0001-0505-5794

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McIntosh, and Hannah Carson (Marques, McIntosh & Carson, 2019), taking the Maori culture in New Zealand as an example, combined local culture with AR technology and displayed the stories and values of Maori culture through AR, enriching the cultural connotations of AR applications. A similar idea can be applied to AR games by integrating traditional festival culture into them to enrich the cultural connotations of the games. However, existing research still has deficiencies in aspects such as technical stability and in-depth exploration of game content. For example, some studies have not fully considered the stability of AR technology in complex environments, and in terms of game content, they have failed to deeply explore the in-depth integration of cultural elements and game play.

This study deeply analyzes the application of AR game scenarios in urban gamification from multiple dimensions. Theoretically, it expands the theories of urban development and gamification, and in practice, it provides innovative ideas for urban planning, cultural inheritance, etc. The study adopts a multi-dimensional perspective and interdisciplinary research methods, and combines specific cases to provide a new perspective and method for research in this field.

2 THEORETICAL ANALYSIS OF AR GAME SCENES AND URBAN GAMIFICATION

Deeply explore the theories of AR game scenes and urban gamification, analyze their concepts, characteristics, and interrelationships, reveal the underlying theoretical logic, and provide theoretical support for the practice and development of this field.

2.1 The Characteristics and Constituent Elements of AR Game Scenes

AR game scenes are of great significance in urban gamification. They possess characteristics such as immersion and interactivity, and are composed of elements like geographical space, visual effects, and task plots. These elements influence the gaming experience, and thus, it is of great importance to analyze them.

2.1.1 Immersion and interactivity

AR technology skillfully overlays virtual information onto the real world, creating a strong sense of immersion for players. Players can interact with virtual elements naturally in the real environment, and this experience of blending the virtual and the real blurs the boundaries between games and reality (Wang, 2025). Take playing an AR puzzle game in an urban park as an example. Players search for hidden virtual props based on the clues in the real scene, as if they were in a mysterious adventure world. "Context-aware gaming" further enhances this immersion and interaction. The game adjusts in real-time according to the environment where the player is located. For instance, when a player walks to a riverside, the game plot may unfold around the river, allowing the player to fully immerse themselves in the game world.

2.1.2 Elements of Scene Construction

Geographical space serves as the foundation for constructing AR game scenes. Real - world spaces in cities, such as streets, buildings, and parks, provide a rich and diverse backdrop for games. Visual effects create a unique gaming atmosphere through the design of exquisite virtual elements, like fantastical character images and dazzling special effects. The task plot is the core that guides players to participate in the game. By setting interesting task goals, such as searching for treasures or completing challenges, it increases the fun and challenge of the game. In "context - aware games", these elements are dynamically adjusted according to the player's real - time location and environmental changes, making every gaming experience fresh for the player.

2.2 The Connotation and Development Context of Urban Gamification

Urban gamification integrates game elements into urban life, aiming to enhance residents' experiences and urban vitality. It has evolved from simple offline forms to online - offline integration and is moving towards intelligence and personalization.

2.2.1 The Concept Definition of Urban Gamification

Urban gamification involves integrating game elements and mechanisms into all aspects of urban life. It stimulates residents' enthusiasm for participating in urban activities in a gaming way, so as to achieve the goals of improving urban management and enhancing residents' quality of life.

For example, in the walking check-in challenge set up in the city, participants can get points by walking to designated locations and checking in, and these points can be exchanged for gifts. This activity integrates the reward mechanism of games into fitness and urban exploration, encouraging residents to go out of their homes. While enhancing their physical fitness, it also deepens their understanding of the city.

2.2.2 Development History and Trends

Urban gamification originated from simple offline interactive games and gradually transformed into an online - offline integration with the development of technology. In the early days, urban treasure - hunting activities relied solely on paper maps and clues (Zhang, 2025). Nowadays, with the help of AR technology, treasure - hunting games have become more vivid and interesting. In the future, urban gamification will develop towards intelligence, personalization, and socialization. "Context - aware games" are expected to become an important model. With the aid of big data and artificial intelligence, games can provide personalized experiences based on players' interests and behavior habits, and at the same time, further enhance social interactions among players.

2.3 The Intrinsic Relationship between AR Game Scenes and Urban Gamification

AR game scenes are closely linked to urban gamification. The former injects vitality into the latter with its unique experiences, while the latter provides a broad application space for the former. The two aspects promote each other and reshape the urban life experience.

2.3.1 The Integration of Technology and Experience

AR technology provides powerful technical support for urban gamification, enabling players to experience the wonderful fun of the intertwining of the virtual and the real in real-world scenes. Relying on AR technology, "context-aware games" make the interaction between players and the urban environment more natural and smooth, greatly enriching the gaming experience (Zhang, 2025). For example, in the AR historical reenactment game carried out in the historical and cultural blocks, players can see ancient figures shuttling through the real streets through their mobile phones, interact with them and learn about historical stories, as if they have traveled through time and space. This unique experience deepens players' understanding and perception of the urban history and culture.

2.3.2 The Reutilization of Urban Space

AR game scenes can tap the potential of idle urban spaces, transforming abandoned factories, old neighborhoods and other places into interesting gaming venues. Under the multi-party public participation model, players can unleash their creativity and create AR scenes, further enriching the gamified content of urban spaces. For instance, an abandoned factory can be converted into an AR adventure game site. Players can explore mysterious ruins and solve puzzles there. This not only injects new vitality into the abandoned space but also enhances the attractiveness and utilization value of the urban space.

2.3.3 The Collection and Utilization of Urban Information

In AR game scenes, players' gaming behaviors will generate a large amount of data, such as location information and interaction records. These data can be used to analyze the usage of urban spaces, residents' points of interest and behavior patterns, providing a basis for urban planning and management and contributing to the construction of smart cities. For example, by analyzing the areas where players are frequently active in AR games, urban managers can find out which public spaces are more popular, and then optimize the layout of urban public facilities.

3 ANALYSIS OF APPLICATION EXAMPLES OF AR GAME SCENES IN URBAN GAMIFICATION

This part will conduct an in - depth analysis and discussion on the application examples of some existing AR game scenes in urban gamification in China from multiple dimensions such as game design, user experience, and urban space utilization, as well as the characteristics of each game.

3.1 "Daydreplay and Sceneam" AR Social Game

3.1.1 Gameplay and Scene Design

"Daydream" integrates AR and LBS technologies. Players can discover various virtual elements, such as

cute little animals and mysterious treasures, by scanning the real - world environment through their mobile phone cameras. The game scenes are ingeniously integrated into the natural and cultural landscapes of the city. For example, a virtual music stage may appear in a city square, and players can interact around it to experience the charm of a virtual performance. Under the concept of "context - aware games", the scenes change according to time and weather. At night, star - themed virtual elements may appear in the square, and on rainy days, there will be different interactive scenes, such as virtual umbrellas and rain boots props.

3.1.2 Influence on Urban Social and Leisure Life

This game has greatly promoted social interaction among players. Players meet new friends during the process of exploring virtual elements and share the fun and discoveries in the game together. Players can also create social activity scenes through multi - party public participation, such as hosting virtual parties and concerts, which enriches urban leisure life and enhances community cohesion. For instance, players can jointly plan a virtual music festival in the game, each playing different roles and inviting other players to participate. This kind of interaction breaks down the social barriers in real life.

3.2 "Taoyang Encounter · Urban Hide - and - Seek"

3.2.1 Game Mechanism and Cultural Integration

This game combines the traditional hide - and - seek gameplay with urban exploration and incorporates ceramic cultural elements. Players search for hidden ceramic elements in the city, such as ceramic fragments and ceramic handicrafts. After finding them, they can unlock corresponding storylines and tasks, and learn about ceramic production techniques, historical stories, etc. Under the "context - aware game" mode, the tasks and storylines are adjusted according to the ceramic cultural attractions where the players are located. Near a ceramic museum, players may trigger tasks related to the museum exhibits and gain a deeper understanding of the cultural connotations behind the exhibits.

3.2.2 Player Experience and Urban Cultural Dissemination

Players gain an in - depth understanding of ceramic culture during the game. The spread of the game has also attracted more tourists to pay attention to the city's ceramic culture. Players share cultural knowledge and stories through multi - party public participation, enriching the cultural connotation of the game and promoting the inheritance and dissemination of urban culture. Many players, after completing the game tasks, develop a strong interest in ceramic culture, and will further visit ceramic factories and learn ceramic production, becoming disseminators of the city's ceramic culture.

3.3 Shanghai Global Harbor Live - Action CS Game

3.3.1 Technical Application and Gaming Experience

The Shanghai Global Harbor live - action CS game uses AR and MR technologies. Players engage in battles in the real - world space of the shopping mall, with virtual weapons and enemies presented realistically, bringing an immersive combat experience. With the support of the "context - aware game", the scene changes with the layout and activities of the shopping mall. When the shopping mall holds promotional activities, the game props are associated with the promotional products. Players can obtain virtual coupons by completing specific tasks, increasing the fun and challenge of the game.

3.3.2 The Promotion of Urban Commerce and Entertainment

The game has attracted a large number of players to the shopping mall, increasing the passenger flow and promoting consumption within the mall. Players design competitive scenes and rules through multi - party public participation, enriching the entertainment content of the shopping mall and injecting new vitality into the development of urban commerce and entertainment. For example, the unique competitive scenes designed by players have attracted more people to come and experience, which not only enhances the popularity of the shopping mall but also drives consumption in surrounding catering, shopping, and other areas.

4 ADVANTAGES AND CHALLENGES OF AR GAME SCENES IN THE APPLICATION OF URBAN GAMIFICATION

AR game scenes bring innovative changes to urban gamification, showing significant advantages in aspects such as expanding experiences and exploring urban spaces. Meanwhile, they also face challenges at the technical and privacy levels, which urgently need to be analyzed.

4.1 Advantage Analysis

Firstly, it can enhance the fun and attractiveness of urban spaces. AR game scenes add novel elements to urban spaces. "Context - aware games" make every corner of the city a potential stage for games, enhancing the fun and attractiveness of urban spaces and attracting residents and tourists to participate. An ordinary urban street can be transformed into a fantastical adventure land due to the setting of AR game scenes, stimulating people's desire to explore.

At the same time, it can promote social interaction and community building. AR games break the single-player mode of traditional games and encourage interaction and cooperation among players. Under the multi-party public participation mode, players jointly create AR scenes, which promotes communication and cooperation among community members and enhances community cohesion. In the game, players complete tasks together and help each other, and this kind of interaction extends to real life, enhancing the relationship between neighbors (Liu, Xu, 2020).

It can also promote the dissemination and inheritance of urban culture. AR game scenes integrate urban cultural elements into the games, and players can imperceptibly understand and inherit urban culture during the game. The AR scenes created by players can also share their personal understanding and perception of urban culture with more people, promoting the dissemination of urban culture. For example, in an AR game with the city's history as the background, players can learn about historical events and figures by completing tasks. This way of cultural dissemination is more vivid and interesting than traditional methods and is more easily accepted by the public.

Finally, it enables urban information collection. AR game scenes can collect a large amount of data on player behavior and the use of urban spaces. These data can be used to optimize urban planning, improve the quality of public services, and contribute to the construction of smart cities. By analyzing the behavior data of players in AR games, urban managers can understand which areas need to improve public facilities and which areas need to optimize traffic flow.

4.2 Challenge Analysis

Firstly, there are technical bottlenecks and limitations. AR technology still has deficiencies in image recognition, positioning accuracy, and device performance. In complex environments, image recognition may make mistakes, and positioning accuracy affects the gaming experience. Some devices cannot run AR games smoothly. "Context - aware games" have higher requirements for the real - time performance and adaptability of technology, and the current technical level is still difficult to fully meet these requirements. Take Vision Pro as an example. Although it has improved the AR experience to a certain extent, it still faces problems such as high cost and adaptability, which limit its wide application in AR games.

There are also great limiting conditions in terms of market competition and user acceptance. The AR game market is highly competitive, and various game products emerge in an endless stream. Some users have a low awareness and acceptance of AR games, believing that they are complex to operate or interfere with real life. Economic factors also affect user acceptance. The costs of purchasing devices and data traffic increase the user cost. When the cost is reduced, the popularization of AR games may embrace new opportunities, but currently, the problems of market competition and user education still need to be solved.

In terms of privacy and security issues, AR games may collect players' location, personal information, etc. during operation, and there is a risk of privacy leakage. Players may ignore real - world safety when focusing on the game, such as playing games while walking on the road and causing traffic accidents. Under the multi - party public participation mode, it is difficult to review and manage the content of the AR scenes created by players, and it is necessary to ensure that the content is legal and safe.

In the philosophical category, the discussion on the existence of virtual scenes is still inconclusive. There are controversies over whether virtual scenes and virtual landscapes should exist and whether people should live in virtual environments. Some people worry that excessive immersion in the virtual environment will affect social interaction and physical and mental health in real life, which makes

the development of virtual landscapes in AR games face doubts and obstacles.

5 DEVELOPMENT STRATEGIES AND PROSPECT OUTLOOK OF AR GAME SCENES IN URBAN GAMIFICATION

5.1 Discussion on Development Strategies

Firstly, technological innovation and optimization are the first step in development. Increase investment in the research and development of AR technology, develop an intelligent self - adaptive technology system, and improve the performance of key technologies such as image recognition and positioning accuracy. Strengthen the integration with other technologies, such as artificial intelligence and big data, to enhance the intelligence level of AR games and improve the user experience. For example, use artificial intelligence to optimize the image recognition algorithm to make the integration of virtual elements and real - world scenes more natural; use big data to analyze player behavior and provide more personalized game content for players.

In terms of content, innovation and diversification are needed. It is necessary to deeply explore the historical, cultural, natural and other resources of the city and develop game content with local characteristics and cultural connotations. In addition to traditional adventure and competitive games, diversified game types such as education, popular science, and cultural experience can also be developed to meet the needs of different user groups. An AR popular science game with the city's natural ecology as the theme can be launched, allowing players to learn about animal and plant knowledge in the game and enhance their environmental protection awareness.

Innovation is required in the cooperation and promotion model. Strengthen the cooperation among game developers, urban managers, enterprises, etc. Urban managers provide policy support and venue resources, enterprises provide funds and market promotion channels, and game developers focus on technology research and development and game production. Innovate the promotion model, use various channels such as social media and offline activities for publicity, establish a user feedback mechanism, and optimize the game products according to user opinions. For example, game developers cooperate with urban tourism departments to hold AR game experience activities at tourist attractions to attract tourists to participate and promote urban tourism resources at the same time (Zhou, 2016).

Finally, public participation in virtual scene construction should be allowed, and the virtual concept and professional scope should be improved. Establish a user public platform to allow players to freely build their personal game virtual environments and spaces to form "individual worlds". Promote the exchange and sharing of "virtual worlds" among players, and promote the development of "multiple virtual worlds", further enriching the content and gameplay of AR games. Players can share the virtual scenes they designed with other players, experience different game worlds, and increase the fun and creativity of the game.

5.2 Prospect Outlook

Firstly, there are potential impacts on urban development. The widespread application of AR game scenes will promote urban economic development and drive the prosperity of related industries. In terms of culture, it promotes the inheritance and innovation of urban culture and enhances the soft power of urban culture. At the social level, it enhances residents' sense of community belonging and social interaction, and promotes the harmonious development of the city. The "context - aware games" and multi - party public participation mode will further stimulate the vitality and creativity of the city.

The future development of AR game scenes will embrace mainstream trends. In the future, the application of AR game scenes in urban gamification will be more widespread and in - depth. "Context - aware games" will become the mainstream mode, and the multi - party public participation mechanism will be continuously improved. AR games will be deeply integrated with urban intelligent transportation, smart city construction and other fields, bringing more possibilities for urban development. The existence of "multiple worlds" will provide players with a more diverse and rich gaming experience.

Finally, it can promote the development of a smart city with a new mode. In the AR scene, urban information collection and user feedback are more convenient, providing more accurate data support for the construction of a smart city. The smart city will embrace a 3.0 mode, urban management will be more intelligent, the city will become a user object

managed by citizens themselves, and the sustainable development of the city will be realized (Lei, 2018).

6 CONCLUSIONS

This research comprehensively analyzes the application of AR game scenes in urban gamification, clarifies its theoretical connotation and internal relationship. Through case analysis, it demonstrates the application effect, expounds on the advantages and challenges, and proposes corresponding development strategies. The "context - aware games" and multi - party public participation mode bring new opportunities for urban gamification and are of great significance for urban development.

This research has deficiencies in case analysis and technical research. In the future, the scope of cases should be expanded, and the research on different types of AR game scenes in different cities should be strengthened. Continuously track the development of AR technology, and deeply study the impact of technology on user experience and urban development, so as to provide more complete theoretical support and practical guidance for the application of AR game scenes in urban gamification.

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