Research on Gamification of Public Seating Design in Shopping Mall Based on Scenario-based Thinking

Shaowei Liu

397252509@qq.com

Guangdong University of Science and Technology，Dongguan，China

Abstract. As a tool for providing temporary rest services for the public in various public places, many large public places in China will install a certain number of public seats, thereby improving the humanized characteristics of urbanization development. For shopping malls, the role of public seats is to provide a temporary rest for those who go to the mall for consumption, play, and other activities, to alleviate fatigue while visiting the mall. Furthermore, for public seats in shopping malls, giving them certain gamification characteristics can add a sense of fun during the shopping mall rest process, allowing the crowd to relax in the busy work and life, Enjoy the relaxation brought by a little more leisure time. Therefore, the research on gamified public seat design in shopping malls based on scenario based thinking refers to using commercial and activity scenes of shopping malls as the basis of design thinking, in order to design public seats based on them, and endow them with gamified characteristics to improve the practical application value of shopping mall public seats.

Keywords: scenario based thinking; Shopping malls; Gamification; Public seats; Design Research

1 Introduction

With the rapid development of the social economy, there are various types of services that can be provided to the masses in our society. Currently, many commercial services are provided based on the basic principle of "service first", followed by products and experiences. At the same time, the acceleration of urbanization in China has led to a surge in the number of shopping malls in China, and the market competition pressure for shopping malls is very fierce, In addition to relying on their own regional advantages, most shopping malls will start with various internal details [1], continuously improving the humanization and personalization of the mall, striving to provide higher quality services to the people who go to the mall for commercial activities, thereby attracting more people to come to the mall and increasing the pedestrian flow. The design of seats is very representative, and compared to other public application tools in shopping malls, the application of public seats is very frequent. Therefore, most shopping malls consume more design time, resulting in unique characteristics of public seats in shopping malls, forming the unique content of this shopping mall[2]. Therefore, the design thinking formed based on the shopping mall scene is from the perspective of the mall users, by analyzing the relationships between people, things, time, and other factors in the mall space, in order to meet the needs of people and improve the design thinking of people's usage needs.

ADDT 2023, September 15-17, Xian, People's Republic of China

DOI 10.4108/eai.15-9-2023.2340861

2 Basic Theory

2.1 Scenario-based design thinking

Scenario-based design originated from film and television design activities, dating back to the early 1960s when it was proposed by Herman Kahn. And the scene refers to a certain set time and space where insiders are performing certain task-based actions[3] Or the relationship formed with things in other spaces, from the perspective of constructed images, called scenes, in simple terms, scenes exist in reality, can appear at a certain time in the past, can occur at the current time, or even be about to occur in the future. Scenes are stories about people and their activities. In addition, design based on scenario based thinking was first proposed by Carroll. Initially, Carroll's understanding of scenario based thinking emphasized that in the design process, the focus of the work should be on describing the task flow of the target user using the system in real scenarios, rather than defining it as the behavior of the system itself [4].

2.2 Gamification design

The definition of 'game' varies greatly in the eyes of different scholars, but in numerous research activities, the characteristics of games can be clearly explained [5], which states that 'games can play basic entertainment functions, require a system of rules to form specific interactive contexts, and require people's participation'. However, in the current context, the definition of games has gradually become blurred due to the influence of the times. Especially with the rapid development of new media, people's understanding of games has become more one-sided and singular, only believing that games are a way to provide interaction, communication, and entertainment for the public. Therefore, gamification design refers to the process of endowing the design content with gamification characteristics, thereby changing the appearance characteristics of the design content, resulting in higher practical application efficiency, wider usage range, and even to a certain extent, endowing the design content with certain iconic features. Fully leverage the entertainment, interactivity, viewing, fun, and mental relief functions of games.

2.3 Design Types Based on Scenario Thinking

The design types based on scenario thinking [6] can be classified into four categories according to workflow, design stage, user objects, and design methods, which are reality scenarios, situational scenarios, usage scenarios, and testing scenarios, as shown in Figure 1.

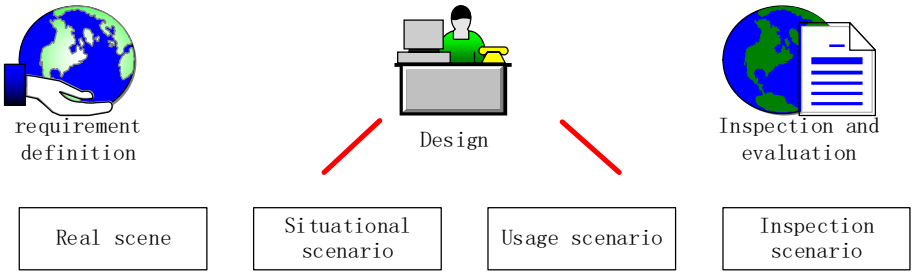

Figure 1 Types of Scenario-based Thinking Design

3. Model establishment

3.1 Gamification User Experience Analysis in Scenarios

When a user is fully engaged in a certain activity, the joy and satisfaction they receive and the state they continue to participate in is called the flow state , and the corresponding experience is called the flow experience. The content that best allows the user to generate this state and experience is the game. Through research and investigation, it was found that the changes in the user's flow state during the game process will occur over time, and the flow experience will also change over time. This is to determine the level of satisfaction of the game based on the user's emotional changes, as shown in Figure 2.

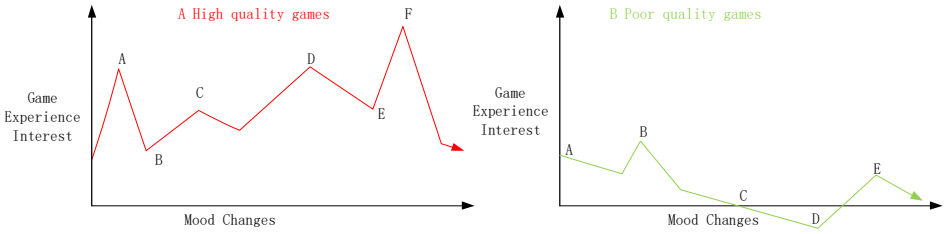

Figure 2: Emotional changes in users' perception of the quality of the game

From Figure 2, it can be seen that users experience changes in their emotions during the game experience. For high-quality games, the user's emotional experience is at a peak of curiosity at point A, while point B is the actual cognitive value. The level of interest in the game experience decreases. However, based on being in an interested state, as the game understanding deepens, the user's interest in the game experience gradually increases and eventually reaches a certain peak F, Even if there is a decrease afterwards, it still shows a state of interest. On the contrary, low-quality game users have a higher B-point, which is reflected in the fact that they have already started experiencing the game. Although their interest in the game experience is not high, they still have certain expectations. However, as their emotions change to reach C-point, they basically have no interest in the game experience. When their emotions change to E-point, their interest in the game experience increases, but they quickly return to the position of C-point.

3.2 Design Mechanism Model

The mechanism model for designing gamified public seats in shopping malls based on scenario based thinking includes four aspects: 1) motivation design for material or spiritual incentives, such as the ability of shopping mall public seats to provide users with spiritual satisfaction and relaxation through gaming during use; 2) During the game development process, use certain stimuli to stimulate users' motivation and enthusiasm, while also designing excitement points that can help users maintain a good emotional experience for a long time; 3) Maintain a balance of positive and negative emotions, and design a balance of positive and negative emotions that alternate rewards and obstacles in the experience; 4) After the game is over, it is the highest point design that allows users to feel the climax and experience regret, as well as arouses their internal motivation, creating an unforgettable impression on them and prompting them to experience it again. As shown in Figure 3.

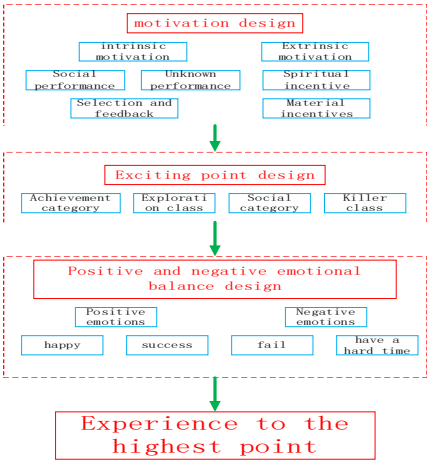

Figure 3 Model of Gamification Public Seating Design Mechanism in Shopping Mall

3.3 Edge manikin

Through investigation and research, it was found that in seat research [7], due to significant differences in human body dimensions, in order to ensure that the designed product can meet the needs of most people and achieve sufficient design adaptability, product specifications need to be determined based on the relevant human body dimensions of different groups. Therefore, this study extracted relevant human body sizes for seat design, and generated human body size samples for male and female populations using Monte Carlo simulation based on the distribution patterns and digital features of these variables. The resulting human body size samples were analyzed, and edge human models were selected in the coordinate system composed of the principal component axis. The process is shown in Figure 4.

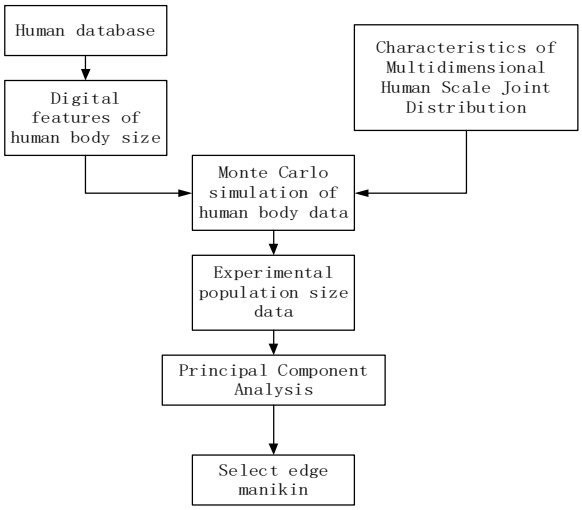

Figure 4 Process of Edge Human Model

1) Monte Carlo simulation generates human body data samples: Due to the joint distribution pattern of multidimensional human body size, which is a multidimensional random variable, the human body data used to determine product size must be selected based on its distribution characteristics, so that the design results meet the required design fitness from a statistical perspective. The formula is expressed as:

$$f(x) = \frac{1}{(2\pi)^{\frac{n}{2}}(\det B)^{\frac{1}{2}}} e^{\frac{1}{2}\{(x-\mu)^T B^{-1}(x-\mu)} \quad (1)$$

2) Principal component analysis of human body size data: Generally, there is a certain correlation between human body size variables, which makes the processing of such multidimensional data more complex. It is necessary to analyze and process these data in a targeted manner, using as few data as possible, and effectively explaining the distribution patterns of these variables while ensuring the integrity and safety of the original data information. Principal component analysis is a multivariate statistical analysis method based on the covariance matrix of variables, which linearly transforms the information of many variables to extract a few important variables. Principal component analysis can achieve reasonable dimensionality reduction effects. Taking the principal component analysis results of the male population as an example, as shown in Table 1.

Table 1 Component Analysis Results - Male Population

	Extract Results		
	Component characteristic values	Proportion of total characteristic values of components in%	Cumulative ratio of component characteristic values%
1	275.86	72.731	72.731
2	73.569	19.421	92.152
3	14.898	3.372	96.025

3) Selection of edge human models: Usually, the edge human model (BM) on the confidence boundary of multidimensional human size distribution is selected as the basis for scheme design and analysis. Extracting Confidence Boundaries on Multidimensional Human Scale Distribution

The closer the range of individual descriptions extracted theoretically to the confidence boundary, the stronger the representativeness of the model, as shown in Figure 5 and Table 2. The formula is expressed as:

$$x^2 = \sum_{i=1}^{3} \left(\frac{F_i - \mu_{Fi}}{\sigma_{Fi}}\right)^2 x^2 \quad (2)$$

Comment: x^2 Is a chi square statistic; Fi as the main component; σ_{Fi} And μ_{Fi} is the standard deviation and mean.

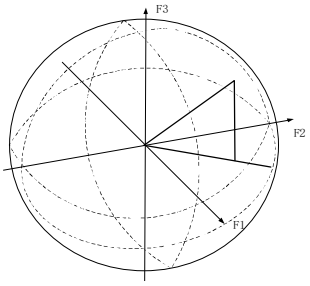

Figure 5 Edge Human Model

Table 2 Principal Component Coordinates and Human Scale of Partial Edge Human Model

Serial Number	F1	F2	F3	Height S/cm	Body mass W/kg
1	0.000	0.000	-2.769	180.420	77.737
2	1.389	1.389	-1.979	189.849	78.868
3	-1.389	1.389	-1.979	172.354	55.932
4	-1.389	-1.389	-1.979	168.065	77.047
5	1.389	-1.389	-1.979	185.650	100.073
6	2.796	0.000	-1.979	193.008	101.073

4 Simulation of the spatial distribution of lumbar feature points in a three edge human model

The back posture and distribution of back feature points of seat users are important factors guiding the design of seat lumbar and back support. To meet the adaptability of the user population, the distribution range of human body size of the user population must be reasonably considered when designing the back support of car seats. Here, the spatial position distribution of lumbar and back feature points is simulated by simulating the posture of BM [8].

4.1 Posture prediction and distribution of waist and back feature points for edge human models

Using Visual C++6.0 software, write a corresponding simulation program on this platform to simulate the distribution of trunk feature points of the edge human model under random seating conditions. At the same time, consider the mean and standard deviation of user posture angles to calculate the distribution of trunk feature points of the edge human model.

4.2 Distribution of waist and back feature points of edge human models

When determining the position of the support surface of the human back on the seat, it is assumed that all users can fully and reasonably utilize the seat cushion and backrest. The position of the lumbar support of the seat can be determined by the relative position of the back

feature points of the human body and the H-point of the seat, without the need to contact the coordinate system. Using the previously predicted H-point as the coordinate origin, unify the simulated lumbar back feature point data in the same coordinate system

4.3 Design of backrest profile for edge manikin body pressure distribution

Through investigation and research, it has been found that body pressure distribution has a significant impact on sitting comfort. The most suitable distribution of body pressure should ensure that: ① most of the mass of the human body is reasonably distributed on the seat cushion and backrest with a larger supporting area and smaller unit pressure; ② The backrest design should comply with the principle of "two point support", that is, the lumbar vertebrae and scapula have the highest pressure, and the pressure level should transition smoothly to avoid sudden changes. A well-designed seat should ensure a reasonable distribution of body pressure and ensure a good fit between the human body feature points and the seat feature parts. Therefore, this article attempts to reverse the shape of the seat sponge based on the ideal pressure distribution pattern.

1) Determination of the position of the lumbar support surface: Draw the characteristic points of the human back at each edge unified in the same coordinate system, taking into account the inclination angle of the passenger car seat backrest, and determine the upper, lower, front, and rear limit positions of the seat lumbar support based on

The four limit points for the distribution of torso feature points in the backrest tilt direction and the edge of the human model perpendicular to this direction have been preliminarily determined, as shown by the highlighted coordinate points in Figure 6. The corresponding distribution characteristics of BM back feature points are shown in Table 3. At this point, the upper, lower, and front and rear limit points are all joint points of the human body. It is necessary to determine the position of the deformed body surface corresponding to each limit point based on the simulation results of human body size and body pressure distribution, and use this to calculate the position of the undeformed seat backrest support part. For seat lumbar support that cannot be adjusted up and down, the final design position can be directly calculated based on the average seat support position; For adjustable seat lumbar support, the limit position of the lumbar support protrusion can be determined based on the upper and lower limit points of the edge human body model lumbar feature point distribution in Figure 6, combined with the pressure distribution to calculate the position after surface deformation.

Table 3 Distribution characteristics of feature points on the back of edge human models: cm

Edge human model	around		M	Up and down	
	Mean	standard deviation		Mean	standard deviation
8	7.855	2.379	5	20.087	3.642
6	15.891	2.135	2	14.661	1.783

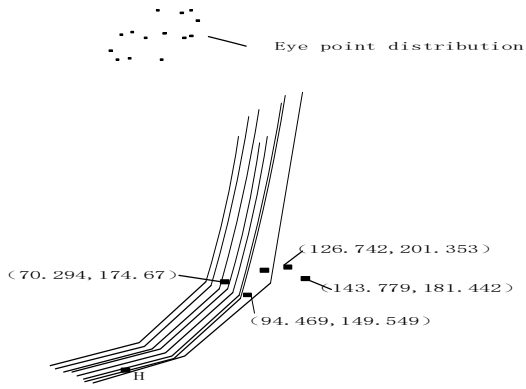

Figure 6: Uniformly removing contours and feature points

2) Reverse calculation of the pressure distribution of the seat backrest profile: The above method can also be used to determine the position of other parts of the seat backrest after deformation. Therefore, it is necessary to reverse the position without deformation based on the pressure distribution calculation results. Select a certain section at the lumbar support of the backrest for research. Simulate the body pressure distribution of the front and last edge individuals in the unified BM back feature point distribution, and obtain the deformation of the seat at the lumbar support area. Based on the previously obtained position after deformation, the initial position of the seat profile is calculated by compensating for the amount of deformation. The compensated deformation amount is the deformation of the seat sponge obtained from the pressure distribution calculation. Determine the shape of the key parts of the seat backrest according to the above method, and obtain the shape reference of the seat backrest after shaping and trimming.

5 Conclusion

In summary, this article draws the following conclusions based on the study of gamified public seat design in shopping malls under scenario based thinking.

Firstly, the basic theories will be elaborated, introducing the design types based on scenario design thinking, gamification design, and scenario thinking studied in this paper as the main research theories and directions;

Secondly, the establishment of the model, gamified user experience analysis in the scene, design mechanism models, and edge human models will be introduced as the main basis for this research activity, laying the groundwork for future research content and refining the main research content.

Finally, taking the simulation of the spatial distribution of waist feature points in the edge human model as an example, the focus of seat design is highlighted. Although there is no intuitive explanation of the gamified characteristics of public seat design in shopping malls, from the perspective of the model, there is an implicit gamified public seat, which can add a sense of fun to people during the process of resting in the mall, allowing them to work and live in a tense and busy environment, Enjoy the relaxation brought by a little more leisure time.

In addition, there are certain shortcomings in this study, mainly reflected in the relatively limited practical content. Therefore, in future research activities, the study of practical content will be the main research direction.

References

[1] Liu Liping, Zhang Awei Research on the Design Strategy of Museum Cultural and Creative Products Based on Scenario-based Thinking [J] Packaging Engineering, 2023,44 (10): 377-382

[2] Yang Bolin, who are you Research on the Design of Online Learning Interactive Products Based on SAPAD and Scenario-based Thinking [J] Packaging Engineering, 2023,44 (2): 167-179

[3]Du Xiaoming, Ren Jindong, Li Runli, et al Research on Seat Design Method Based on Edge Human Model Simulation [J] Automotive Engineering, 2014 (6): 757-762

[4] Liu Peng, Deng Liwen, Xie Yueyue Research on Gamification of Public Seating Design in Shopping Mall Based on Parent-child Interaction [J] Furniture and Interior Decoration, 2021 (10): 71-75

[5] Champion S , Barr C , Lange B ,et al.Chair design for older immobile people: Comparison of pressure mapping and manual handling outcomes[J].Applied Ergonomics, 2022, 98:103581-.DOI:10.1016/j.apergo.2021.103581.

[6] Carvalho D E D , Callaghan J P .Effect of office chair design features on lumbar spine posture, muscle activity and perceived pain during prolonged sitting[J].Ergonomics, 2022:1-12.DOI:10.1080/00140139.2022.2152113.

[7] Nelfiyanti, Mohamed N , Rashid M F F A ,et al.Ergonomic Chair Design in Minimizing MSD Chassis Assembly Workers Complaints Using Ergonomic Function Deployment (EFD)[J].Springer, Singapore, 2023.DOI:10.1007/978-981-19-1577-2_7.

[8] Liu Ying, Wang Guoguang The application of modified concrete in the design of public seats [J] Packaging Engineering, 2020,41 (6): 322-328