

FACTORS INFLUENCING USER SATISFACTION IN STEREO PARKING SYSTEMS: A CASE STUDY OF SHANGHAI

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Abstract: The design and development of stereo parking systems involves a comprehensive set of functional requirements, manufacturing processes, user operational comfort, and environmental friendliness. However, the current market's stereo parking systems primarily focus on product-centered design and functional achievement, without adequately considering and meeting user needs. The design philosophy lags behind the demands of contemporary development.

The objectives of this study are: 1) To explore the key factors affecting the use of stereo parking systems. 2) To verify that the basic attributes of the product, customer expectation attributes, and product attraction attributes positively influence user satisfaction with the product. This study selects stereo parking systems in Shanghai, China, as the case study area and collects user data through surveys, with a sample size of 400. Quantitative research methods are used to analyze the data.

The research results indicate: 1) User satisfaction with stereo parking systems is influenced by the basic attributes of the product, customer expectation attributes, and product attraction attributes. 2) The three factors of basic product attributes, customer expectation attributes, and product attraction attributes have a significant positive impact on user satisfaction with stereo parking systems.

Studying user satisfaction with stereo parking systems has practical value in shifting the design philosophy from product-centered to user-centered. This means that, in addition to considering the basic functional elements of stereo parking systems, it is essential to research how to fully meet the needs of user groups and comprehensively design and develop stereo parking systems.

Keywords: Stereo Parking Systems, User Satisfaction, Influencing Factors

Introduction

With the development of the automobile industry and the increase in car ownership per capita, urban land resources are becoming increasingly scarce. Parking difficulties have become a significant social issue that urgently needs to be addressed in modern cities. Developing stereo parking systems is a primary solution to this contradiction and a necessary demand of social development (Liu, Fei &

Wang, 2020). However, despite the continuous improvement and maturation of product design technology and production processes, the actual market acceptance of stereo parking systems remains low. High vacancy rates in stereo parking garages are common, resulting in significant resource waste and hindering industry development (Yi, 2020).

Compared to major countries worldwide, China still has considerable growth potential in car ownership per capita, leading to an ongoing increase in parking space demand (Liu, Fei & Wang, 2020).

Currently, China faces a parking space shortage of at least 80 to 95 million spaces (Yao & Liu, 2020). Parking difficulties have garnered widespread social attention and urgently need resolution in modern cities (Yi, 2020). In contrast to the growing car ownership and the resulting substantial parking space demand, urban land resources are finite and non-renewable. In recent years, the Chinese government has emphasized focusing on existing land and controlling new land use. Under this backdrop, vigorously developing stereo parking equipment has become the most effective solution to parking difficulties (Yi, 2020). Consequently, governments at various levels in China have introduced policies from the perspectives of planning, construction, fees, and standards, promoting the standardized construction of stereo parking systems to alleviate parking difficulties in urban areas.

Taking the mechanical stereo parking garages in Shanghai as an example, practical survey analysis reveals that users believe existing stereo parking systems have numerous deficiencies in usability, visual and psychological comfort, user experience and operating habits, management and operation methods, space dimensions, and safety and durability.

Research Objectives

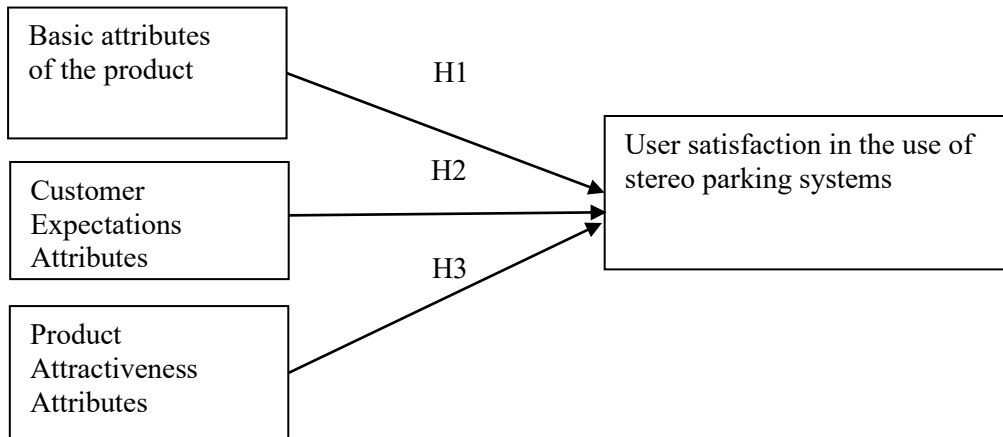
The acceptance of stereo parking systems varies among customer groups as they continue to develop. Identifying existing issues, proposing targeted improvement strategies, and offering guidance for the improvement and development of stereo parking systems are the specific research purposes outlined as follows:

1. To analyze the factors influencing user satisfaction with stereo parking systems.
2. To demonstrate that the three factors: basic product attributes, customer expectation attributes, and product attraction attributes significantly positively impact user satisfaction with stereo parking systems.

Hypotheses

To analyze the factors influencing customer satisfaction, this study constructs a model with product basic attributes, customer expectation attributes, and product attractiveness attributes as independent variables.

Customer satisfaction is the evaluation result of users. Stereoscopic garage production enterprises need to determine the needs of the target user group based on the results of customer satisfaction, and use this as the direction of improvement, in order to provide users with a good product and service experience, ultimately gain their trust, become loyal users of the enterprise, and achieve the effect of the virtuous cycle of enterprise operation. Therefore, hypotheses are proposed as shown in Picture 1.



Picture 1: Conceptual Framework

H1: Product basic attributes have a positive impact on customer satisfaction.

H2: Customer expectation attributes have a positive impact on customer satisfaction.

H3: Product attractiveness attributes have a positive impact on customer satisfaction.

Literature Review

The literature review of this study is based on user-centered design theory, design cognition theory, and affective engineering theory to analyze the factors influencing user satisfaction in the use of stereo parking systems. Using a literature review approach, this study aims to clarify the influencing factors of user satisfaction. The literature is reviewed and analyzed to understand the relationship between this study and existing literature, grasp the development context of research, and establish a theoretical foundation for subsequent studies.

The factors influencing user satisfaction in the use of stereo parking systems involve multiple theoretical foundations, including social psychology, marketing, and consumer behavior. Here are some of the main concepts and theories:

Basic attributes of the product

The design and operation of stereo parking systems involve various fundamental attribute factors. Among them, management time efficiency, labor cost, and operation mode directly affect the implementation of operational management (li et al., 2020).

In terms of production, factors such as production efficiency, product structure complexity, and product qualification rate are significant (wang & chen, 2019). Installation and maintenance focus on product safety, convenience of installation and maintenance, and product qualification rate (xu & zhao, 2021).

Therefore, the secondary factors related to user assistance include management time efficiency, labor cost, operation mode, production efficiency, product structure complexity, product qualification rate, safety and reliability, installation and maintenance, and product qualification rate (yang et al., 2017).

In conclusion, the design, production, installation, operation, and maintenance of stereo parking systems involve a complex process requiring consideration of multiple attribute factors (xu & zhao, 2021). In practice, continuous optimization of these factors is necessary to ensure that system performance meets user needs while maintaining economic and sustainable operation.

Customer Expectations Attributes

When discussing the customer expectations attributes of stereo parking systems, we need to consider the influences of usage environment, spatial layout, and consumer factors (chen & huang, 2015). The usage environment is one of the important factors that customers consider when choosing stereo parking systems (lin et al., 2016).

The cleanliness and maintenance of the environment also affect users' experience and, consequently, their expectations and overall satisfaction (lu & skoog, 2017). An efficient design can maximize space utilization, provide more parking spaces, and ensure that vehicles can enter and exit quickly (wang & huang, 2018).

In summary, the design and operation of stereo parking systems should comprehensively consider these factors to meet or even exceed customer expectations, thereby enhancing customer satisfaction and the system's market competitiveness. Future research can further explore how to enhance the overall user experience of stereo parking systems through technological innovation and service optimization.

Product Attractiveness Attributes

When exploring the attractiveness attributes of stereo parking systems from the perspective of customers, it is essential to consider factors that exceed user expectations and provide users with a sense of "delight" in their experience (Zhang et al., 2020).

These factors not only influence users' actual usage experiences but also involve their physiological and psychological responses (li & wang, 2019). By optimizing human-machine interfaces, such as simplifying operation processes and providing intuitive feedback and guidance, designers can reduce users' psychological cognitive load, enhance operational intuitiveness, and increase pleasure (li & wang, 2019).

The design of stereo parking systems should minimize users' psychological cognitive load to make the parking process more relaxed and enjoyable. Designers can achieve this by providing clear instructions, simplifying operation processes, and implementing intelligent user interfaces (wu & chiang, 2020).

In summary, the attractiveness attributes of stereo parking systems are achieved through a deep understanding of users' physiological and psychological needs and the optimization of human-machine interaction design.

Design Cognitive Theory

In exploring the field of design cognition, scholars endeavor to optimize the interaction between users, products, and service systems by applying theories and methods of cognitive science to design practice (Ege Cansev et al., 2019); This interdisciplinary research domain focuses on users' cognitive behaviors such as perception, thinking, and emotions during the use of products or services (Huang et al., 2020).

For example, through studying the emotional touch characteristics and their effects on the nervous system, design goals and standards for emotional touch interfaces have been proposed to meet specific psychological needs (Ege Cansev et al., 2019).

Addressing cognitive processing issues related to robot malfunctions, a model for processing robot malfunction information was developed to facilitate the development of user-centered fault handling strategies (Honig et al., 2019). Emphasizing the importance of graphic visualization, a model for aesthetic treatment of graphic visualization was proposed based on theories of user cognitive psychology (Huang et al., 2020).

User Satisfaction Theory

User satisfaction is the result of the interaction between factors such as supply and demand, product positioning, product functionality, and market environment. Users can intuitively perceive every aspect of the product or service provided during their experience (Bai & Liao, 2014).

User satisfaction management is a novel management approach that emerged at the end of the last century. User satisfaction reflects the comparison between the products and services provided by the supplier and the perceptions and expectations of the end demander, representing the individual feelings and expectations of users (Yi, 2003).

User satisfaction is an accumulative process, not merely evaluated based on a single experience. User satisfaction theory reveals the issues existing in the products and services provided by enterprises, enabling them to analyze and address these difficulties with the goal of enhancing user satisfaction.

User satisfaction theory is the study of users' satisfaction levels and influencing factors during the use of products or services. Through research on user satisfaction, enterprises can better

understand user needs, improve product or service quality, and thereby enhance user satisfaction and loyalty.

Methodology

This study adopts a quantitative research approach. Based on existing theoretical foundations and previous studies, the content of the questionnaire section is confirmed, and the questionnaire is distributed and analyzed. Through feedback from the data, adjustments are made to the questionnaire content, forming the formal questionnaire, and SPSS is used for reliability and validity analysis of the questionnaire data.

This study adopts a quantitative research method. The research survey adopts simple random sampling. The questionnaire was accurately distributed through the "Credamo Platform" sample library, and cash rewards were given to participants with good questionnaire completion quality. A total of 482 questionnaires were collected. After excluding invalid questionnaires, 400 valid questionnaires were obtained, with an effective rate of 82.99%.

The scale measurement of the three variables in this study, namely, product basic attributes, customer expectation attributes, and product attractiveness attributes. Corresponding items are designed for each variable, and the items are coded as shown in Table 1.

Before conducting the questionnaire survey, this study conducted a pre-test. The questionnaire was precisely distributed to respondents through the "Credamo platform," and cash rewards were given to participants with good questionnaire completion quality. A total of 482 questionnaires were collected, and after excluding invalid ones, 400 valid questionnaires were obtained, with an effective rate of 82.99%. A 5-point scale was used to measure respondents' opinions on each item, where 1 point represented "strongly disagree" and 5 points represented "strongly agree." The pre-test found that although the instructions given before the survey explicitly requested objective answers, respondents may still have formed subjective judgments of good or bad, right or wrong, leading to a tendency to choose extreme values in their responses. Therefore, in the formal survey questionnaire, questions will be further elaborately described to prevent ambiguous statements. Due to the uncontrollability of respondents' answering situations when anonymously filling out the questionnaire online, online incentives were used to encourage respondents to complete the survey seriously, thereby stimulating their enthusiasm for participating in the survey through paid responses. According to the collected data, 482 individuals participated in the pre-test. After screening out cases of missed questions and extreme situations where all answers were the same, 400 valid questionnaires were obtained.

Through the statistical analysis of the data from 400 samples, it was found that 270 individuals often and frequently use stereo garage systems, while 130 individuals rarely make use.

The ratio is close to 3:1, indicating a reasonable distribution of purchase frequency. This sample is relatively consistent with the theme of this study.

Table 1: Factors affecting customer satisfaction.

Variable	Measurement items	NO.
Basic attributes of the product	1. Satisfied with the ease of parking and picking up?	Q1
	2. Are you satisfied with the parking management system?	Q2
	3. Are you satisfied with the level of difficulty in operating the stereo garage system?	Q3
	4. Operate the stereo garage system parking and picking up process satisfaction?	Q4
	5. Satisfied with the ease of reversing when operating the stereo garage system?	Q5
	6. Are you satisfied with the structural design of the entrance/exit convenience and parking spaces?	Q6
	7. Are you satisfied with the safety of operating the stereo garage system in and out?	Q7
Customer Expectations Attributes	1. Are you satisfied with the overall colour scheme and environment of the garage?	Q8
	2. Are you satisfied with the location of the stereo garage for vehicle access?	Q9
	3. Are you satisfied with the size of the parking space in the stereo garage?	Q10
	4. Are you satisfied with the size of the vibration sensation of the car body when stopping and picking up the car?	Q11
	5. Are you satisfied with the eye-catching design of the entrance/exit guide signs?	Q12
	6. Satisfaction with the charging method and consumption level?	Q13
	7. Satisfied with the design in terms of sun protection, wind and rain protection?	Q14
Product Attractiveness Attributes	1. Are you satisfied with the human-machine interface for operating the stereo garage system?	Q15
	2. Are you happy with the ease and pleasure of operating a stereo garage system for parking?	Q16
	3. Are you pleased and surprised by the operation process of parking and picking up the car in the stereo garage?	Q17
	4. Are you satisfied with the overall functionality and physical and mental perception of the product design?	Q18
	5. Are you happy with the human-computer interaction experience of operating the stereo garage system?	Q19
	6. Were you pleasantly surprised by the overall mechanical feel of the stereo garage styling?	Q20
	7. Is it satisfactory in terms of the efficiency of installation and maintenance, and in dealing with faults?	Q21

Reliability refers to the consistency of a measure with the variable it is intended to measure. It assesses the extent to which scores can be trusted. The higher the reliability, the less error is introduced into scores from different items on the same scale. Therefore, scores on the scale move in a consistent manner among respondents, reflecting the true state of affairs. Greater consistency indicates higher reliability, and vice versa. In this study, Cronbach's Alpha is used as the basis for assessing questionnaire reliability. Generally, Cronbach's alpha values range from 0 to 1. A higher Cronbach's alpha coefficient indicates higher questionnaire reliability. All values are greater than 0.8, indicating high stability and consistency of the scale. This demonstrates excellent questionnaire

reliability in the present study, as shown in Table 2.

Table 2: Variable Reliability Tests

Variable	Cronbach Alpha	N of Items
Basic attributes of the product	0.824	7
Customer Expectations Attributes	0.859	7
Product Attractiveness Attributes	0.801	7

Validity refers to the examination of the validity of each variable in the questionnaire. Factor analysis is a commonly used method to test the validity of a questionnaire. The validity of the questionnaire is determined through factor analysis. The KMO test and Bartlett's sphericity test of the questionnaire need to be conducted before principal component factor analysis. Factor analysis can only be conducted if the KMO value is greater than 0.7. The survey data show that the overall KMO value is 0.837, with a significance of 0.000, which is less than 0.05, reaching a significant level, indicating that factor analysis can be performed. This study employs confirmatory factor analysis (CFA). The results of factor analysis on each variable indicate that the KMO and Bartlett's sphericity tests were conducted on the pre-test data to validate the structural validity of the scale. The results are shown in Table 3, with KMO values exceeding 0.8 and significant Bartlett's sphericity test, indicating good structural validity of the scale. This implies good independence of each dimension, indicating good overall validity of the questionnaire.

Table 3: KMO and Bartlett's test

Kaiser -Meyer -Olkin Sampling Adequacy Measures		0.837
Bartlett's test of sphericity	Approx. CARTES	6942.00
	df	194
	organizations	0.000

Results

1). Correlation Analysis

Correlation analysis is primarily used to illustrate the relationships between different variables. Pearson correlation analysis is used to describe the linear relationship between variables, with Pearson correlation coefficients ranging from -1 to 1. By employing Pearson correlation coefficient analysis, the relationships among the factors influencing impulsive purchases were analyzed. Based on Table 4, it can be concluded that the Pearson correlation coefficients for the product's basic attributes, customer expectations, and product attractiveness are all greater than 0.5 but less than 0.9, with a significance level of $P < 0.01$, indicating that there are significant positive correlations among the variables.

Table 4: Correlation between variables (Pearson correlation matrix)

Variable	Basic attributes of the product	Customer Expectations Attributes	Product Attractiveness Attributes
Basic attributes of the product	1		
Customer Expectations Attributes	.591 **	1	
Product Attractiveness Attributes	.551 **	.665 **	1

Note: *p < 0.05, **p < 0.01, ***p < 0.001

From the table, it can be observed that the Pearson correlation coefficients for the product's basic attributes, customer expectations, and product attractiveness are all greater than 0.5 but less than 0.9, with a significance level of $P < 0.01$, indicating a positive correlation between variables. The Pearson correlation coefficient between the product's basic attributes and customer expectations is 0.591, with $P < 0.01$, indicating a general correlation between these two variables. The Pearson correlation coefficient between the product's basic attributes and product attractiveness is 0.551, with $P < 0.01$, suggesting a correlation between them, also of a general nature. Similarly, the Pearson correlation coefficient between customer expectations and product attractiveness is 0.665, with $P < 0.01$, indicating a general correlation between them. Based on the above research analysis, factors influencing user satisfaction with the use of the stereo parking system include product basic attributes, customer expectations, and product attractiveness.

2). *Multivariate Regression Analysis*

The data underwent multiple regression analysis to ascertain the relationship between the dependent variable, user satisfaction, and the independent variables: product basic attributes, customer expectations, and product attractiveness. The regression equation was significant, with an F-value of 142.172 and $p < 0.001$. The Durbin-Watson test yielded a value of 1.944, falling within the range of 1.8 to 2.2, indicating independence of data and meeting the requirements of linear regression. In covariance diagnostic results, the variance inflation factor (VIF) values were close to 1, with the product basic attributes VIF at 1.118, customer expectations at 1.091, and product attractiveness at 1.195, indicating no covariance in the data. Product basic attributes ($\beta=0.135$, $p < 0.05$), customer expectations ($\beta=0.217$, $p < 0.05$), and product attractiveness ($\beta=0.101$, $p < 0.05$) significantly and positively influenced user satisfaction. These variables collectively explained 57.5% of the variance in user satisfaction with the stereo parking system, meeting the criteria.

According to the multivariate regression analysis, the relationships among the variables are obtained: $\text{User satisfaction} = 3.209 + 0.145 * \text{product basic attributes} + 0.218 * \text{customer expectations} + 0.112 * \text{product attractiveness}$.

Therefore, based on the data analysis results, in the study of factors influencing user

satisfaction with the stereo parking system, product basic attributes have a significant positive effect on user satisfaction, supporting hypothesis H1. Customer expectations have a significant positive effect on user satisfaction, supporting hypothesis H2. Product attractiveness has a significant positive effect on user satisfaction, supporting hypothesis H3.

Table 5: Multiple Regression Analysis

Item	Un-std. B	Std. Beta	t	Sig.	VIF	F	Durbin-Watson
C	3.209	-	7.506	0.000		142.172	1.944
Basic attributes of the product	0.135*	0.175	4.176	0.000	1.118		
Customer Expectations Attributes	0.217*	0.262	5.327	0.000	1.091		
Product Attractiveness Attributes	0.101*	0.130	2.753	0.006	1.195		
R-squared	0.579						
Adjusted R-square	0.575						

Note: *p <0.05, **p <0.01, ***p <0.001

Discussion

With the development of the automobile industry and the increase in per capita car ownership in China, parking difficulties have become a pressing issue in modern cities that urgently needs to be addressed. Developing stereo parking systems is the primary solution to this dilemma and is an inevitable requirement for social development.

Currently, the development of stereo parking equipment in China has reached a certain scale and market. Although the design technology and production processes of stereo parking equipment are becoming increasingly sophisticated and mature, the current design and development of such systems are product-centered, with the goal of achieving functionality, but they do not fully meet the needs of users, and the design concepts lag behind the development demands of the times.

Based on the empirical analysis results of user satisfaction with stereo parking systems. proposes marketing strategies beneficial to the development of stereo parking systems from three aspects: product basic attributes, customer expectations, and product attractiveness. The aim is to guide enterprises in leveraging survey experiences to improve the promotion and usage of stereo parking systems.

Conclusions

1). *Basic product attributes have a positive effect on user satisfaction.*

To enhance user satisfaction of Shanghai's stereo parking system, key factors like operation, production, structure, installation, maintenance, and safety must be optimized. This involves improving management efficiency, reducing costs, updating operational models, refining production, enhancing installation & maintenance, ensuring safety, and optimizing user experience.

2). *Customer expectation attributes have a positive effect on user satisfaction.*

The user satisfaction of Shanghai's stereo parking system hinges on customer expectations. Alongside basic attributes, it's also shaped by expectations-related factors like environmental usability, spatial layout, and consumer demands. Deficiencies in these can detract from satisfaction. To enhance it, key factors need comprehensive optimization, ensuring high operational, design, and service standards. Future efforts should prioritize enhancing the overall user experience through technological and service innovations.

3). *The attractiveness attributes of the product have a positive impact on user satisfaction.*

Analyzing user satisfaction of Shanghai's stereo parking system requires considering its "attractiveness" attributes that exceed expectations and bring "delight." To boost satisfaction, key factors must be optimized for high standards in operation, design, and service. Future efforts should prioritize enhancing the overall user experience via technological innovation and service design.

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