An Empirical Research on the Characteristics and Improvement Direction of Self-Service Kiosk at Shanghai Pudong Airport

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Abstract. This study explores the characteristics and improvement directions of the self-service kiosks (SSKs) at Shanghai Pudong International Airport. By providing multilingual support, accessible interfaces, high recognition accuracy, and aesthetically pleasing designs, SSKs help reduce check-in time and minimize interpersonal contact, thereby enhancing passenger satisfaction and expanding customer base. By using the Shanghai Pudong International Airport as a case study, the relevant data was collected through online questionnaires to analyze the impact of SSK characteristics on their usage by using T-tests and Chi-square tests. The results indicate that apart from satisfaction with the accessibility interface, there were no statistically significant differences in passenger satisfaction related to other SSK features. Furthermore, there was no significant correlation between passengers' willingness to use SSKs and their inherent characteristics. The study suggests that future design and optimization of SSKs should focus more on improving accessibility and user-friendliness to cater to a wider range of users.

Keywords: Self-Service Kiosk (SSK); Shanghai Pudong International Airport; Empirical Analysis.

1. Introduction

The majority of source markets maintain a positive outlook on air travel, indicating a speediness recovery [1]. The airport infrastructure worldwide must adapt to a variety of evolving demands [2]. The current challenge faced by most airports is the shortage of infrastructure capacity [3]. This challenge arises due to constraints in physical space, cost, and time requirements. One option is to improve and optimize existing infrastructure. For example, online booking tickets has become a widely accepted time-saving ticketing operation. This change is precisely due to the optimization of the operational processes of airport infrastructure, transitioning from offline to online. For airports, it is important to utilize self-service technologies (SST) to reduce check-in time and avoid personal contact [4]. The technological entity underutilization is a self-service kiosk (SSK). In this device, customers can use the software with an interactive interface to check in, print boarding passes, and print luggage tags.

Many face-to-face service interactions is being replaced by SSKs to enhance the passenger satisfaction degree [5]. Moreover, this advancement enables organizations to significantly augment their customer base without incurring proportional increments in staffing expenses or the costs associated with expanding physical operational facilities [6]. To keep pace with current trends, an increasing number of airlines have implemented online check-in systems and SSKs at airports to accommodate the needs of their passengers [7].

Shanghai Pudong International Airport (PVG) is operated by the Shanghai Airport (Group) Company, Ltd. (SAA), a leading aviation enterprise in China. SAA is a public company in China's securities market, according to the yearly report, more than 204,400 aircraft took off and landed at PVG. Also, more than 14.7 million passenger’s take-off or landing via PVG in 2022. Also, a large number of SSK devices are available for passengers at PVG. This study will take PVG as an example.

To comprehend the factors contributing to passengers' reluctance to utilize self-service kiosks (SSKs) during airport check-in processes, this study aims to analyze the characteristics of SSKs and examine their impact on usage patterns. This study will focus on the convenience of SSK devices,

such as multilingual support, accessibility, and passenger satisfaction with the interface. To know passenger perspectives, data of this study will be collected by online questionnaire, and it will be collected in PVG by scanning QR code. Furthermore, the T-test is utilized for analyzing the impact of SSK characteristics on its utilization, while the Chi-square Test is employed to examine the independence between SSK and utilization.

2. Literature Review

Tyagi et al. focus on the statistical analysis of passengers at Sydney Kingsford Smith Airport, employing T-tests and Chi-square tests to evaluate the effects of sociodemographic and situational factors on SST usage [7]. Key findings suggest that education level, flying experience, age, signage quality, staff cooperation, and crowd/waiting time management significantly influence SST utilization. The study also highlights how travel frequency and SST usage impact passenger processing times and airport arrival times, respectively.

Moon and Lee examine the influence of consumers' motivations on their intention to use SST in airline services, utilizing the Stimulus-Organism-Response model [8]. Conducting an online survey at Incheon International Airport, the research reveals that both intrinsic motivations and extrinsic motivations significantly enhance the expectation and estimate of SST, subsequently influencing behavioral intention towards SST usage. The study highlights the mediating roles of experience and SST estimate in linking motivations to behavioral intention, providing practical implications for effectively promoting SST adoption through customer perception management.

Rolim, Correia, and Borille propose a scheme to estimate the level of service for airport check-in procedures, aiming to assess the impacts of operational protocols, infrastructure development, and the expansion of demand [9]. The research emphasizes the importance of factors such as check-in hours, processing time, and SST in improving passenger satisfaction and reducing wait times, providing a framework for airport operators to enhance check-in service levels.

This article contributes to the literature by examining the relationship between the characteristics of SSKs and their usage. Compared with previous research on passengers and flow experience, this article focuses on enhancing SSK characteristics through collaboration with airport companies, drawing upon the methodology proposed by Rolim, Correia, and Borille [9]. Understanding the underlying factors influencing passengers' choices is crucial for airport companies to enhance SSK and self-service technology.

3. Methodology

3.1. Hypothesis Development

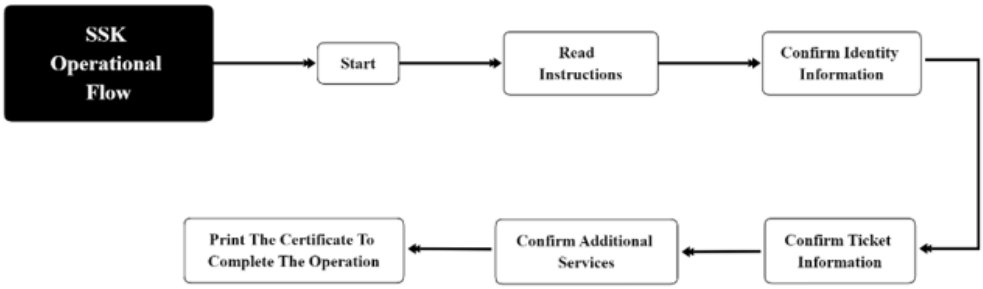

Fig 1. The operational flow for utilizing Hainan Airlines' SSKs at Beijing Capital International Airport (Picture credit: Original).

SSK operational Flow could almost be divided into seven sections, as shown in Figure 1. Chinese civil aviation is confronted with a myriad of challenges in improving the quality of service. Enhancing service quality has become imperative for Chinese airlines to effectively compete with their international counterparts [10]. The present study will focus on the improvable features of SSKs, including their robust multilingual support, disability-accessible interface, high recognition accuracy,

and aesthetically pleasing design. Additionally, according to technical requirements and conformance testing for Internet content accessibility in the field of information technology, disability accessible interfaces should include perceptibility, operability, intelligibility, and compatibility. For those features as illustrated in Figure 2, a conceptual framework has been formulated in this study. The model utilizes the features of SSKs to evaluate their correlation with the SSKs employed at PVG. Specifically, these features of SSKs could be developed into two hypotheses as shown in Table 1.

Table 1. Two hypotheses groups.

Null Hypotheses (a)	Null Hypotheses (b)
H_{a1}: The utilization of SSKs is contingent upon the provision of robust multilingual support.	H_{b1}: The utilization of SSKs and the robust multilingual support are independent.
H_{a2}: The utilization of SSKs is contingent upon the disability accessible interface.	H_{b2}: The utilization of SSKs and the perceptibility of disability accessible interface are independent.
H_{a3}: The utilization of SSKs is contingent upon the provision of high recognition accuracy.	H_{b3}: The utilization of SSKs and the operability of disability accessible interface are independent.
H_{a4}: The utilization of SSKs is contingent upon the provision of aesthetically pleasing design.	H_{b4}: The utilization of SSKs and the intelligibility of disability accessible interface are independent.
	H_{b5}: The utilization of SSKs and the compatibility of disability accessible interface are independent.
	H_{b6}: The utilization of SSKs and the high recognition accuracy are independent.
	H_{b7}: The utilization of SSKs and the aesthetically pleasing design are independent.

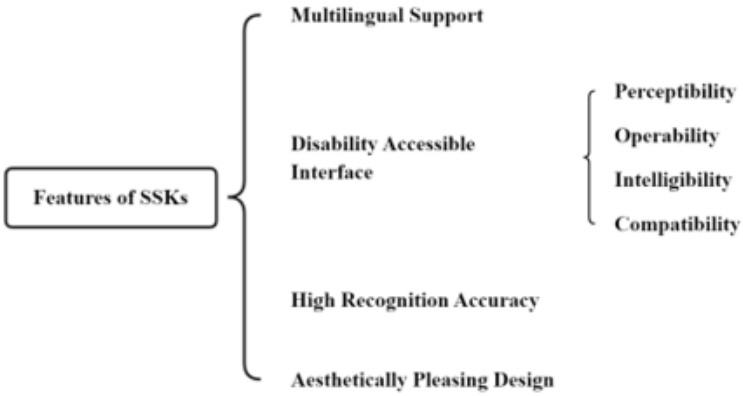

Fig 2. The features of SSKs (Photo/Picture credit: Original).

The relationship between the features of SSKs and their usage at PVG was evaluated using statistical analysis methods, specifically employing a T-test for Null Hypothesis (a) and a Chi-square test for Null Hypothesis (b). These data will be collected by questionnaire, and analyzed data and results will help in better understanding passenger perspectives and will help to improve the SST facilities.

3.2. Data Collection

The study was conducted through a questionnaire. Specifically, the survey was divided into three different parts, including effective validity check, SSK features quantification rating slider, and respondents' inclination. More specifically, the first part inquires and assesses whether the participants have utilized the SSK available at PVG and it also encompasses whether one has had any air travel experience. The second part entails a comprehensive analysis of passenger satisfaction levels regarding the specific attributes of "SSKs". Mainly, this questionnaire assesses multilingual support, disability accessible interface, high recognition accuracy, and aesthetically pleasing design, where the disability accessible interface was divided into four specific contexts, including perceptibility, operability, intelligibility, and compatibility. The third part focuses on the respondents'

inclination towards utilizing SSK, encompassing their current inclination, inclination after improving SSK, and propensity to recommend others for usage. This questionnaire is uninvolved in passenger characteristics.

The survey was disseminated online in both Chinese and English languages via the WJX website and a QR code featuring an identical hyperlink. The WJX platform offers functionalities that are comparable to those provided by Amazon Mechanical Turk. At the beginning of the survey, intent and motive have been explained to passengers. The survey participation was based voluntarily.

Ultimately, a total of 74 responses have been collected by using online survey. However, 25 responses were deemed ineligible for inclusion in the study, resulting in a total of 49 valid responses that were utilized for analysis.

3.3. Statistical Analysis

The T-test and Chi-square test are two common methods of hypothesis testing in statistics, each suitable for different situations and types of data. The T-test is primarily used for comparing differences in means, applicable to continuous data [11]. While the Chi-square test is mainly used for comparing differences in frequencies or proportions, applicable to categorical data [12]. The choice of a suitable test relies on the characteristics of the data and the research question.

The initial set of null hypotheses (a) was examined through a T-test to evaluate the satisfaction of users and the characteristics of SSKs. The second set of null hypotheses (b) was examined using a Chi-square test to ascertain the independence or dependence of SSK utilization on their characteristics. The results from both tests enabled us to ascertain whether there were significant differences in SSK utilization and whether such use depended on or was independent of specific SSK characteristics. Generally, the significance level will be set as 0.05, this study set the same level.

4. Empirical Results

The paired sample T-test is employed to examine each hypothesis within the framework of Null Hypotheses (a). For H_{a1}, the result is shown in Figure 3. By computing, the T statistic is about 1.94 and the p-value is about 0.059. This implies that, statistically, there is no significant difference between customer satisfaction with multilingual support and their overall satisfaction, since the p-value exceeds the significance level of 0.05. This suggests that customer satisfaction with multilingual support is comparable to their overall satisfaction. During the actual usage process, the accurate comprehension of textual content by users forms their initial impression of the device, thereby determining the smoothness of subsequent operational procedures. For example, the UK's tourism industry greatly benefits from visitors, thus the implementation of multilingual devices would enhance the satisfaction of foreign guests from non-English speaking countries and contribute to their overall experience [13].

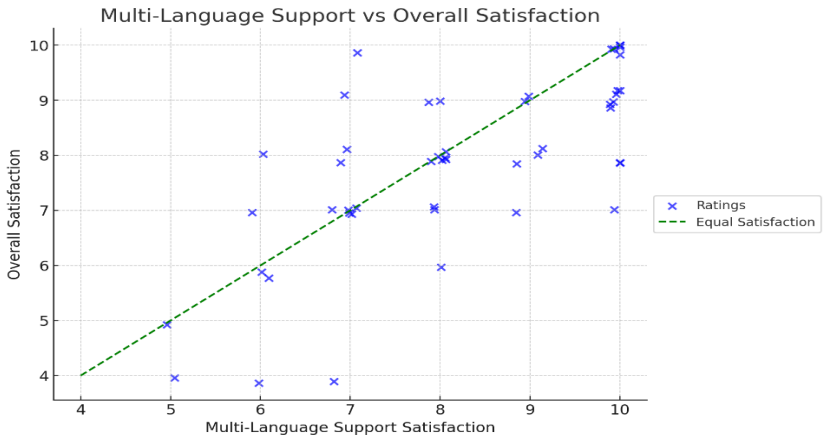

Fig 3. Paired sample T-test for multilingual support and overall satisfaction (Photo/Picture credit: Original).

For H_{a2}, the result is shown in Figure 4. By computing, the T statistic is about -3.02 and the p-value is about 0.004. The present finding demonstrates a statistically significant distinction in the scores between the two groups, as indicated by a p-value below 0.05. The findings suggest that passengers generally perceive the accessible interface as unsatisfactory, despite SSK's overall satisfactory performance.

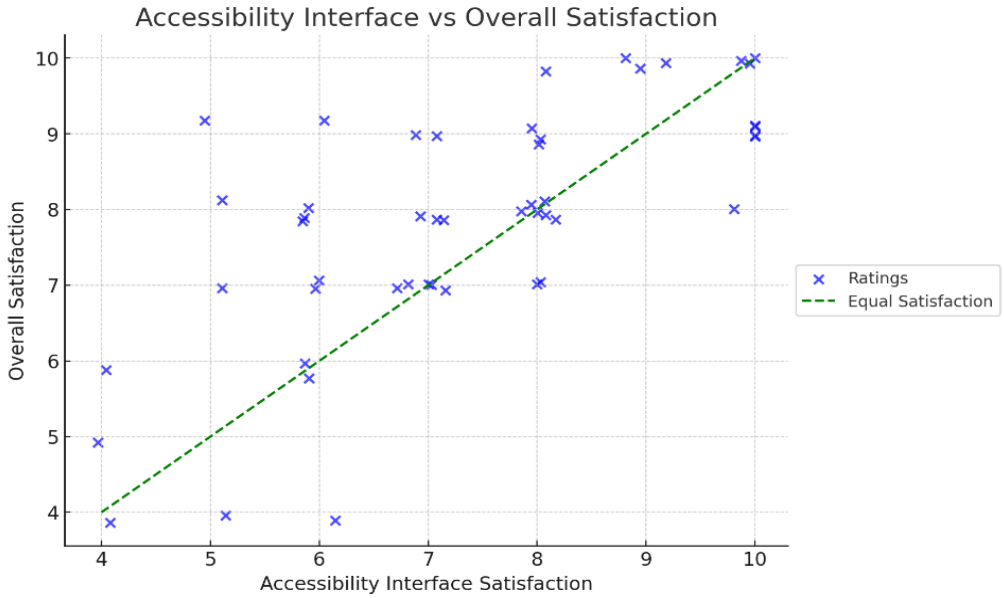

Fig 4. Paired sample T-test for accessible interface and overall satisfaction (Photo/Picture credit: Original).

For H_{a3}, the result is shown as Figure 5. By computing, the T statistic is about 0.676 and the p-value is about 0.503. This suggests that, from a statistical standpoint, there is no significant disparity between satisfaction with ID recognition accuracy and overall satisfaction, as the p-value exceeds 0.05 by a considerable margin. This indicates that customers' satisfaction with the accuracy of ID recognition and their overall satisfaction with self-service devices do not differ significantly in a statistical sense. Additionally, the implementation of biometric entry and exit screening has resulted in a reduction of waiting times by 4 minutes [14].

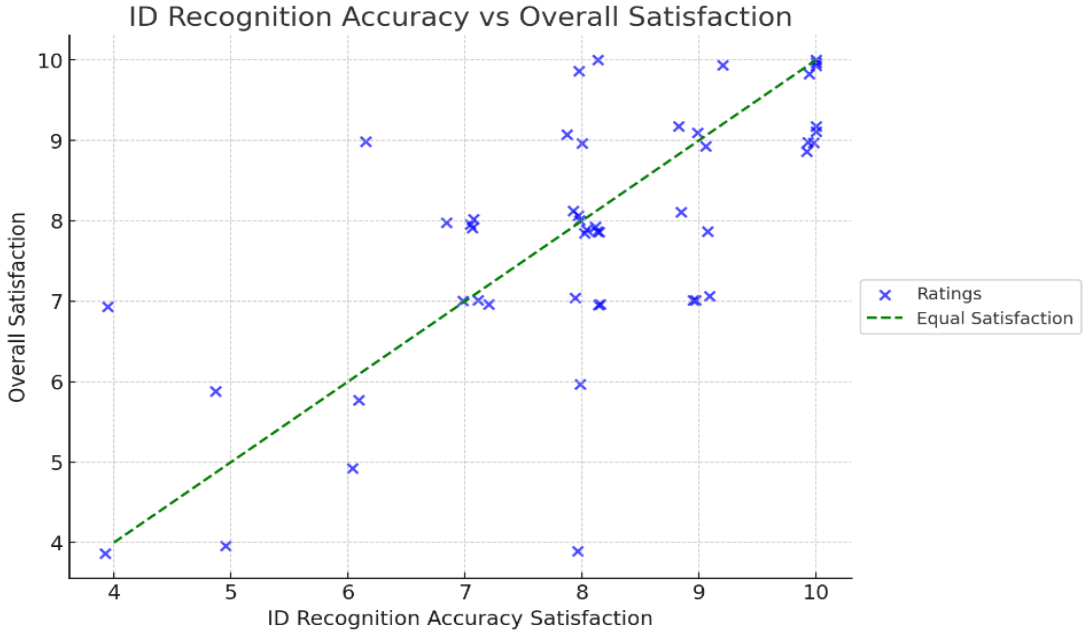

Fig 5. Paired sample T-test for ID recognition accuracy and overall satisfaction (Photo/Picture credit: Original).

For H_{a4}, the result is shown in Figure 6. By computing, the T statistic is about –1.57 and the p-value is about 0.123. The p-value of 0.123 is greater than 0.05, indicating that there is no significant difference between satisfaction with the interface aesthetic and overall satisfaction statistically.

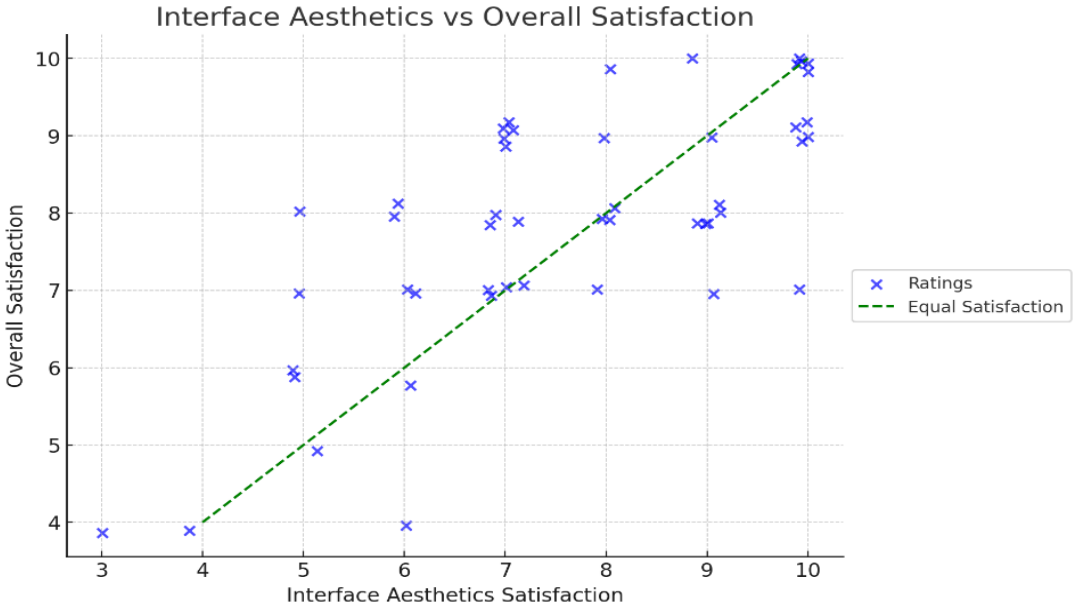

Fig 6. Paired sample T-test for interface aesthetic and overall satisfaction (Photo/Picture credit: Original).

The Chi-square test of independence is utilized to test each hypothesis in Null Hypotheses (b). For H_{b1}~H_{b7}, the result is shown in Table 2. By computing, the degree of freedom is 7 and the significance level is 0.05, denoted by $\alpha = 0.05$, $df = 7$. By searching Chi-Square Probabilities, 14.067 is the critical value under $\alpha = 0.05$ and $df = 7$. Obviously, the critical value is greater than each Chi-square value, as shown in Figure 7. In the meantime, all P values exceed the significance level of 0.05.

Table 2. The result of Chi-square test of independence for H_{b1}~H_{b7}

No.	Features	Chi-square value	P value
H_{b1}	The robust multilingual support	3.219	0.864
H_{b2}	The perceptibility of disability accessible interface	6.317	0.503
H_{b3}	The operability of disability accessible interface	7.936	0.338
H_{b4}	The intelligibility of disability accessible interface	6.202	0.516
H_{b5}	The compatibility of disability accessible interface	10.622	0.156
H_{b6}	The high recognition accuracy	6.284	0.507
H_{b7}	The aesthetically pleasing design	5.178	0.638

Therefore, based on the available evidence, we fail to find sufficient grounds for rejecting the null hypothesis, which posits that these features and user preferences are statistically independent and have no significant correlation. In other words, the willingness of passengers to utilize SSK is independent of the inherent characteristics of the equipment. Although numerous studies have reported an enhanced quality of hospitality services resulting from SSK, a complete substitution of personal services remains highly implausible considering customer willingness [15]. Airport operators should still respect customers' wishes and provide service assistance.

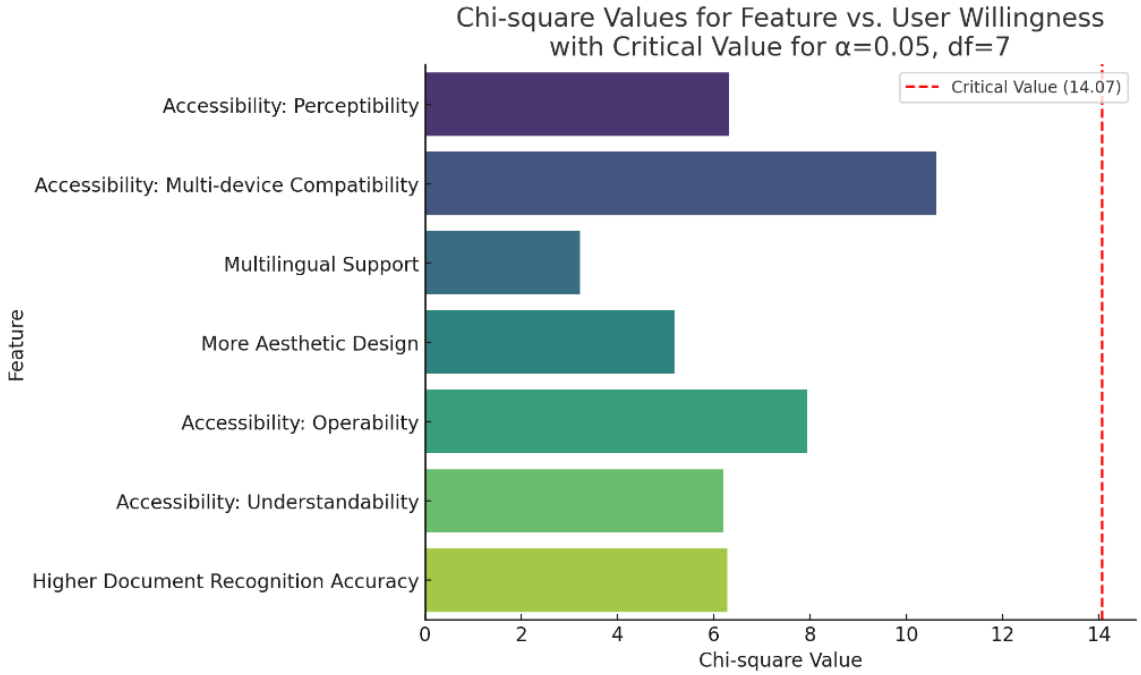

Fig 7. The Chi-square test of independence for each feature and user willingness (Photo/Picture credit: Original).

5. Conclusion

Transport infrastructure serves as the fundamental pillar for fostering economic and social prosperity. However, the ever-increasing demographic, technological, economic, and social transformations impose significant strains on the existing transport infrastructure. This study of PVG has observed the relationship between SSK characteristics, passenger satisfaction, and passenger willingness. SSK characteristics are included multilingual support, accessible interface, recognition accuracy, and aesthetically pleasing design. The T-test result of the relationship between each SSK characteristic and passenger satisfaction do not differ significantly in a statistical sense, except accessible interface satisfaction. The Chi-square test result of the independence between SSK characteristics and passenger willingness shows that the willingness of passengers to utilize SSK is independent of the characteristics of SSK self. In addition, a few limitations need to be addressed. T-test and Chi-square test have certain requirements for samples. The accuracy of the model can be increased by increasing the number of samples and strengthening the data cleaning process. In conclusion, the design and optimization of SSK in the future should pay more attention to improving its accessibility and user friendliness. SSK is expected to play a role in advancing the modernization of transportation infrastructure and enhancing passenger satisfaction and aspirations for usage through continuous technological advancements and service enhancements.

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