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Research on Aging Adaptive Design for Rural Elderly Users Using Government Service Apps

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SUMMARY: *With the deepening of aging, the collision of digitization and aging has formed an insurmountable "digital divide", and how to promote the optimization of aging service supply has become an urgent problem for the government to solve. In this paper, we take the government service APP "SuServiceOffice" as the object to carry out the research on ageing-friendly design. Firstly, a questionnaire survey was conducted to understand the needs of rural elderly people, and secondly, Kano model and QFD theory were applied to categorize the needs of rural elderly users and explore their multi-level needs, so as to locate the direction of the app design more accurately. In the usability test of the optimized "Su Service Office" App, the overall task completion rate of the subjects is high, with most of them completing the tasks in less than 2 minutes, and the average satisfaction score of the participants reaches 89.88, which indicates the feasibility of the aging-friendly design scheme proposed in this paper. This paper has certain reference value in effectively identifying and acquiring the functional needs of the elderly group for ageing-friendly apps, and improving the satisfaction of ageing-friendly apps.*

KEYWORDS: *rural elderly; government service app; aging-friendly design; Kano model; quality function expansion*

1 Introduction

With the rapid development of information technology, as well as the development of the Internet, big data, artificial intelligence and other fields, intelligent services have been widely used in various fields, and such services have profoundly changed our way of production and life, and improved the effectiveness of social governance and government services [1-3]. In this context, government service APP has become is an important channel for the government to contact the public, serve groups and unite the public in the Internet era. At the same time, with the rapid growth of the global population of the elderly, aging has become a major challenge for all countries, in which the aging phenomenon in rural areas is more serious than that in urban areas [4]. However, many older people do not know how to access the Internet or use smartphones, which makes them inconvenient in their daily lives, such as traveling, medical care, and consumption, and they are unable to fully enjoy the convenience brought by intelligent services, and this phenomenon is more significant in the rural elderly group [5-8].

In addition, some of the elderly, even though they can use smart APPs, have problems such as information asymmetry, lack of trust, and low acceptance [9, 10]. The problem of "digital divide" faced by the elderly is becoming more and more prominent. For these problems, a series of solutions are needed to improve the aging level of government services. Through the

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continuous improvement of digital aging and information accessibility services, we can optimize the service quality of government service APPs, improve the public's trust and participation in APPs, and narrow the service effect gap of the aging public in different places, so as to promote fairness, comprehensiveness, and inclusiveness of government services.

In recent years, research on age-friendly apps has been carried out; Molnár and Kő [11] explored the usability and acceptance factors of e-government systems for older people in Germany and Hungary using the developed framework “IGUAN”, identifying the needs of and barriers to older people's access to government services. Vogel et al [12] worked to create a digital community platform suitable for older adults to activate the human, technological, and infrastructural resources in the community and utilize them for the well-being of older adults to alleviate the problems of an aging society. Speck et al [13] introduced an “Easier to use cell phone” app that simplifies the operation on a smartphone and connects two phones for remote virtual help, allowing the elderly and vulnerable to gain more confidence in the operation of the app. Chen et al [14] reviewed and analyzed that most mobile apps are designed to enhance the well-being of older adults, and apps for health needs are commonly used programs for older adults, where the usability of the app is the focus of the age-appropriate experience element. Kong [15] evaluated a dual-interface mobile app using hierarchical analysis and fuzzy comprehensive evaluation to identify strategies for optimizing the user interface for the elderly in the app, i.e., large fonts and buttons, high-contrast colors, and visualization to better meet the health and safety management of the elderly. Yang et al [16] showed that the elderly may not use APP aging mode due to factors such as loss of limb function, secondary interface layout and font adjustment, etc., while simple operation, easy to grasp, effective function description, and effective assistive system are the focus of middle-aged and elderly users. At present, most studies explore the usability, acceptance, and aging needs of APP for the elderly, and provide simple aging-friendly designs, such as font adjustment, interface color parameter adjustment, and expansion of interface operation buttons, etc. Few studies directly put forward aging-friendly APP design for government services.

Aiming at the aging design of government service APP, this paper takes “SuServiceOffice” APP as the research object, conducts a questionnaire survey for rural elderly users, determines the initial demand items of rural elderly users for government service APP, and ranks the importance of the demand items by using the Kano model. On this basis, the design requirements of government service APP are summarized, and the importance of each design requirement is quantitatively analyzed based on the quality function development theory. Finally, based on the results of mining the needs of rural elderly users and the design requirements of government service APPs, the “SuServiceOffice” APP is designed for aging and tested for usability.

2 Research methodology

2.1 Kano model

Kano model is an analytical model for classifying attributes and ranking the importance of user requirements.Kano model is shown in Fig. 1, which reveals the non-linear relationship between product performance and user satisfaction. The X-axis represents the degree of product quality attributes and the Y-axis represents user satisfaction. The Kano model can be applied to categorize the importance of products according to their performance: Must-have quality (M), Expected quality (O), Attractive quality (A), Indifferent quality (I), Reverse quality (R).

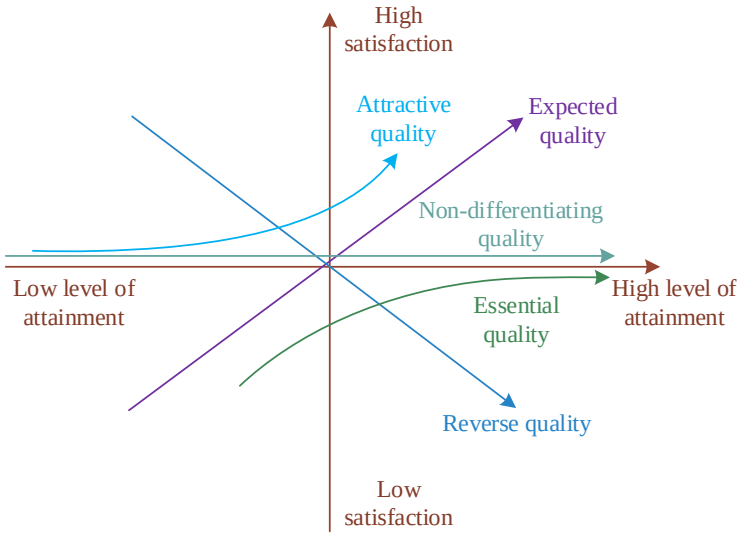

Figure 1: Kano model

The advantage of Kano model is mainly reflected in the fact that the model analyzes from the perspective of users' actual needs. In this paper, the Kano model is used to collect and analyze the needs and satisfaction of rural elderly users to the government service APP, so as to obtain the quality characteristics of the government service APP that need to be improved, and put forward the corresponding aging-adapted design improvement plan.

2.2 Quality Function Development (QFD)

Quality Function Deployment (QFD) is a product design planning method that takes customer demand as input, and its core is the transfer and distribution of customer demand to design demand, i.e., QFD realizes the conversion of customer demand information to product information through the operation of the House of Quality Planning (HOQ) and distributes it to the development and design. Traditional product quality planning house is shown in Figure 2, it is through a more intuitive matrix representation.

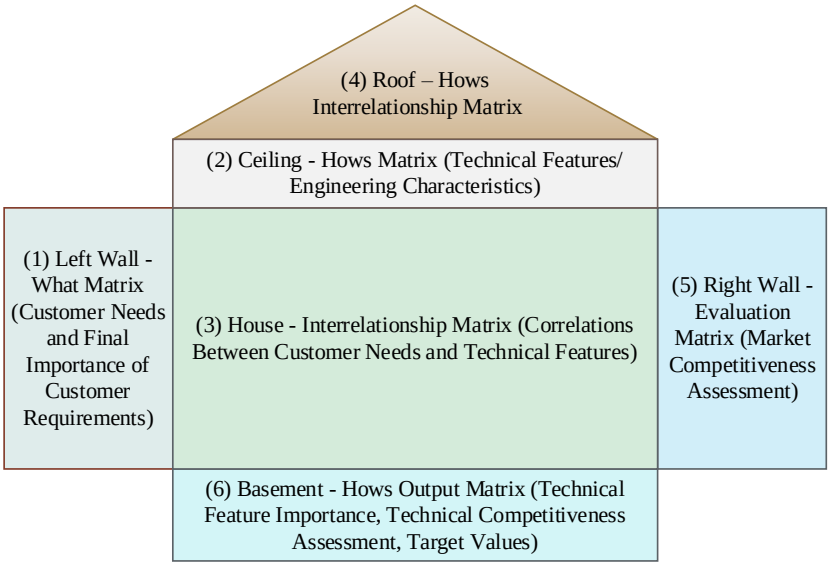

Figure 2: Product planning house of quality

The difference between the technical requirements of government service APP and traditional product technical requirements is that it includes both product technical requirements and service technical requirements. This makes it necessary to consider the needs of elderly users, product design needs, service design needs, as well as the correlation between the needs of elderly users and the design needs when applying the QFD theory to the aging design of the government service APP. Therefore, this paper improves the traditional product planning quality house into the product service system program planning quality house. The product service system program planning quality house is shown in Fig. 3, and the components are as follows:

(1) Left wall-Elderly user needs and their importance. The needs and the importance of the needs of the elderly users are still the inputs to the Product Service System Programming Quality House.

(2) Ceiling-Requirements for government service app design obtained based on elderly user needs.

(3) Room-Relationship between elderly user needs and design requirements.

(4) Roof-Autocorrelation matrix of government service APP design requirements. Autocorrelation relationship between product and service design requirements, and correlation relationship between product and service.

(5) Right Wall-Competitive Evaluation Matrix. By comparing the technology of this government service APP with the technology of other government service APPs, the development strategy in line with this government service APP is formulated.

(6) Basement-Importance of Technology Demand of Government Service APP. Output product and service technology demand, and their demand importance.

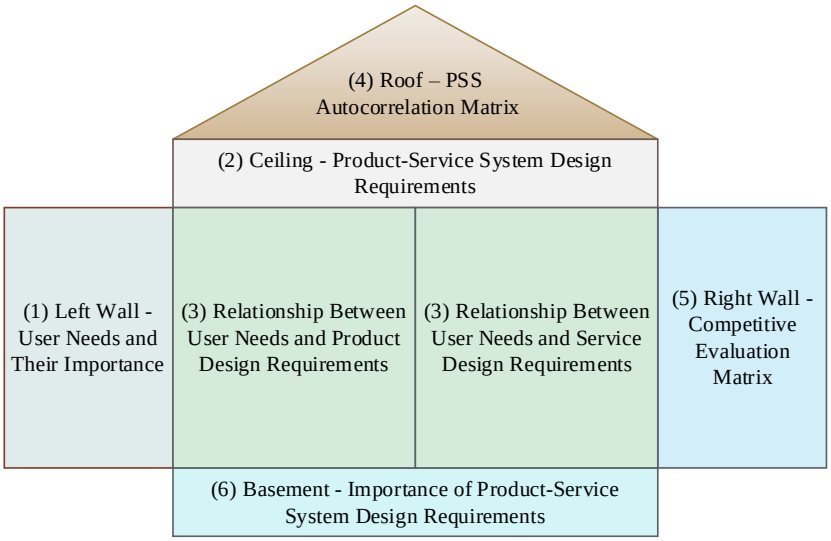

Figure 3: Product service system planning house of quality

By analyzing the traditional product planning quality house and the product service system programming quality house, it can be seen that the difference between the two is reflected in both the composition and the treatment. In terms of composition, the ceiling of the product-service system program planning quality house contains product design requirements and service design requirements, as well as the relationship between their influences. In the processing way, due to the complexity of the relationship between the parts in the product service planning quality house, the traditional digital scale method can not respond to the ambiguity and uncertainty of the expert evaluation, and it is particularly important to choose which method to deal with the expert evaluation in the process of the quality function of the

APP of the government service.

2.3 Kano-QFD based ageing app design process

2.3.1 Designing a User Requirements Questionnaire Using the Kano Model

Firstly, through pre-investigation, determine the demand elements of rural elderly user groups for the elderly-friendly design of government service apps. Secondly, for each need, set up two questions in the Kano questionnaire, namely "When the need is met and when the need is not met", with the options being "very much like", "should be like this", "don't care", "can tolerate", and "cannot accept". Finally, the attributes of each demand element are determined by combining the Kano model classification judgment matrix, and they are classified into essential elements (M), expected elements (O), attractive elements (A), and undifferentiated elements (I).

2.3.2 Quantifying the Kano model to obtain relevant data

The M, O, A, and I data from the research of each demand element are brought into Eqs. (1) and (2) to obtain Better and Worse values:

$$Better\left(SI\right)=\frac{A+O}{A+O+I+M} \tag{1}$$

$$Worse\left(DSI\right)=-\frac{O+M}{A+O+I+M} \tag{2}$$

where: SI is the satisfaction coefficient after meeting the user's needs, the value range is 0~1, the larger the value is the stronger the satisfaction enhancement. DSI is the dissatisfaction coefficient after eliminating a certain function demand, the value range is -1~0, the smaller the value is the more satisfaction decreases.

In short, the closer SI and DSI are to 0, the smaller the impact on user satisfaction, and the closer to 1, the larger the impact on user satisfaction. Therefore, the user satisfaction index T_i is expressed based on the absolute value of both SI and DSI with the following formula:

$$T_i=\max\left(\left|SI\right|,\left|DSI\right|\right) \tag{3}$$

Combined with the Likert five-level scale, the current state and target state of the surveyed rural elderly group's satisfaction with the government service app were quantified, with 1 indicating the most dissatisfied and 5 indicating the most satisfied, and the average of which was taken as the value of the current satisfaction S_0 and the value of the target satisfaction S_i, and the following formula was used to compute the target improvement ratio of the elderly's satisfaction with their needs IR_0:

$$IR_0=\frac{S_i}{S_0} \tag{4}$$

In order to better identify the user needs of the rural elderly group, this paper incorporates an adjustment coefficient K into the original target improvement ratio of demand satisfaction so as to obtain the transformation function used to refine the original improvement ratio with the following formula:

$$IR_i = \left(1 + T_i\right)^K IR_0 \tag{5}$$

Regarding the value of K, combined with the results of Kano's classification, the must-have, expectation, and charisma factors are assigned values of 0.5, 1, and 1.5, respectively.

According to the improvement rate of demand satisfaction IR_i and user demand importance H_i, the following formula is used to calculate the adjusted demand importance IR_i for the elderly group:

$$LR_i = H_i \cdot IR_i \tag{6}$$

where, regarding the assignment of H_i, it will be combined with the ratings of the needs of the surveyed older adults, with 5 being the most important and 1 being the least important.

2.3.3 Determining Design Requirement Importance Using QFD Models

Combined with the QFD model, the needs of rural elderly user groups for government service apps are organized, the design requirements of government service apps are obtained after generalization and summarization, and the relationship matrix between user needs and design requirements is constructed. According to the scoring method of relevance degree, the researched rural elderly users and the aging designers of government service App score the relevance of user needs and design requirements, and the relevance scores of strong, general and low are 9, 5 and 1 respectively, and finally the importance degree of each design requirement is calculated according to the following formula:

$$W_j = \sum_{i=1}^{n} LR_i \cdot R_{ij} \tag{7}$$

where W_j denotes the importance of the j th design requirement, LR_i denotes the adjusted importance of the i th user requirement, and R_{ij} denotes the coefficient of correlation between the i th user requirement and the j th design requirement.

After calculating the degree of importance according to equation (7), it is ranked in the order from the largest to the smallest.

3 Case studies

In this chapter, the elderly version of SuServiceOffice APP is selected as an object for case study, and the Kano-QFD method is applied to analyze the demand attributes and importance ranking of the aging design of government service APP.

3.1 Design and Distribution of the Kano Questionnaire

3.1.1 Design of the questionnaire

Kano questionnaire contains the following two parts: the first part is the basic information, including gender, age, education level, smart device ownership and use, knowledge and use of government service APPs and so on. The second part is a survey study about Kano model. Five measures were set using the Likert Five-point scale, corresponding to five attitudes: "Like", "should be like this", "Don't care", "can tolerate", and "don't like".

Through combing, screening and integrating related research literature, policy texts and in-depth interview results, this study finally summarizes a total of 31 initial demand items of rural elderly groups for government service APPs in terms of service content and universal design as shown in Table 1 as the second part of the questionnaire survey.

Table 1: Project on the demands of rural elderly groups through government service Apps

Category	Number	Service requirements
Service content requirements	R1	Living expense payment service
	R2	Special time and special needs services
	R3	Transportation services
	R4	Social security service
	R5	Electronic license service
	R6	Offline service appointment
	R7	Elderly care services
	R8	Medical and health services
	R9	Cultural, sports and entertainment services
	R10	Tourism and sightseeing services
	R11	Elderly education services
	R12	Secondary employment service
	R13	Welfare assistance services.
	R14	Emergency rescue service
	R15	Policy promotion service
	R16	News and information service
	R17	Network security information
	R18	Daily life information
	R19	Interactive services between the government and the people
General design requirements for apps	R20	User-friendly interface design
	R21	Situational design
	R22	User-friendly operation
	R23	Security and privacy protection
	R24	Client interaction function
	R25	Convenient search function
	R26	Accessibility
	R27	Contactless authentication
	R28	Voice invocation and fuzzy recognition
	R29	Personalized service.
	R30	System stability
	R31	Use the help service

3.1.2 Questionnaire distribution and collection

The audience group of the government service APP is users with a certain understanding and basic operation ability base, therefore, this paper takes the respondents' ability to understand and use smart devices into account, and selects a group of rural elderly people over 55 years old, who have the ability to understand and express themselves, and who can independently use a basic cell phone device, as the target of the survey. The questionnaire is distributed in two ways: one is to ask questions directly to the respondents, and the respondents take notes on the spot. The second is to distribute a written questionnaire and collect the results on the spot. Considering the respondents' bias in understanding the logic of the questionnaire, in order to ensure the accuracy of the survey, the author mainly adopts the first questionnaire form.

After nearly half a year of research, a total of 420 questionnaires were sent out, and the questionnaires that were missed, omitted or had significant logical errors were screened and excluded, and finally 386 valid questionnaires were obtained, with an effective recovery rate of 91.9%. Among them, the respondents were mainly concentrated in the age group of 55 to 65

years old, with a relatively small proportion of senior citizens and a relatively good cognitive status. The proportions of male and female were 46.37% and 53.63% respectively, with a relatively balanced gender ratio. In terms of education level, respondents are mainly those with elementary school education and those who have not received primary education, and the overall education level is on the low side. The overall smart device ownership rate of the interviewees is about 70.47%, which is slightly higher than the proportion of elderly Internet users among the current elderly population. It can be seen that the situation of the interviewees is consistent with the research intention population of this paper.

3.2 Calculation of the composite score of the importance of the needs of rural elderly users

3.2.1 Determination of Kano's traditional hierarchy of needs

By analyzing the collected questionnaire data against the Kano model demand classification evaluation table, the affiliation degree of each initial service demand corresponding to the Kano category can be obtained, and then according to the principle of “taking the largest” in the traditional Kano model, the Kano category to which each initial service demand belongs is shown in Table 2.

Table 2: Initial classification of Kano attributes for the requirement project

Function/Service	A	O	M	I	R	Q	Classification result
R1	0.3498	**0.3808**	0.0492	0.2202	0.0000	0.0000	O
R2	0.2668	**0.3808**	0.1477	0.2047	0.0000	0.0000	O
R3	**0.3964**	0.3368	0.0855	0.1761	0.0026	0.0026	A
R4	0.2694	**0.3938**	0.1295	0.2021	0.0052	0.0000	O
R5	**0.3808**	0.2642	0.0933	0.2591	0.0026	0.0000	A
R6	0.3109	0.2565	0.1114	**0.3160**	0.0000	0.0052	I
R7	**0.4119**	0.2694	0.1088	0.2073	0.0026	0.0000	A
R8	**0.3264**	0.3212	0.0985	0.2487	0.0026	0.0026	A
R9	**0.4041**	0.2824	0.0777	0.2332	0.0000	0.0026	A
R10	**0.3446**	0.2798	0.0725	0.2953	0.0000	0.0078	A
R11	0.2539	0.2927	0.0725	**0.3757**	0.0052	0.0000	I
R12	**0.3549**	0.2513	0.0570	0.3316	0.0026	0.0026	A
R13	0.2927	0.2798	0.1166	**0.3057**	0.0026	0.0026	I
R14	0.3497	**0.4404**	0.0985	0.1088	0.0000	0.0026	O
R15	0.2306	**0.3394**	0.0958	0.3316	0.0000	0.0026	O
R16	0.2591	0.2902	0.0958	**0.3523**	0.0000	0.0026	I
R17	0.2565	**0.3238**	0.1269	0.2902	0.0000	0.0026	O
R18	0.3471	**0.3601**	0.1140	0.1762	0.0000	0.0026	O
R19	0.2746	0.2720	0.1010	**0.3498**	0.0026	0.0000	I
R20	0.2176	**0.4068**	0.1347	0.2409	0.0000	0.0000	O
R21	0.2461	**0.3757**	0.1321	0.2461	0.0000	0.0000	O
R22	0.2357	**0.4016**	0.2254	0.1321	0.0000	0.0052	O
R23	0.1373	**0.4430**	0.3264	0.0881	0.0026	0.0026	O
R24	**0.4093**	0.3083	0.0933	0.1865	0.0000	0.0026	A
R25	**0.3834**	0.2979	0.0881	0.2254	0.0000	0.0052	A
R26	0.2513	**0.2720**	0.2202	0.2461	0.0052	0.0052	O
R27	**0.3445**	0.3394	0.1192	0.1736	0.0155	0.0078	A
R28	**0.3523**	0.3368	0.1192	0.1865	0.0026	0.0026	A
R29	**0.3834**	0.2694	0.0803	0.2643	0.0026	0.0000	A
R30	0.1917	**0.3523**	0.2435	0.2125	0.0000	0.0000	O
R31	0.3135	**0.3731**	0.1554	0.1580	0.0000	0.0000	O

Comprehensive Table 2 analyzes the Kano initial classification of the rural elderly user group demand items of the government service APP, and obtains the summary of the initial categories as shown in Table 3.

It can be seen that there are 12 charismatic qualities (A): R3 transportation and travel services, R5 e-certificate services, R7 elderly care services, R8 medical and health services, R9 sports and recreation services, R10 tourism and sightseeing services, R12 secondary employment services, R24 client-side interactive functions, R25 convenient search functions, R27 contactless authentication, and R28 voice calling and fuzzy recognition functions, R29 personalized service. There are 14 expected quality (O): R1 life bill payment service, R2 special-time and special-needs service, R4 social security service, R14 emergency assistance service, R15 policy publicity service, R17 network security information, R18 daily life information, R20 user-friendly interface design, R21 situational sensory design, R22 user-friendliness, R23 security and privacy protection, R26 easy accessibility, R30 system stability, and R31 use of help services. There are five undifferentiated qualities (I): R6 Offline office appointment, R11 Elderly education service, R13 Welfare and assistance service, R16 News and information service, R19 Government-citizen interaction service. No essential quality (M), reverse quality (R), and questionable quality (Q).

Table 3: Summary of the initial Kano categories for the demand project

Belonging category	Demand Project number
M	-
O	R1, R2, R4, R14, R15, R17, R18, R20, R21, R22, R23, R26, R30, R31
A	R3, R5, R7, R8, R9, R10, R12, R24, R25, R27, R28, R29
I	R6, R11, R13, R16, R19
R	-
Q	-

3.2.2 Better-Worse coefficient analysis

The traditional Kano model categorization approach is inherently flawed by the simple “take the maximum” method of identifying attributes. Therefore, this study introduces the Better-Worse coefficient for further quantitative analysis, which assists in identifying the attributes and ranking the importance of each requirement.

The Better-Worse coefficients of the needs of rural elderly user groups of government service APP are obtained according to formulas (1)~(2), as shown in Table 4.

Table 4: Demand project Better-Worse coefficient

Demand project	*DI*	*DSI*	Belonging class	Demand project	*DI*	*DSI*	Belonging class
R1	0.7306	-0.4300	A	R17	0.5818	-0.4519	I
R2	0.6476	-0.5285	O	R18	0.7090	-0.4753	O
R3	0.7370	-0.4245	A	R19	0.5480	-0.3740	I
R4	0.6667	-0.5260	O	R20	0.6244	-0.5415	M
R5	0.6467	-0.3584	A	R21	0.6218	-0.5078	M
R6	0.5704	-0.3698	I	R22	0.6406	-0.6303	O
R7	0.6831	-0.3792	A	R23	0.5833	-0.7734	M
R8	0.6510	-0.4219	A	R24	0.7195	-0.4027	A
R9	0.6883	-0.3610	A	R25	0.6849	-0.3880	A
R10	0.6293	-0.3551	I	R26	0.5288	-0.4974	M
R11	0.5495	-0.3671	I	R27	0.7002	-0.4695	O
R12	0.6094	-0.3099	I	R28	0.6927	-0.4584	O
R13	0.5755	-0.3985	I	R29	0.6545	-0.3506	A
R14	0.7922	-0.5403	O	R30	0.5440	-0.5958	M
R15	0.5715	-0.4363	I	R31	0.6866	-0.5285	O
R16	0.5507	-0.3870	I				

Based on the *SI* and *DSI* values, the Better-Worse coefficient quartile diagram is plotted as shown in Figure 4. The Kano classification of the demand items of the rural elderly user group of the government service APP obtained in the Better-Worse coefficient Table 4 and Figure 4 is summarized as shown in Table 5.

The first quadrant is Desired Needs (O), where the absolute values of Better and Worse are high, i.e., providing this service or having this attribute will increase the satisfaction of the target group and vice versa. The demand functions on this quadrant should be satisfied to the best of their ability. Elements falling in the first quadrant include: R2 Special time and special needs services, R4 Social security office services, R14 Emergency assistance services, R18 Information on daily life, R22 Operator friendliness, R27 Contactless authentication, R28 Speech calling and fuzzy recognition, and R31 Use of help services.

The second quadrant is Charming Demand (A), with a high value of Better and a low absolute value of Worse, i.e., although not providing the function will not significantly reduce the satisfaction of the target group, providing the function or having the attribute will significantly increase the satisfaction, and it is necessary to satisfy the demanded functions on this quadrant as well. Elements falling in the second quadrant include: R1 life payment service, R3 transportation service, R5 e-license service, R7 elderly care service, R8 medical and health service, R9 sports and recreation service, R24 client interaction function, R25 convenient search function, and R29 personalized service.

The third quadrant is undifferentiated needs (I), where the absolute values of Better and Worse are low, i.e., the target group does not care much whether the service is provided or has the attribute. Often it can be left out or resources can be partially shifted to the provision of other services, taking into account minimum feasibility. Elements that fall in the third quadrant include: R6 Offline Appointments, R10 Travel and Tourism Services, R11 Elderly Education Services, R12 Secondary Employment Services, R13 Welfare and Aid Services, R15 Policy Advocacy Services, R16 News and Information Services, R17 Cybersecurity Information, and R19 Government-Citizen Interaction Services.

The fourth quadrant is the necessary demand (M), Better value is low, but the absolute value of Worse is high, that is, although the provision of the service or with this attribute will not significantly enhance the satisfaction of the target group, but not to provide or do not have, it will greatly cause their dissatisfaction, the needs of the quadrant is usually the most basic

functions or conditions of the product, it must be satisfied first. Elements that fall in the fourth quadrant include: R20 Interface Friendly Design, R21 Situational Sense Design, R23 Security and Privacy Protection, R26 Ease of Access, and R30 System Stability.

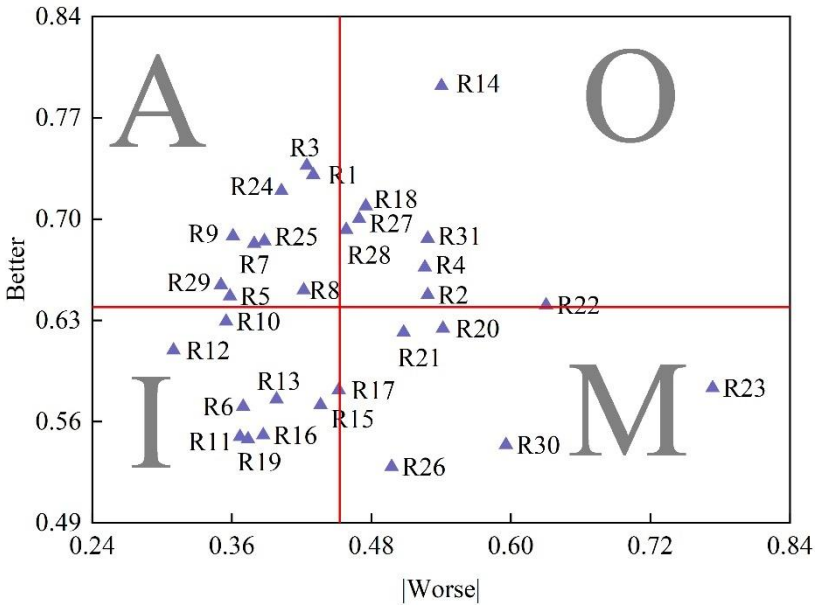

Figure 4: Quartile plot for the classification of demand items

Table 5: Summary of Kano categories for the required items

Belonging category	Demand Project number
M	R20, R21, R23, R26, R30
O	R2, R4, R14, R18, R22, R27, R28, R31
A	R1, R3, R5, R7, R8, R9, R24, R25, R29
I	R6, R10, R11, R12, R13, R15, R16, R17, R19

3.2.3 Calculation of demand satisfaction target improvement rate

The satisfaction target improvement rate of rural elderly users reflects the degree of urgency of rural elderly users to fully realize a demand, the degree of urgency and the size of the value is positively proportional to the value will be directly involved in the comprehensive rating of the importance of rural elderly users' demand, in order to affect the final government service APP key design requirements output and user interface design program planning. The present value of rural elderly users' satisfaction S_0, the target value S_i and the satisfaction target improvement rate IR_0 values after the research and organization are shown in Table 6.

Comparing the IR_0 values between the demands, the urgency of rural elderly users to improve each demand can be found, for example, R22 operation friendliness and R31 use of the help service, R22's $S_0 = 3.00, S_i = 3.26, IR_0 = 1.09$ and R31's $S_0 = 3.45, S_i = 4.50, IR_0 = 1.30$, from the value of IR_0 of the target improvement rate of rural elderly users' satisfaction, R22<R31, which indicates that the rural elderly users' expectation of the improvement of the demand of R31, which is the use of the help service, is higher than the improvement of the demand of R22, which is the user-friendliness of the operation.

Table 6: The S_0, S_i and IR_0 values of elderly rural users

Serial number	S_0	S_i	IR_0	Serial number	S_0	S_i	IR_0
R1	2.46	4.88	1.98	R17	3.17	4.3	1.36
R2	2.50	4.64	1.86	R18	3.16	4.85	1.53
R3	2.93	3.94	1.34	R19	2.59	4.28	1.65
R4	2.12	4.46	2.10	R20	3.12	4.41	1.41
R5	2.13	4.07	1.91	R21	3.32	3.94	1.19
R6	3.86	4.57	1.18	R22	3.00	3.26	1.09
R7	3.95	4.87	1.23	R23	2.09	3.22	1.54
R8	2.87	3.58	1.25	R24	3.40	3.74	1.10
R9	2.42	4.56	1.88	R25	2.57	4.53	1.76
R10	2.27	4.86	2.14	R26	3.10	4.48	1.45
R11	3.07	4.44	1.45	R27	3.20	3.49	1.09
R12	2.27	4.57	2.01	R28	3.71	4.44	1.20
R13	3.18	4.36	1.37	R29	3.07	3.97	1.29
R14	3.00	3.99	1.33	R30	3.66	4.01	1.10
R15	3.18	4.88	1.53	R31	3.45	4.50	1.30
R16	3.34	4.78	1.43				

3.2.4 Calculation of composite demand importance score

The calculation of the composite rural elderly user demand importance score Z includes the calculation of the rural elderly user satisfaction improvement index SI and the elderly dissatisfaction index DSI, the KANO classification of the rural elderly user demand, the target improvement rate, and the rural elderly user demand importance self-score (H_i), which is a more comprehensive calculation of the composite rural elderly user demand importance score LR_i.

After the weighted calculation of rural elderly users' needs, the composite scores of the importance of various rural elderly users' needs can be derived as shown in Table 7. There are 31 rural elderly user requirements in Table 7, and each requirement corresponds to its own importance composite score. In the QFD phase, the rural elderly user requirements and the requirement importance composite scores in the table will be entered into the quality house to calculate the critical design requirements.

Table 7: Comprehensive scores for the importance of demands of rural elderly users

Serial number	H_i	Classification	K	*SI*	*DSI*	T_i	IR_0	LR_i
R1	4.73	A	1.5	0.7306	-0.4300	0.7306	1.98	21.32
R2	4.83	O	1	0.6476	-0.5285	0.6476	1.86	14.80
R3	3.05	A	1.5	0.7370	-0.4245	0.7370	1.34	9.36
R4	3.25	O	1	0.6667	-0.5260	0.6667	2.10	11.38
R5	4.44	A	1.5	0.6467	-0.3584	0.6467	1.91	17.92
R6	3.95	I	0	0.5704	-0.3698	0.5704	1.18	4.66
R7	3.76	A	1.5	0.6831	-0.3792	0.6831	1.23	10.10
R8	4.40	A	1.5	0.6510	-0.4219	0.6510	1.25	11.67
R9	4.19	A	1.5	0.6883	-0.3610	0.6883	1.88	17.28
R10	3.19	I	0	0.6293	-0.3551	0.6293	2.14	6.83
R11	4.40	I	0	0.5495	-0.3671	0.5495	1.45	6.38
R12	4.19	I	0	0.6094	-0.3099	0.6094	2.01	8.42
R13	3.04	I	0	0.5755	-0.3985	0.5755	1.37	4.16
R14	3.23	O	1	0.7922	-0.5403	0.7922	1.33	7.70
R15	3.56	I	0	0.5715	-0.4363	0.5715	1.53	5.45
R16	4.64	I	0	0.5507	-0.3870	0.5507	1.43	6.64
R17	4.87	I	0	0.5818	-0.4519	0.5818	1.36	6.62
R18	3.75	O	1	0.7090	-0.4753	0.7090	1.53	9.81
R19	4.81	I	0	0.5480	-0.3740	0.5480	1.65	7.94
R20	3.75	M	0.5	0.6244	-0.5415	0.6244	1.41	6.74
R21	3.82	M	0.5	0.6218	-0.5078	0.6218	1.19	5.79
R22	3.16	O	1	0.6406	-0.6303	0.6406	1.09	5.65
R23	4.49	M	0.5	0.5833	-0.7734	0.7734	1.54	9.21
R24	4.39	A	1.5	0.7195	-0.4027	0.7195	1.10	10.89
R25	3.09	A	1.5	0.6849	-0.3880	0.6849	1.76	11.89
R26	3.12	M	0.5	0.5288	-0.4974	0.5288	1.45	5.59
R27	5.00	O	1	0.7002	-0.4695	0.7002	1.09	9.27
R28	3.17	O	1	0.6927	-0.4584	0.6927	1.20	6.44
R29	3.94	A	1.5	0.6545	-0.3506	0.6545	1.29	10.82
R30	3.96	M	0.5	0.5440	-0.5958	0.5958	1.10	5.50
R31	4.08	A	1	0.6866	-0.5285	0.6866	1.30	8.95

3.3 QFD-based Importance Calculation of Design Requirements

3.3.1 Determination of design requirements

According to the needs of rural elderly users for government service APP, the corresponding government service APP design requirements are summarized, which should facilitate the quantitative analysis of the importance of each design requirement in the later QFD stage, assigning weight values and outputting key design requirements. After summarizing and organizing, five dimensions and 18 government service APP design requirements for rural elderly users are obtained as shown in Table 8.

Table 8: Design requirements for the government service APP for rural elderly users

Dimension	Serial number	Design requirements
Integration of life services	D1	One-stop payment
	D2	Daily care connection
	D3	Special needs care and protection
Optimization of travel services	D4	All-round travel planning
	D5	Social security processing at your fingertips
	D6	The convenience of offline reservations
Health and safety guarantee	D7	Medical service closed loop
	D8	Precise positioning for emergency rescue
	D9	Privacy encryption protection
	D10	Risk early warning and prevention
Rich in spiritual culture	D11	Cultural and entertainment information push
	D12	Exclusive for customized travel
	D13	Cloud classroom for elderly education
	D14	Secondary employment assistance
Improvement of interactive experience	D15	Voice intelligent interaction
	D16	Search with ultra-fast direct access
	D17	Interactive and heartwarming bridge
	D18	The convenience of non-contact authentication

3.3.2 Determine the relationship between design requirements and user needs

Based on the QFD principle, this paper judges the relationship between 18 design requirements of the user's government service APP and 31 demands of rural elderly users, and obtains the two-dimensional matrix table of the relationship between the demands of rural elderly users and the design requirements as shown in Table 9. In a two-dimensional matrix table, different symbols are used to represent different strong and weak relationships. The symbol "●" indicates a "strong" correlation, with a value of 9. The symbol "○" indicates that it is related to "zhong", and its value is 5. The symbol "△" indicates "weak" correlation and takes a value of 1. A blank space indicates extremely weak or no correlation.

Table 9: The relationship between user requirements and design requirements

Serial number	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
R1	●									△					●	●		○
R2			●	○			○			●					●	●	△	△
R3			○	●							△	○			△	●		
R4					●	●	○									○	△	△
R5					●				●	○				△				○
R6			●			●	○							△	○			○
R7		●	●	○			●	●			△	△	○	○			△	
R8		●	○				●	●	○	△								○
R9		△	△	○							●	●	○		○	○		
R10				●							●	●			△	△		
R11											○		●	○	○			
R12			○										●	●		○		
R13		●																
R14		○	●				○	●		△				○			○	△
R15											●		○	○		●	○	
R16											●	△			△	●		
R17										●	●	△	△			●	○	
R18		●		△					●	●	△		○		○			
R19															●		●	
R20			○												●			
R21				○							○	○			●			
R22	●			○	○	●					△	△			●	●		●
R23									●	●	△	△						○
R24											△		○		●	○		
R25																●		
R26																	●	
R27									●	○					●			●
R28									○						●	●		○
R29			△	○					○		●	●	●	●		○	○	
R30						●									○	○		○
R31					△	△				△	△			○	●	●		

The two-dimensional matrix of the relationship between the design requirements of the APP for government services for rural elderly users and the needs of rural elderly users will form the quality house room part of the quality house stage, which will construct the important modules of the APP quality house and lay the foundation for the output of the key design requirements in the quality house stage.

3.3.3 Calculation of the importance of design requirements

The APP quality house for government services for rural elderly users is built as a collection of data such as rural elderly users' needs, rural elderly users' needs composite scores, design requirements and design requirements goals, and the relationship between design requirements and users' needs from the preliminary research, etc. The ultimate goal is to calculate the

importance value of each design requirement, and push to the government services APP design requirements based on the importance value to find out which are the critical design requirements and which The ultimate goal is to calculate the importance value of each design requirement, and based on the importance value, to deduce which are the critical design requirements and which are the design requirements that can be hidden or removed in the APP design requirements, which helps designers to improve the accuracy of APP design planning.

After determining the relationship between user needs and design requirements, the importance of each design requirement and its ranking are calculated using formula (7) as shown in Table 10.

It can be seen that the various design requirements are sorted in descending order of importance as follows: D16 ultra-fast search direct access (1202.36), D15 intelligent voice interaction (1121.09), D11 cultural and entertainment information push (607.58), D9 privacy encryption protection (560.54), D18 convenient non-contact authentication (551.76), D10 risk warning prevention (549.55) D3 Special Care Guarantee (544.39), D13 Cloud Classroom for Elderly Education (504.85), D4 All-round Travel Planning (477.72), D12 Customized Exclusive Travel (428.34), D14 Secondary Employment Assistance (388.64), D7 Medical Service Closed Loop (388.63) D2 Daily Care Connection (377.44), D17 Interactive Warm Bridge (311.00), D5 Social Security Fingertip Processing (300.90), D8 Emergency Rescue Express Delivery (265.23), D6 Convenient Offline Appointment (253.66), D1 One-stop Payment (242.73). Based on the importance values of the design requirements and their ranking, designers can clearly define the priority of each design requirement, distinguish the primary and secondary aspects of the design as well as the key points to note, and avoid the design of the government service APP deviating from the needs of rural elderly users due to personal cognitive limitations.

Table 10: The importance of each design requirement and its ranking

Design requirement number	W_j	Sorting	Design requirement number	W_j	Sorting
D1	242.73	18	D10	549.55	6
D2	377.44	13	D11	607.58	3
D3	544.39	7	D12	428.34	10
D4	477.72	9	D13	504.85	8
D5	300.90	15	D14	388.64	11
D6	253.66	17	D15	1121.09	2
D7	388.63	12	D16	1202.36	1
D8	265.23	16	D17	311.00	14
D9	560.54	4	D18	551.76	5

3.4 Adaptive design and evaluation of government service apps

3.4.1 Adaptive design for government service apps

The previous section mainly researched the use of government service apps by rural elderly users, and explored the design requirements of government service apps and their order of importance factors. This section combines the results of the previous research and the results of the ranking of design requirements and importance factors to carry out the aging design of SuServiceOffice App, and the contents of the revision design are mainly: structural adjustment, content extension, and visual optimization.

(1) Functional structure design

The key pages of the original Sufuban App for the elderly are composed of "Home",

"Suqitong" and "My". The Banner on the homepage takes up a large area. The "Commonly Used Service Recommendations" section is composed of "Jiangsu Health Code", "Pension Benefit Distribution Inquiry", "Elderly Care Institutions", and "Appointment for Medical Treatment". The "Suqitong" section mainly serves enterprises, aiming to provide one-stop policy consultation services online for them. The "My" section mainly includes personal information, "My three funds", "electronic receipts", "electronic social security card", "electronic business license", "My certificates and licenses", and other contents.

The reconstructed information architecture starts from the needs of rural elderly people, optimizes the interaction experience of rural elderly users, classifies the content by importance and category, replaces the "Jiangsu Health Code" in the "Commonly Used Service Recommendations" section on the home page with "Travel Services", and places "Elderly Care Institutions" under "Retirement and Elderly Care". Adjust the recommended frequently used services to "Travel Services", "Government Headlines", "Appointment for Medical Treatment", and "Pension Benefit Distribution". Adjust "My Three Golds", "Scan Code", "My Express Delivery", "My Vehicle", "My Letters" and "Suqitong" to the home page to facilitate elderly users to quickly search by category. The "Report Inquiry" and "My Appointments" sections have been added to the appointment medical consultation section to facilitate elderly users in checking their appointment medical consultation information. Add "Location" on the home page to facilitate users to change locations and handle business at different locations. Moreover, a "Government Service Hotline" will be added to the homepage. When elderly users encounter problems, they can directly call the government service hotline here for quick assistance in solving the problems. Add "Government Headlines", "New Policies for Assisting the Elderly", and "Hot Videos". Categorize the information. Place "Government Headlines" in the "Recommended Common Services" section to facilitate elderly users in viewing daily new policies. "New Policies for Assisting the Elderly" helps elderly users quickly understand policy information closely related to themselves. "Hot video" enables elderly users to understand the content in a more vivid way.

(2) Interaction prototyping

The Figma software was used to optimize the design of the senior version of the SUO App. According to the constructed information architecture diagram, a low-fidelity prototype diagram was firstly drawn in this software. And in the low-fidelity prototype diagram production stage, try to use the interface style of hair glass visual effect to explore the feasibility of this interface style. Simplify the content of the whole set of interface, and simplify the information structure, operation steps, etc., so as to facilitate the elderly users to quickly obtain the information they need from the interface, and to enhance the perceived ease of use of the SUO App.

(3) Visual design

The visual specifications of this optimization design mainly include mood board, color specification, font specification, layout specification, stylization, and components.

As a tool, the mood board can help designers define the visual style and guide the design direction. Mood board keywords are: friendly, efficient, streamlined.

With the help of Contrast Ration online inspection tool to regulate the color, the color uses a variety of highly saturated colors, the optimized primary color is blue, the secondary colors are orange and red, the use of color to deepen the official sense of the government app, present a sense of vitality, and improve the degree of recognition. The neutral colors are B10, B20, B40, B60, and the background color is B96. The Chinese font is Apple Square, which is simple and beautiful, while the English and numbers use DIN font, and the font sizes are 32pt, 24pt, 22pt, 20pt, 18pt, which is convenient for distinguishing between different information, and improves the reading experience of the elderly users in rural areas.

At the same time, on the basis of saving page space display rate, the spacing is adjusted, and the spacing is 30pt, 20pt, 16pt, 10pt, 8pt, 4pt, 2pt. cards with large rounded corners have stronger internal directionality, and the two sides of the neighboring sides show obvious differences, which can clearly distinguish the boundaries between the elements, so that the user's browsing efficiency for the content of the card is improved, the development of the The size of rounded corners is 8pt, 4pt. and some components are stylized, using masks and background blurring.

In addition, the optimized interface is componentized, which can speed up the design and development efficiency at the development level, reduce the communication cost, and shorten the product development cycle. On the visual level, it can improve the visual unity of the whole product, enhance the reading efficiency of the content, highlight the key content, increase the interest of the interface, and facilitate the maintenance of the subsequent upgrades and iterations.

3.4.2 Usability test results for ageing-friendly designs

The main purpose of this test is to evaluate the usability of the optimized SuServiceOffice App for seniors through the measured data and results, and to further verify the reasonableness of the optimization. The subjects in this part are consistent with the age group of the users in the previous research, which is also 55 years old and above, and all the subjects have experience in using smartphones. The time of the test is August 2024, and the users who participated in this experiment are 6 women and 4 men, and the success level of the task is categorized into level 1~4 from good to bad.

(1) Analysis of the results of the validity indicators

The task success levels of the four test task scenarios are shown in Figure 5. The steps of Task 3 and Task 4 are relatively few. The success level of both Task 3 and Task 4 is Level One. During the testing process, the subjects successfully completed the tasks within the prescribed time. The scenario of Task 1 is "hospital follow-up", and that of Task 2 is "Watching the news to learn about the latest policy information". In each scenario, one participant encountered a problem, and the success level of the task was at level two. The scenario of Task 3 was "taking a taxi home". The page was set with the function of "one-click taxi", and all the subjects completed this task accurately and quickly. Task 4 was "Viewing bus stop information", and none of the 10 subjects encountered any problems during the test.

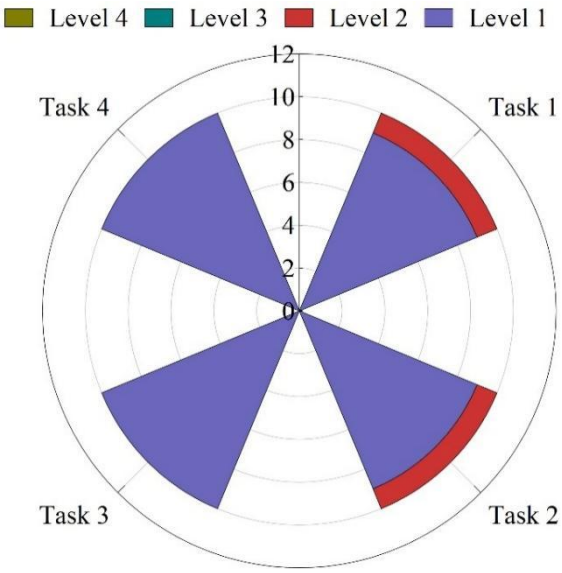

Figure 5: Distribution of success levels of tasks

(2) Analysis of the results of efficiency indicators

The length of time for the 10 subjects to complete the task is shown in Table 11. It can be seen that the overall task completion rate of this experimental test is high. Only one subject took more than 2 minutes to complete task 1, and the remaining 9 subjects completed the task within 2 minutes. Task 1 had the most flow of operations and the most page jumps, so the subjects spent the most time in Task 1. Most users spent less time in task 2. Task 3 and Task 4 had simpler processes and the subjects had shorter operation time.

Table 11: Completion duration of tasks

	Task completion duration (s)			
User number	Task 1	Task 2	Task 3	Task 4
U1	99.14	43.36	14.85	22.77
U2	87.57	38.58	14.13	21.33
U3	92.03	45.46	16.28	20.37
U4	103.25	42.99	20.08	22.92
U5	147.34	40.73	19.52	22.45
U6	94.15	61.94	19.38	21.34
U7	99.66	40.15	19.38	28.24
U8	102.50	58.30	20.28	22.22
U9	101.58	47.38	17.12	23.28
U10	96.32	40.25	18.34	20.56
Average completion time	102.35	45.91	17.94	22.55

(3) Analysis of Subjective Satisfaction Indicator Results

After the test, 10 participants were invited to fill out the SUS usability scale. The final SUS scores are shown in Figure 6, and their average score is about 89.88, indicating that the overall satisfaction of the participants with the optimized interface is high.

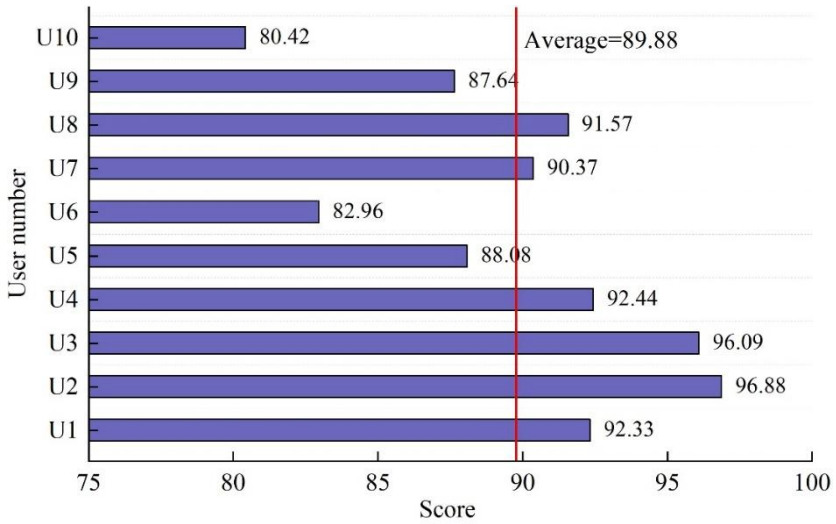

Figure 6: SUS score

4 Conclusion

In this paper, we selected the aging design of “SuServiceOffice” APP as a case study, and

combined the Kano model and QFD theory to explore the needs of rural elderly users for government service APPs and the hierarchical structure of the design requirements of government service APPs, so as to carry out the aging design of APPs and the evaluation of its effect. The main research results are as follows:

(1) Through literature analysis and in-depth interview method, a total of 31 initial needs of rural elderly groups for government service APP in terms of service content and universal design are identified, and a hierarchical model of the needs of elderly groups for government service APP is constructed.

(2) According to the needs of rural elderly groups for government service APP, 18 design requirements of government service APP were summarized.

(3) According to the importance value of the design requirements and their ranking, the aging-adapted design of "SuServiceOffice" APP was carried out in three aspects: structural adjustment, content extension, and visual optimization. Ten rural elderly people were selected as subjects for the design usability evaluation. The overall performance of the subjects in the four test tasks was good, only one subject took more than two minutes to complete task 1, and the other nine subjects completed the task within two minutes, and the average satisfaction score of the participants used reached 89.88, which indicates that the design scheme is effective and the design requirements are set reasonably.

This study has the following shortcomings due to limitations in some areas:

(1) Limitations in the source of respondents and subjects. The number and scope of rural elderly users invited is limited, and it is hoped that subsequent studies can cover more elderly groups.

(2) Due to technical limitations, the optimized design interface could not really achieve running operation, and could only be tested and tried with the help of Figma software. It is hoped that subsequent research can solve the technical problems.

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