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Interface Design of College Life Circle APP Based on Improved KJ Method-Entropy Power Method

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Abstract. With the expansion of the size of the city and university groups and the diversification of user demand services, the map APP design needs to consider the relationship between urban development and user demand. Therefore, to improve the users' demand and enhance the users' use of neighborhood services, an APP based on the university life circle, "U-Tour", is designed. Firstly, the improved KJ method and entropy weight method are used to obtain the user demand and weight, and the existing living circle demand and weight; secondly, the comprehensive weight and ranking are obtained; and then the two types of variables are verified through correlation analysis, and the design of "U-Tour" APP is carried out based on the comprehensive weight and ranking after the verification is passed. It is found that the weights of traffic and access service, accommodation service and catering and shopping service are higher in the comprehensive demand, which are 0.252, 0.232 and 0.152 respectively, which proves that the APP design based on university life circle needs to focus on the navigation design and service design. The study points out that college map-based APP design needs to be measured to the factors of city life and user needs.

Keywords. University, Life Circle, App interface design, Improved KJ method, Entropy weight method, Correlation analysis

1. Introduction

Accompanied by the change of people's travelling mode and living needs, the living area as a planning method gradually affects people's production and life through the connection of facilities and needs, space and behavior [1]. In recent years, in Chinese cities, the number of infrastructures, trade places and cultural consumption service centres built around the special group of college students has been increasing, while at the same time, the enrolment scale and area of colleges and universities have been expanding, which has led to the creation of college living circles [2]. Taking the school as the starting point and the surrounding POI as the destination, the college life circle has become an important factor influencing the development of the city. However, there are still some problems with college life or college life circle, such as Chai Zonggang [3] mentioned that the backward concept of college campus planning in China and the

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phenomenon of human-vehicle conflict in colleges and universities need to be based on the theory of life circle to update the concept of college campus planning. In his study, Sun Yingnan[4] also found that there are irrationally placed service facilities in the living circle of colleges and universities. These studies reflect that the university community has difficulties in travelling and the university life circle cannot meet the needs of people well.

This study aims to use the improved KJ method to explore the needs of university users, and also extract the needs of the existing university life circle through the entropy power method, so as to better address the needs of users through the different functional interfaces of the APP design. This study proposes for the first time the improved KJ method-entropy weight method: that is, adding user assignment in the KJ method to carry out the calculation of user needs, and on this basis, weighting the results of the improved KJ method and entropy weight method to obtain the final demand weights.

The rest of this study is as follows: Chapter 2 reviews the research on college life circle and related APP design, traditional KJ method-entropy weight method, and improved KJ-entropy weight method, to illustrate the reasonableness and feasibility of the study; Chapter 3 conducts experiments using the improved KJ method-entropy weight method and verifies the results of the experiments, which proves the validity of the present study; Chapter 4 develops a specific design practice based on the results of the study, and designs a college life circle and related APP. Based on the results of the study, Chapter 4 develops a concrete design practice, designing the interface of the college life circle APP-"U-Tour".

2. Theoretical Background

2.1. College Life Circle and Its Related APP Design

Accessibility is used in urban planning and plays an important role in urban transport sustainability and environmental sustainability. Measurements of accessibility can be broadly classified into two categories: place-centred and person-centred, where life circle as a place-centred accessibility analysis takes into account the importance of the time dimension[5]. In traditional life circle analysis, the origin (starting point) is given and points of interest (POIs) in its vicinity are displayed based on that point, showing different travelling times through points, lines, or areas. Location-centred accessibility spatio-temporal analysis not only enriches the spatio-temporal data of urban space, but also provides pre-design information for urban design. The study of life circle in urban space focuses on the driving time around certain types of locations in the city centre, for example, Wu Guohao et al.[6] analysed the isochronous circle of the fire station in Nanjing, analysed the spatial accessibility of the fire station through its spatial distribution pattern and coverage, and put forward reasonable development suggestions for the layout of fire fighting resources. Another example is the study by Wu, Chao-Yu and Zhou, Xiang[7] on the distribution of educational facilities, which found that the "isochronous circle" approach based on the actual travelling distance and population size can better provide educational facility services for mountainous cities. These studies demonstrate that analyses of life circles can be used to identify the problems and needs of life circles in certain types of locations.

For the college life circle research focuses on student travel behaviour, daily needs, service mode, such as Li Xuefeng[8] through the student daily life circle, for the student

campus public facilities configuration and campus planning to provide solutions to the problems that arise. Zhang Jing and He Tian[9] explore the value of the campus WeChat service platform for the design of college life circle in Changzhou, which shows that online service is valuable for perfecting the user experience and improving the college life circle, and lays a theoretical foundation for this study. The map APPs designed for college groups in China are mainly divided into two types: navigation and information service, such as "My University" APP, which has the functions of campus guide, campus socialisation and study assistant, and is a more mature map APP at present. There are more information service APPs in the theoretical research, such as the campus errand APP designed by Bao Wenxia[10] based on the Axure platform, which digs deeper into the user requirements to drive the digital campus environment. He Runxin and Tang Xuelian[11] designed the "Zhixiao" APP for college staff, which provides the staff with services such as financial enquiry, campus food ordering, student list enquiry, etc. It provides a specialised service platform for college staff.

From the above studies, it is easy to find that there are many APP designs based on certain types of services or groups in colleges and universities, with more specific functions and focusing on services within the campus, while there are fewer studies on APP designs targeting the needs of the periphery of the campus. College life circle APP design is committed to the use of POI around the campus, through the navigation guide, provide information and other ways to drive the campus internal and external services, so as to meet the needs of different groups.

2.2. Traditional and Improved KJ Method - Entropy Weight Method

The KJ method, also known as the affinity diagram method, was proposed by Professor Jiro Kawakita of Tokyo Institute of Technology in 1964 as a method of investigation and analysis from the product itself. The traditional KJ method collects the needs of user groups through questionnaires and other forms, and then gradedly summarises and collates them according to their interrelationships, lists the list of indicators, and finally forms a clear first-level indicator of the content of the needs[12]. While entropy in entropy weight method is a measure of the degree of disorder of the system, you can use the entropy value to judge the degree of dispersion of a certain indicator, and analysis based on the premise of objective data is the basis of entropy weight method[13].

In the known design research, the KJ method is often used in the improvement of design research, in addition to the combination of different methods for innovative design[14], such as W Ding and YM Zhou[15] KJ technology and AHP (Hierarchical Analysis) combined with the elderly wheelchair design, from the point of view of the designer and the elderly to explore the needs of the power wheelchair and then carry out the design of the entity, the method of the user's real ideas and needs for in-depth excavation, which provides a certain theoretical basis for the study of the user's needs in this paper. This method provides a certain theoretical basis for this paper to study the user's needs by digging deeper into the user's real ideas and needs. Another example is He Yongliang[16], who extracts the functional requirements of the gun and ammunition cabinet from the traditional KJ method, and then uses the KANO model to carry out data statistics and analysis for the functional design, which converts the requirements into actual real-world functions. From the above papers, we can see that the traditional KJ method can get the required design elements from the user in the case of vague design requirements, and then carry out innovative design. However, as far as the KJ method itself is concerned, the traditional KJ method only obtains the elements of requirements

through the card processing editor, which have an explanatory role, but cannot derive the specific weights of these elements.

Therefore, this study adopts the improved KJ method in the research methodology, and the flow is shown in Fig. 1. The improved KJ method retains the research process (Step 1) of the traditional KJ method, such as respondent selection, grouping of textual information, and creation of function cards, etc., but it adds users' subjective assignments of textual information in the research in order to compute the weights of the indicators at different levels in Step 2. At the same time, add the calculation of the weight of the function card, that is, in step 3, let the users choose the indicators that they think are the most important, and determine the weight of each indicator through the weight of the most important indicators chosen by different users. Finally, the results in step 2 and step 3 are superimposed to obtain the final user requirement weights and ranking.

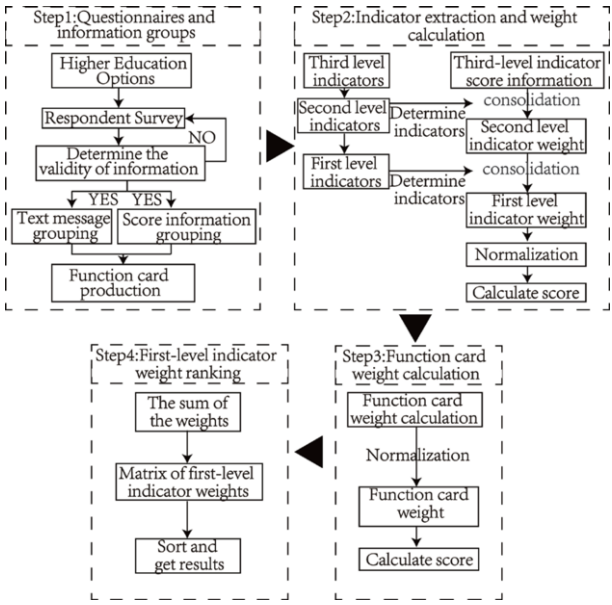

Figure 1. Improved KJ method research flow chart.

In addition to this, the entropy weight method, which is based on objective data analysis, is added to analyse the requirements, considering that the improved KJ method only considers user requirements. Entropy weight method has been widely used in design research to combine with other models to enhance the objectivity of design requirements. For example, Wang Weiwei et al.[17] determine the weights of evaluation indexes through F-AHP, and extract the key Chinese Spring Festival cultural design factors through entropy weighting method in the design, and then Yang Yuling et al.[18] firstly AHP and entropy weighting method respectively on the pre-determined indexes to calculate the weights, and then use the combination of AHP-entropy weighting method to get the comprehensive ordering of the design scheme, and select the optimal ASD child intervention APP navigation interface design. programme. The above study shows that the entropy weight method is feasible to be combined with other models and that this method can help designers to select the optimal design solution or design factors.

Compared with the traditional KJ-entropy weighting method, the improved KJ-entropy weighting method starts from the user demand and the objective reality demand,

and takes the similar or the same index data as the premise to derive the specific weights of the above two types of variables, and then weights the weights to get the final demand and ranking results, i.e., the comprehensive demand and ranking results. In addition, in order to measure whether the final results are credible, the method will analyse the correlation between the two types of variables, and the final results will be credible when the two types of variables are correlated.

3. Experiments and Results

3.1. User Requirements Analysis

- Descriptive statistics of the questionnaire

This research selects 16 colleges and universities in the main city of Xi'an, 126 questionnaires were distributed, 120 questionnaires were valid, and the validity rate of the questionnaires was 95.2%. This questionnaire survey increases the choice of the college group on the demand, that is, the questionnaire respondents are allowed to select the indicators they think are the most important among the 11 indicators of living services, catering services, sports and leisure services, shopping services, accommodation services, scientific and technological and cultural services, and transport facility services, and give them a score (out of 10 points).

Table 1 illustrates that about 50.8% of the 120 respondents interviewed were female, and 70% of the respondents were between the ages of 21 and 30. The group with the highest monthly disposable income (CNY) ranged from $1,001 to $3,000 per month, with a high percentage of undergraduates at 28.3 per cent.

Table 1. Demographic characteristics(n = 120).

Variable	Options	n	%	Variable	Options	n	%
Gender	Male	59	49.2	Age	21years old below	19	15.8
					21—25years old	84	70
	Female	61	50.8		26—30years old	6	5
					31—40years old	3	2.5
Monthly disposable income (CNY)	<500	22	18.3		40years old above	28	7.1
	501-1000	19	15.8		Undergraduate	34	28.3
	1001-3000	42	35		Postgraduates	17	14.2
	3001-5000	12	10	Career	PhD and above	9	7.5
	5001-7000	17	14.2		Teaching staff	21	17.5
	>7000	8	6.7		Other staff	39	32.5

- User Requirements Indicators and Weights

Screening respondents' specific needs as tertiary indicators, including demand for commercial complexes, demand for snack abundance, demand for beverage merchants, etc. POI coding classification can more objectively reflect the city's data characteristics[19], so these specific demand indicators are categorised according to the degree of similarity of POIs, which can basically be classified into 11 categories of secondary demand indicators. Finally, the weights of the second-level indicators are merged and processed according to the Golder POI coding table, resulting in six

categories of first-level indicator demand weights. User Requirements indicators merging and weights are shown in Figure 2.

It is found that accommodation services, catering and shopping services, and transport services occupy the first three places in the needs of the university community, with weights of 0.267, 0.232, and 0.171 respectively, followed by sports, science, education and culture services, medical and health services, and social work services, with weights of 0.149, 0.105, and 0.076 respectively.

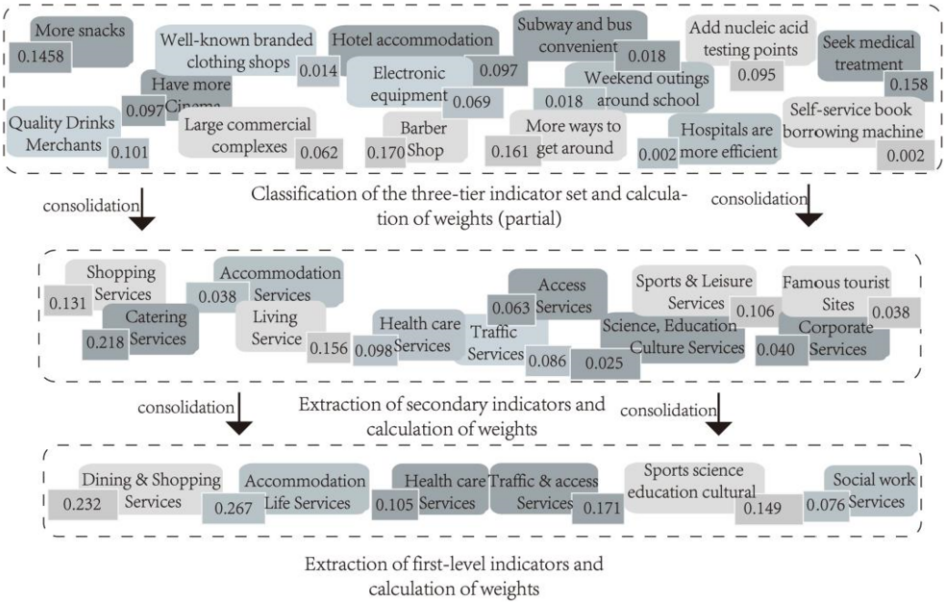

Figure 2. Indicator extraction and weighting.

3.2. Demand Analysis of Existing Life Circle

- Data sampler

The data were taken from the points of interest (POIs) in the four main districts of Xi'an, Beilin District, Lianhu District, Yanta District and Xincheng District in the 2021 Gaode map, and four colleges and universities were selected in each district. Firstly, the locomotive collector was used to crawl the latitude and longitude coordinates, categories and names of 4000 POIs, and the POIs were sorted according to the POI classification and coding table provided by Gaode Map, with a total of 18 categories (only the major categories were counted); secondly, the current situation of college Life Circle in Xi'an's main urban areas was analysed by using the 30-minute walking isochronous circle, and the interval of the isochronous circle was 5 minutes. Secondly, the 30-minute walking "isochronous circle" was used to analyse the current situation of university life circle in the main city of Xi'an, and the isochronous circle interval was 5 minutes. Based on the OSM data and the Open Route Service of the OGC standard Open LS interface, we analyse the walking isochronous circle range of the major colleges and universities in the four districts, and obtain the isochronous circle set from the centre to the edge; once again, the latitude/longitude coordinates of the 4,000 POIs extracted from the first step are substituted into the Arc GIS software, and we finally obtain the number of college

Life Circle and the related POIs in Xian, and the specific number of samples is the number of POIs. The number of specific samples is the pre-data calculated by entropy weight method.

- Entropy weighting method for calculating life circle demand

The study can calculate the weight of each POI indicator in the existing life circle according to the information entropy to derive the objective demand hierarchy of the college life circle. In this experiment, it is assumed that there are m colleges and universities and n evaluation indicators, forming the original data matrix K :

$$\mathrm{K} = \left(\mathrm{k}_{ij}\right)_{m\times n} = \begin{bmatrix} \mathrm{k}_{11} & \mathrm{k}_{12} & \cdots & \mathrm{k}_{1n} \\ \mathrm{k}_{21} & \mathrm{k}_{22} & \cdots & \mathrm{k}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \mathrm{k}_{m1} & \mathrm{k}_{m2} & \cdots & \mathrm{k}_{mn} \end{bmatrix} \tag{1}$$

To eliminate the effect of different magnitudes on the data, the matrix K was normalised using equations (2) and (3).Where Eq. (2) is the forward indicator formula and Eq. (3) is the reverse indicator formula.

$\max \mathrm{k}_{ij}$ is the maximum value of k_{ij} and $\min \mathrm{k}_{ij}$ is the minimum value of k_{ij} .

$$\mathrm{k}_{ij}^{'} = \frac{\mathrm{k}_{ij} - \min \mathrm{k}_{ij}}{\max \mathrm{k}_{ij} - \min \mathrm{k}_{ij}} \tag{2}$$

$$\mathrm{k}_{ij}^{'} = \frac{\max \mathrm{k}_{ij} - \mathrm{k}_{ij}}{\max \mathrm{k}_{ij} - \min \mathrm{k}_{ij}} \tag{3}$$

Calculate the characteristic weight of the evaluation value of the i school under the j evaluation indicator, i.e. the value of the indicator weight of the j evaluation indicator in the i school:

$$f_{ij} = \frac{K_{ij}^{'}}{\sum_{j=1}^{n} K_{ij}} \tag{4}$$

Entropy value calculation. Calculate the first value of the j indicator:

$$E_j = -\frac{1}{\ln m}\sum_{j=1}^{n} p_{ij} \ln f_{ij} \ , 0 \le E_j \le 1 \tag{5}$$

Determine the weights of the evaluation indicators W_j .

$$W_j = \frac{1-E_j}{\sum_{j=1}^{m} E_j}, 0 \le W_j \le 1, \sum_{j=1}^{m} W_j = 1 \tag{6}$$

$$W_j = \begin{bmatrix} 0.2163 & 0.0843 & 0.0757 & 0.0669 & 0.0552 & \cdots & 0.0293 \end{bmatrix} \tag{7}$$

The 18 indicators in equation (7) are ranked in a weight hierarchy, in which the first three indicators with higher weights are road ancillary facilities, public facilities, and transport facility services, with weights of 0.216, 0.084, and 0.076, respectively.

3.3. Design Requirements Results

The 6 user requirements indicators and 18 life circle requirements indicators are combined with the indicators, and the merger refers to the classification table of GODE POI codes), and seven indicators are obtained for catering and shopping services, accommodation and life services, traffic and access services, medical and health services, sports, science, education and culture services, social work services, and public and governmental departments.

Secondly, the combined weights W are calculated using equation (8), where W_i and W_j are the user requirements weights and life circle requirements weights, respectively.

$$W = 0.5W_i + 0.5W_j \tag{8}$$

Table 2. Demand calculation and sequencing.

Variant	Indicators	weights	Consolidation of indicators	Combined weights	Rank
User Requirements	Catering & Shopping Services	0.232	0.232	Catering & Shopping Services	3
	Residential Life Services	0.267	0.267		
	Traffic Access Service	0.171	0.171		
	Health Services	0.105	0.105		
	Sports Science Education and Cultural Services	0.149	0.149	Residential Life Services	2
	Social Work Services	0.076	0.076		
	Living Services	0.032	0.032		
Life Circle Requirements	Catering Services	0.044	0.044	Traffic Access Service	1
	Sports and Leisure Services	0.036	0.036		
	Shopping Services	0.029	0.029		
	Accommodation Services	0.038	0.038		
	Science, Education and Culture Services	0.051	0.051		
	Scenic Spots	0.076	0.076		
	Corporate	0.030	0.030	Health Services	7
	Traffic Facilities	0.076	0.076		

Government Institutions and Social Organisations	0.048	0.048	Sports Science Education and Cultural Services	4
Healthcare Services	0.033	0.033		
Roads	0.216	0.216		
Financial and Insurance Services	0.038	0.038	Social Work Services	5
Residential	0.036	0.036		
Name and address information	0.047	0.047		
Access Facilities	0.041	0.041	Public and Government Sector	6
Public Facilities	0.084	0.084		
Car Service	0.055	0.055		

Table 2 comprehensive ranking results show that the importance of transport services, accommodation and living services, catering and shopping services occupy the first three and the weight is significantly higher than the other items of demand, the weight of the first three were: 0.252, 0.232, 0.152, the last four were sports, science, education and cultural services: 0.117, social work services: 0.090, public and government departments: 0.089, Medical and health services: 0.068.

3.4. Correlation Analysis Validation of Variables

If there is a correlation between the two variables and the correlation is significant, it can verify the rationality of the final demand ordering method, in which case the priority order of the final demand obtained has a certain basis and significance.

Table 3 shows that through Pearson correlation coefficient analysis, it can be known that the correlation coefficient between user requirements and life circle requirements is 0.546, which is significantly correlated at the level of 0.05, i.e., there is a significant strong positive correlation between user requirements and life circle requirements. Therefore, the final comprehensive weights and ranking obtained in this study are reasonable and can be designed based on this.

Table 3. Correlation analysis between user requirements and life circle requirements.Note:* Indicates significant correlation at the P< 0.05 level.

	Mean	**Std.**	**User requirements**	**Life circle needs**
User requirements	5.5611	3.82917	1	
Life circle needs	5.6111	4.31698	0.546*	1

4. Innovative Design of Life Circle APP for Xi'an Colleges and Universities

Based on the results, the APP interface design is carried out, and the correspondence between the design strategy, service groups, and design panels is shown in Table 4.The university groups served by this APP design can be divided into staff groups, school production staff, catering-related staff, and student groups. The definitions and weightings of each group are shown in Figure 3, and the design strategy is described in the following:

Strategy 1: Build a clear travelling mode and navigation path. The determination of travelling mode and the selection of navigation path are the core of college life circle APP design, and also the demand of traffic access service.

Strategy 2: Demonstrate the content of commercial services of different systems. the APP contains two categories of catering and shopping and accommodation life services, and the design can visualise and indicate the distance, passage distance and time of these information, so that the college user group can retrieve them more easily when using them, and promote the accessibility and utilisation of this type of POIs in the college life circle.

Strategy 3: Provide users with richer guidance on activity facilities. Convenient and rich activity facilities guidance can help university groups to quickly obtain the location, which is consistent with the characteristics of the map app itself. The design helps users to quickly collect locations by displaying the locations of medical and health services, sports, science, education and cultural services, social work services, public and governmental departments in the vicinity of the school, which improves the efficiency of users' navigation in the future.

Table 4. Correspondence between design strategy, service groups, and design boards.

Design strategy	Supporting services	Type of target group	Design board
Strategy 1	Traffic Access Service	All tertiary groups	Navigation Interface
Strategy 2	Catering & Shopping Services	All tertiary groups	Services Interface
	Residential Life Services	Faculty, staff and university students mainly	
	Health Services	All tertiary groups	
Strategy 3	Sports Science Education and Cultural Services	High school students mainly	Convenience Interface
	Social Work Services	Work production staff, faculty and staff mainly	
	Public and Government Sector	Work production staff, faculty and staff mainly	

The overall design of "U-Tour" APP is divided into four sections, namely, navigation, services, university convenience points, and my page, see Figure 4. The navigation interface includes three modules, namely, starting point setting, starting navigation, and access information.

A: Navigation interface, including the starting point settings, start navigation, access information three modules. The starting point setting module and the start navigation module can help users to quickly obtain the location, so as to build a clear navigation path; the access information includes four pieces of information: access distance, access speed, access time, and access service points, of which the access service points can reflect the existing POI data in the college life circle, help users to more quickly obtain all kinds of services around the school, and also meet the user's needs in the navigation process. B: The service interface adds the information of different services.

B: The service interface increases the display of different service types, and the order of display is catering services, shopping services, accommodation services, living

services, and the order of display refers to the final comprehensive weighting, and the display form is mainly based on the label classification and modularity.

C: The interface of the convenient location of the university mainly presents the accurate locations of medical and health services, sports, science, education and cultural services, social work services, public and government departments, and users can collect the locations.

D: "Home" summarises the user's collection information, navigation history and browsing history, helping users to find the POI locations they are interested in conveniently and efficiently.

5. Conclusion and Limitations

The study shows that the demand of college life circle app design mainly focuses on three aspects: traffic and access service, accommodation and life service, and catering and shopping service. In addition, this study also proves that the improved KJ method can get the user requirements and weights by increasing the user assignment, and the improved KJ method-entropy weight method is also feasible to analyse the requirements. In terms of design practice, the user and urban space perspectives can be analysed to determine the functions required for the design of map-based apps. However, this paper only calculates the demand for life circle through the number of POIs of the existing life circle, and does not measure other factors affecting the demand for life circle, so other factors can be added or changed in the future to make the research results more accurate and comprehensive.

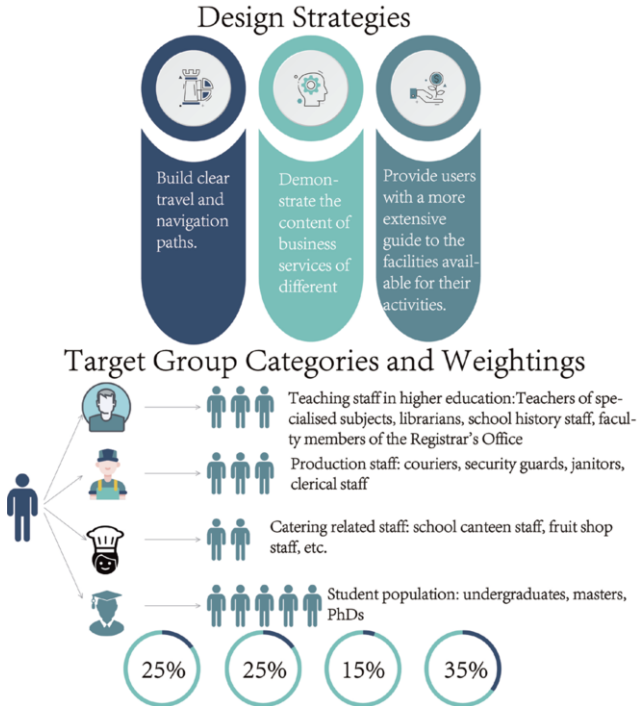

Figure 3. APP design strategy, user group classification and weighting.

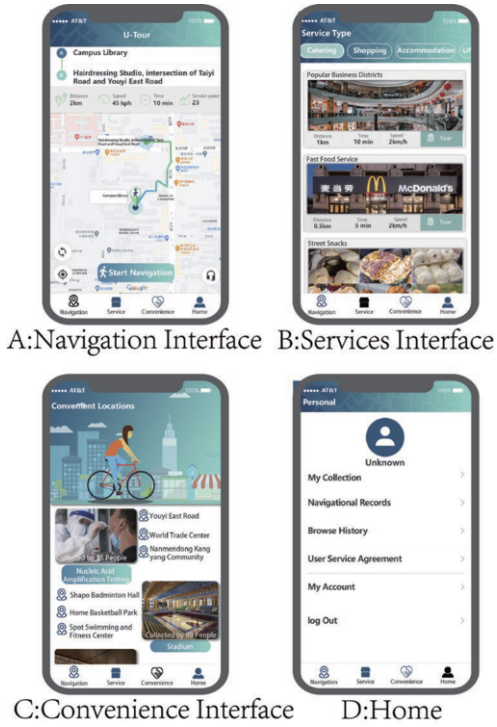

Figure 4. "U-Tour" interface design demonstration.

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