An Empirical Study of Evaluation of Library WeChat Micro Service by Mobile Information Network Technology

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Abstract. This research established an assessment mechanism for university library's micro services from the perspectives of user, information and technology. First, it proposed a Group AHP method based on clustering technique to construct a judgment matrix to evaluate the target system. Second, it conducted an empirical analysis of 8 representative university library WeChat accounts with the fuzzy membership degree function. This paper provides new research perspectives for the WeChat account micro-services, as well as methods to improve their quality and efficiency.

1. Introduction
Under the wave of micro era, libraries have realized the importance of micro service, and began to explore the application of micro media, such as Weibo, WeChat, and other mobile applications, in the library. With the help of Weibo, WeChat and other new media platforms, libraries display themselves to the patrons and serve them, and have gradually established a micro service mode suitable for micro communication and with the help of mobile terminals. Micro service applications not only provide ubiquitous mobile information services for users, make users pay more attention to the “micro” things, “micro” changes, “micro” focus around them, but also effectively make up for the lack of traditional information service means and improve the convenience of library services. The libraries have been changed from static information provision to dynamic and interactive information provision expanded the influence scope of library services [1]. In particular, the application of micro service not only have a profound impact on the information behavior of the young generation who are used to the existence of network, from the semi closed Internet to the cross domain mobile Internet, but also meet the development requirements of library innovation service. This paper aims to provide theoretical basis and criteria for the construction of micro service of university libraries WeChat account.

2. Literature review
2.1. Micro service
There is no strict definition of micro service, but scholars have a consensus: micro service is a small single purpose program that can be accessed through API [2]. Micro service architecture (MSA) is an architecture concept, which aims to decouple solutions by decomposing functions into discrete services. MSA and service-oriented architecture (SOA) have significant characteristics in business capability, automatic deployment, end-to-end integration, and decentralized control of language and data [3-4]. The earliest micro service is to provide personalized services for small and medium-sized enterprises [5]. In
western countries, Twitter is the earliest and the most famous micro service platform, and other micro service pioneers include Amazon, Netflix, the guardian, etc. [6-7]. After that, Sina Weibo, Tencent micro blog, WeChat, Taobao launched the corresponding open platform “micro service” system. Micro service is a new concept for all kinds of services provided by libraries. Under the background of digital micro era, library micro service is a differentiated, personalized and diversified information and knowledge service that library provides to patrons by relying on various high-tech information technologies and mobile clients [5]. Different from traditional library services, micro services pay more attention to the use of mobile devices to provide knowledge services for users [8]. And the library micro service has realized the micro service system function module with the characteristics of loose coupling, potential reuse, independence and autonomy [9].

2.2. Micro service of library WeChat account
Based on the research of scholars in China and abroad, this paper uses the definition of micro service in digital library to define the WeChat account micro service. The micro service of library WeChat account is centered on users, relying on electronic communication, network information and digital multimedia technology, and is applied in the Tencent public service platform of WeChat. Users can enjoy convenient, personalized, differentiated and subtle knowledge services through mobile terminals.

2.3. Evaluation system of micro service of library
Related researches at home and abroad mainly evaluate library micro service from the perspective of user interaction, content and service. The research of micro service evaluation based on user interaction in digital library starts from user experience and service performance, focuses on user participation and service interaction, uses three-dimensional modeling method based on user, service process and service performance to build micro service evaluation model, and realizes interactive service evaluation in dynamic environment [10]. Content based micro service evaluation of digital library mainly aims at digital objects, metadata, information content and collection [11]. When processing the original data, we should ensure the applicability, accuracy, readability, timeliness, easy to understand, informative and low cost of digital resources, so as to provide suitable digital resources for users with different backgrounds and changing needs. The main purpose of digital library micro service evaluation is how to provide additional needs to help users complete their tasks [11]. SERVQUAL and LibQUAL are widely used library service evaluation models [12-13]. The six evaluation indexes of digital library service include accuracy, politeness, recognition, satisfaction, and cost and reuse [14]. In addition, there are also face-to-face library service evaluation indicators, including accessibility, reliability, and intervention difference before and after service, expectation and cognitive gap, etc. Also, the evaluation criteria of digital library micro service also include information transmission delay and communication invisibility, such as response time and user control [8].

Although the research results of domestic scholars on Library micro service evaluation are relatively rich, they mainly focus on the quality evaluation of digital library micro service. As a new and widely used form of service, the official account number micro service is focused on public services based on technology services. Therefore, based on the perspective of human-information-technology interaction, this study constructs a practical evaluation standard to evaluate the micro service of library WeChat account and dynamically evaluate the effectiveness of micro service.

3. Methods
3.1. The construction of evaluation system
The construction of WeChat account micro service evaluation index system should follow the basic principles of purpose, science, operability and guidance. This study refers to the relevant digital library micro service evaluation index system [15]. According to the characteristics of the library official account micro service, from the perspective of human-information-technology interaction, the micro service evaluation index system of library WeChat account is constructed, which includes three first
level indicators of human, information and technology, and the structural hierarchy relationship between
the index system is shown in Table. 1. Each level of indicators is developed by the upper level indicators,
and the upper level indicators need to be reflected by the results of the next level.

| 1st level indicators | 2nd level indicators | 3rd level indicators |
|----------------------|----------------------|----------------------|
| subject & object of  | subject a            | behavior wiliness of  |
| micro service        | service subject a1   | subject              |
| a                    |                      | a11                  |
|                      | micro service object | support ability of   |
|                      | a2                   | operation and        |
|                      |                      | maintenance of       |
|                      |                      | subject a12          |
|                      | quality of           | intention of user a21|
|                      | interactive process  | engagement of user a22|
|                      | b1                   | information literacy of user a23|
|                      | quality of           | equality of interactive b11|
|                      | service result b2    | information richness of interactive b12|
|                      |                      | ease of use of interactive information b13|
|                      |                      | controllability of interactive b14|
|                      |                      | degree of interactive b15|
| technology quality   | technology achievement c1 | reliability of information b21|
| of micro service     |                      | accuracy of information b22|
| c                    |                      | completeness of information b23|
|                      |                      | standardization degree of information b24|
|                      |                      | appropriateness of information amount b25|
|                      |                      | timeliness of information b26|
|                      |                      | customization of information b27|
|                      |                      | effectiveness of information b28|
|                      | technology support c2| service diversity for platforms c11|
|                      |                      | friendly operation interface c12|
|                      |                      | stability of service platform c13|
|                      |                      | fluency of service platform c14|
|                      |                      | system security c21|
|                      |                      | transmission speed c22|
|                      |                      | integration of platform architecture c23|

### 3.2. Method and process of evaluation

The essence of analytic hierarchy process [16] is to decompose the complex system into several components according to the requirements of solving problems. These factors are grouped according to the correlation relationship to establish a hierarchical structure; the importance of system factors is compared in pairs according to a certain scale, and the judgment matrix is constructed to determine the relative importance order of each factor to the upper level factors; On the basis of hierarchical structure, the importance order of policy factors to objectives is obtained [17]. In order to reduce the subjectivity of decision-making results, this paper adopts the group AHP method based on clustering, and uses this method to construct the judgment matrix [18]. The degree of membership function [19] in fuzzy mathematics is used as a scale system to evaluate the library WeChat account micro service. The specific algorithm flow is shown in Figure 1.
(1) The judgment matrix is constructed and the weights are calculated. Delphi Method evaluation of the system is carried out in different levels. The importance of each index is assigned by 1-9 scale method. 5 experts (3 library and information professors and 2 library WeChat account operators) are assigned to build a single level comparison judgment matrix $A_{n \times n}$. The judgment matrix filled by experts is normalized.

(2) Use formula (1) to normalize each column element of the judgment matrix. Then use formula (2) to add the normalized matrix by row and get the row vector, and use formula (3) to normalize it, and use formula (4) to calculate the maximum eigenvalue [18].

$$\bar{b}_{ij} = \frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}} \quad (i, j = 1, 2, \ldots, n) \tag{1}$$

$$W_i = \frac{\sum_{j=1}^{n} \bar{b}_{ij}}{\sum_{i=1}^{n} \bar{b}_{ij}} \quad (i, j = 1, 2, \ldots, n) \tag{2}$$

$$W_i = \frac{\sum_{j=1}^{n} W_j}{\sum_{j=1}^{n} W_j} \quad (i, j = 1, 2, \ldots, n) \tag{3}$$

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} (AW_i) / W_i \tag{4}$$

(3) C.R. = C.I. / R.I. is used for standardization and consistency inspection, and the judgment matrix of unqualified consistency inspection is deleted. The consistency index was C.I. = 0.14. According to
the different orders of the judgment matrix, the average random consistency index R.I. =1.45 is obtained by looking up the table. The result shows that C.R. = 0.097 (when C.R. < 0.1, the consistency of judgment matrix is acceptable) [19], thus a new judgment matrix is obtained \( R_{n \times n} \).

(4) For the new judgment matrix \( R_{n \times n} \), A new similarity matrix is obtained by using formula (5) [19].

\[
F_{ij} = \frac{1}{1 - C \sum_{k=1}^{m} |X_{ik} - X_{jk}|} \quad i = j \quad i \neq j \tag{5}
\]

The similarity matrix obtained in this paper cannot be classified directly, so it should be modified. \( R^2 = R \times R, \quad R^4 = R^2 \times R^2, \quad R^8 = R^4 \times R^4 = R^4 \). Therefore, \( R^4 \) is selected as the fuzzy equivalent matrix, that is, \( R^* = R^4 \). According to the classification of individual ranking vectors, three categories are selected: There are three experts in the first category, numbered 1, 3 and 4, one expert in the second category, numbered 5, and one expert in the third category, numbered 2.

(5) The new expert weight is \( K_i = F_i \lambda_i \), in which \( \lambda_i \) is obtained by formula (6) [18]. In formula (6), \( \lambda_i \) is the weight of the ith expert; \( t \) is the number of clusters; \( \theta_p \) is the number of individuals in the cluster. The weight of the first kind of experts is 0.473, the second kind of experts is 0.094, and the third kind of experts is 0.155.

\[
\lambda_i = \frac{\theta_i}{\sum_{p=1}^{p} \theta_p} \tag{6}
\]

(6) According to formula (7) [18], the new weight of the first level index is obtained. \( W_j \) is the new weight, \( K_i \) is the ith expert weight, \( W_i^* \) is the original weight. Normalize it according to formula (8) [18], and the final evaluation index system weight summary results are shown in Table 2.

\[
W_j = K_i W_i^* \tag{7}
\]
\[
W_j^* = \frac{W_j}{\sum_{i=1}^{N} K_i W_i^*} \tag{8}
\]

| Table 2. Weight list of the micro service evaluation index system of library WeChat account |
|---------------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1st level | 2nd level | 3rd level | 1st level | 2nd level | 3rd level | 1st level | 2nd level | 3rd level |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| a1        | a11 (0.333) | b11 (0.220) | b21 (0.114) | c11 (0.291) |
|          | a12 (0.667) | b12 (0.276) | b22 (0.122) | c12 (0.092) |
|          | a21 (0.444) | b13 (0.164) | b23 (0.111) | c13 (0.514) |
| a2        | a22 (0.444) | b14 (0.120) | b24 (0.136) | c14 (0.103) |
| (0.115)  | (0.413)   | (0.197)   | (0.216)   | (0.299)   |
|          | b15 (0.220) | b25 (0.147) | c21 (0.450) |
|          | (0.288)   | (0.413)   | (0.131)   | (0.350)   |
|          | (0.112)   | (0.125)   | (0.125)   | (0.200)   |
|          |           |           | (0.114)   |           |           |           |           |
4. Empirical analysis

4.1. Sample selection

Searched “University Library”, “WeChat” and “service”, in the field the title in CNKI (China National Knowledge Infrastructure) and combined with the ranking of WeChat WCI value, after taking into account the wide representation of research samples, and seeking opinions of 5 experts, 8 university libraries WeChat accounts are finally selected as samples. As shown in Table. 3.

Table 3. Weight list of the micro service evaluation index system of library WeChat account

| Institution                        | ID of WeChat account | Type of WeChat account |
|-----------------------------------|----------------------|------------------------|
| 1. Library of Peking University   | Pkulib               | Service account        |
| 2. Library of Tsinghua University | Thu-lib              | Subscribe account      |
| 3. Library of Tongji University   | tongjilib            | Service account        |
| 4. Library of Xiamen University   | Xmulib               | Subscribe account      |
| 5. Library of China University of Mining and Technology | Cumtlib1909          | Service account        |
| 6. Library of Wuhan University of Technology | Whutlib             | Subscribe account      |
| 7. Library of Guangxi Normal University | gxsdtsg            | Service account        |
| 8. Library of Shanxi University of Finance and Economics | jxufelib            | Service account        |

4.2. Evaluation process and results

In view of the fact that developers and operators are the subject of WeChat account service, and readers are the objects of the micro service of WeChat account. According to the evaluation index, different questionnaires were designed for the subject group and the object group. The measurement range of each item was 5 points (poor, general, good, good, very good) Likert scale method to distinguish different user perception.

The subject group is composed of 14 developers and operators of the 8 university library accounts. The object group consists of the above 8 universities’ students. The online questionnaire is distributed through the Questionnaire Star platform. 137 questionnaires are recovered, and 17 invalid questionnaires are eliminated. Finally, 120 valid questionnaires are obtained, with an effective rate of 88.19%. The 8 university library accounts are studied by using the trigonometric degree membership function (the formula as follows) as a scaling system. The scores of the two groups were summarized and fuzzed according to formula (9), letting d–c=0.5, b–a=0.5, a, b, c, d \{1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5\}. The weight of each indicator is calculated according to table 2, and the final score is obtained according to the maximum membership principle, as shown in Table. 4.

\[ f(x,a,b,c,d) = \begin{cases} 
0 & x < a \\
\frac{x - a}{b - a} & a \leq x < b \\
\frac{b - a}{d - x} & c \leq x < d \\
\frac{d - c}{d - x} & x > d 
\end{cases} \]
Table 4. Score of micro service of 8 university library Wechat account

| Samples | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---------|---|---|---|---|---|---|---|---|
| Micro service subject | 4.43 | 4.12 | 4.43 | 4.26 | 4.63 | 3.56 | 4.22 | 3.38 |
| Micro service object | 4.05 | 4.32 | 4.82 | 4.74 | 3.58 | 4.19 | 2.61 | 3.87 |
| Quality of interactive process | 4.84 | 4.84 | 3.84 | 3.84 | 4.00 | 2.84 | 5.00 | 3.16 |
| Quality of service result | 4.43 | 4.43 | 3.89 | 3.03 | 3.97 | 4.35 | 4.51 | 3.68 |
| Technology achievement | 3.30 | 3.10 | 3.52 | 3.30 | 4.22 | 3.62 | 4.02 | 3.31 |
| Technology support | 4.54 | 3.53 | 1.27 | 2.52 | 4.80 | 2.02 | 3.79 | 2.78 |
| Average | 3.83 | 3.68 | 3.27 | 3.17 | 3.72 | 3.14 | 3.74 | 3.04 |

4.3. Result analysis

This paper discusses and analyzes the micro service data of the 8 university library WeChat accounts from three aspects.

1) The 2nd level index data show that the key indicators affecting the comprehensive score of university library WeChat account micro service are the quality of technology achievement and interaction process. It indicates that the key to micro service is the micro service front-end technology that users can perceive and directly affect their experience. It is the core of reducing the logging out rate and improving user satisfaction. At the same time, it is also very important to provide users with rich data resources and enable them to download, which is the key to enhance user loyalty. From the comparison of account types, the scores of technology support and result quality of subscriber service of service account are higher than those of subscribe account, which reflects to a certain extent that subscribe account should improve the technical support ability of micro service and attach importance to the construction of digital resources from the perspective of user-information-technology interaction. From the comparison of university categories, micro service score of technology implementation of 985 universities library account is higher than the 211 university library, and those score of 211 university library account is higher than the ordinary university library account. It shows that the category of university plays a great role in the construction of the WeChat account micro service team and the procurement of services.

2) From the average score, the WeChat account of Peking University library was the first, and most of the scores were higher. All resource provided can be obtained and downloaded free of charge. At the same time, API is open for resource interaction and sharing. Micro service tools such as APP and WAP are used for information integration, and third-party micro service platforms such as small programs are used for user service and interactive communication. In these aspects, there are more or less certain gaps in other library micro services, especially in the open API for resource interaction and sharing, personalized customized information services. Peking University Library micro services set a benchmark for domestic university libraries to strengthen the construction of WeChat micro services. This paper also notes that the horizontal contrast development of similar universities is uneven, which means that we should pay more attention to the WeChat account, the important user flow platform, and plan, build and upgrade the micro service of account operation.

3) The WeChat account micro service of university library should pay attention to the harmonious development of user-information-technology. University libraries should build professional WeChat account operation team to enhance the core competitiveness of micro service. University library should implement differentiated and personalized service strategy to strengthen the WeChat account’s willingness to micro service and enhance user's behavior ability. Information is the foundation of the micro service of university library. WeChat account of university library will transmit the abundant digital information to the users timely and accurately, and effectively improving the user satisfaction. Technology is the guarantee of the micro service of university library. WeChat account micro service is
a new form of service. University library should adopt advanced information technology, that is, it guarantees efficient, timely, accurate and massive information transmission, and it can also establish a wide range of users from the user’s perspective. University libraries should keep pace with the development of micro service within its industry, constantly learn their advanced experience, and continuously enhance the overall level of WeChat account micro service.

5. Conclusion

From the perspective of technology interaction of user-information-technology, the paper constructs the evaluation index system of WeChat account micro service for university libraries. The evaluation of micro service is a multi-level problem involving many factors and complex relations. In order to increase the accuracy of decision results, this paper proposes a group AHP method based on clustering method, and constructs a judgment matrix by using it. The degree membership function of fuzzy mathematics is chosen as a scale system to evaluate the micro service index of university library WeChat account. At the application level, the paper select 8 representative university library WeChat accounts as sample to verify and analyze the index system by using the empirical analysis method. The empirical results show that the index system has practical application value and strong operability, and can guide the construction of WeChat account micro service in university libraries.

There are still some limitations in this study to be compensated for by subsequent research. The evaluation index, evaluation criteria, and index weight need further in-depth analysis according to the conditions and problems of specific university library WeChat account. In the empirical study, the sample size is small, thus the conclusion is limited. Also, it is subjective to adopt a few numbers of experts to score the index.

In order to reduce the influence of subjective factors, we will programmatically access the open platform of WeChat account to obtain objective data and distribute large numbers of questionnaires to obtain subjective data. We will use fuzzy data envelopment analysis to screen the evaluation indicators, so that the evaluation index system can better meet the construction requirements of the library WeChat account micro service, that is, the management and evaluation of micro services. Improve the quality and efficiency of library micro service, so as to meet the needs and expectations of users.

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