Research on Co-occurrence Associations of WeChat Service Items and Information Dissemination Influence in University Libraries: A Case Study of WeChat Official Accounts of C9 League University Libraries (Postprint)

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Abstract

[目的/意义] To analyze the co-occurrence relationships of information service items on university library WeChat Official Accounts and their impact on information dissemination influence. [方法/过程] First, existing research on information services and information dissemination influence of university library WeChat Official Accounts is summarized and synthesized. Then, taking the WeChat Official Accounts of C9 League university libraries as research subjects, their service items are classified based on prior studies. An association network is constructed according to the co-occurrence relationships of service items in dropdown menus, and the relative importance of nodes is determined through closeness centrality calculations. Finally, the WCI index is employed to analyze and measure the information dissemination influence of each official account. Combined with the quantity of high-readership articles and their affiliated service types, the study analyzes their impact on information dissemination influence. [结果/结论] Among the services provided by university library WeChat Official Accounts, the three service categories of user information, resource retrieval, and information express exhibit relatively high importance in the association network. However, information express service content has the greatest impact on information dissemination influence, while resource retrieval, user information, interactive consultation, and other services have relatively minor effects.

Full Text

Research on the Co-occurrence Relationships and Information Dissemination Influence of University Library WeChat Service Items: A Case Study of C9 League University Library WeChat Official Accounts

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Abstract: [Purpose/Significance] This study analyzes the co-occurrence relationships of information service items on university library WeChat official accounts and their impact on information dissemination influence. [Method/Process] First, we systematically review existing research on library WeChat information services and information dissemination impact. Next, we select the WeChat official accounts of C9 League university libraries as our research subjects, classify their service items based on prior studies, construct an association network according to the co-occurrence relationships of service items in dropdown menus, and determine the relative importance of nodes through closeness centrality calculations. Finally, we employ the WCI index to measure the information dissemination influence of each official account and analyze its relationship with service types by examining high-readership articles and their service categories. [Results/Conclusions] Among the services provided by university library WeChat official accounts, user information, resource retrieval, and information delivery services demonstrate relatively high importance in the association network. However, information delivery services exert the greatest impact on information dissemination influence, while resource retrieval, user information, interactive consultation, and other services have comparatively smaller effects.

Keywords: university libraries; WeChat official account; service items; co-occurrence relationship; information dissemination; influence
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WeChat has been widely adopted in library information services due to its immediacy, interactivity, and diverse information formats[1], with university library WeChat services becoming a crucial channel for library-student/faculty interaction and user experience enhancement, representing a core focus for service capability upgrading[2]. Service functions and message 推送 constitute important

components of university library WeChat services[3]. Scholars have investigated the current status of these services and corresponding improvement strategies[4], conducted in-depth surveys on platform construction, operational status, service content, and promotion[5], and analyzed the content and existing problems of WeChat services in "985" universities[6–8]. Given that university library WeChat services primarily target campus faculty and students, they exhibit strong consistency in information service content. However, due to differences in history, culture, scale, geographic location, and institutional characteristics, each university library's information service function configuration possesses unique features. What similarities and differences exist among various university library WeChat services? What associations exist among information service items? How do they differ in terms of information dissemination influence?

To address these questions, we selected the WeChat official accounts of C9 League university libraries as our research subjects, systematically cataloged their specific service items, constructed a library WeChat service item association network based on service item co-occurrence relationships, and determined the relative importance of different service items within the entire network through closeness centrality calculations. We then compared the information dissemination influence of different university library WeChat official accounts by calculating the WeChat Communication Index (WCI), combined this with service types to compare the impact of different information services on dissemination influence, and finally proposed recommendations for improving WeChat official account information dissemination influence from the perspective of service content optimization. This study innovatively constructs a co-occurrence-based association network of university library WeChat official account service items and integrates service types with information dissemination influence to explore how different services affect influence, thereby providing references for the configuration and improvement of WeChat official account service items.

2 Literature Review

With the popularization and functional improvement of mobile smartphones, the combination of mobile devices and social platforms has expanded library service domains, enriched service content[9], and enhanced service efficiency[10]. Information services and information dissemination influence represent two primary aspects of library WeChat research, which we systematically review below.

2.1 WeChat Information Services in University Libraries

University library WeChat official accounts, as social media platforms, feature immediacy, interactivity, and high dissemination capacity without geographical or temporal constraints[11], providing not only additional channels for library information services but also more effective, convenient, and timely service delivery to users[12]. Service items have evolved from basic functions such as catalog queries, announcement searches, and personal borrowing inquiries[13] to functions and services centered on news dissemination, interactive communication, and

mobile portal customization[2], with more university libraries offering personalized services through WeChat official accounts[14].

Based on service content and characteristics of university library WeChat accounts, Yang Yanni and Ming Junren categorized services into five aspects: user information, resource retrieval, information delivery, interactive consultation, and other services[15]. Xu Tiancai et al. found that among 38 "Double First-Class" universities with library WeChat official accounts, information release and collection resource retrieval were universal service contents[16]. Although no unified classification standard exists for university library WeChat service content, all classifications are based on fundamental functions and user needs.

Scholars have examined not only service content but also operational problems and improvement strategies. Ma Dayan et al.'s investigation of "985" university library WeChat official accounts revealed issues such as incomplete service functions, monotonous 推送 content, and low frequency[7]. Wu Xiaoying et al. similarly identified incomplete service content and 单一推送 formats as primary problems in Hubei university libraries[17]. Yang Yanni and Ming Junren also emphasized the need to strengthen service function development and improve 推送 resource quality[15]. Additionally, user needs and experience should be prioritized in service improvement processes[18]. These findings demonstrate that information service functions and 推送 content meeting user demands are key factors affecting university library WeChat information service capabilities.

2.2 Information Dissemination Impact of Library WeChat

Research on library WeChat information dissemination impact primarily encompasses influencing factors and influence evaluation[19]. The information dissemination process involves five main components: communicators (account maintenance personnel), recipients (primarily faculty and students), medium (the official account platform), information (推送 content), and dissemination environment (internal and external environments including technology, law, society, culture, and campus atmosphere)[20]. Timeliness of information 推送, user scale, and relationship strength with users constitute important factors affecting library official account information dissemination[21].

For influence evaluation, the WeChat Communication Index (WCI) is widely applied, comprising reading and liking indices further subdivided into daily average reads, per-article average reads, maximum reads, daily average likes, per-article average likes, and maximum likes[22]. WCI has been used in studies on library WeChat content marketing effectiveness[13], reading promotion[23–24], dissemination influence of "Double First-Class" university libraries[2], and information dissemination influence of "985" university libraries[22]. Therefore, this study also employs the WCI index to evaluate the information dissemination influence of C9 League university library WeChat official accounts.

3 Co-occurrence Analysis of Information Service Items

3.1 Classification of Information Service Items

We selected China's C9 League universities as our research sample, as these nine institutions represent China's top-tier universities and have been used in studies on international influence of university journals[25], research innovation levels, and digital library service comparisons between Chinese and American top universities. Thus, analyzing the WeChat official accounts of C9 League university libraries provides strong representativeness for studying information service types and their impact.

To analyze the specific content of information services provided by university library WeChat official accounts, we cataloged service items from the nine C9 League libraries (Tsinghua University, Peking University, Zhejiang University, Shanghai Jiao Tong University, Fudan University, University of Science and Technology of China, Nanjing University, Xi'an Jiaotong University, and Harbin Institute of Technology) during March 23-25, 2019. The services included user centers, collection services, event delivery, announcements, information queries and 推送, campus culture, and problem assistance. Referencing Yang Yanni and Ming Junren's classification framework[15] and combining specific service content, we categorized the service items of the nine libraries, with results shown in Table 1 .

Table 1 reveals that all nine libraries provide resource retrieval and information delivery services. Except for Tsinghua University Library, all offer user information services. In interactive consultation, all except Peking University Library provide this function. For other services, several libraries feature a few unique service items not found in Tsinghua or Zhejiang University libraries.

Due to libraries' identical fundamental functions in universities, C9 League library WeChat official accounts exhibit strong similarity in service items. However, institutional characteristics result in unique column designs that reflect distinctive features in information service content and format.

3.2 Co-occurrence Association Analysis of Information Service Items

Social network analysis has been widely applied in social relationship and content association studies, using co-occurrence relationships to determine content associations and co-occurrence frequency to measure relationship strength[26]. Therefore, to analyze associations among library information service items, we constructed a network based on service item co-occurrence relationships, following these steps:

First, we identified service item series S , = {s , } for each library's WeChat official account, where s , represents a specific service item name, i denotes the library account number, and j denotes the service item number. For example, Tsinghua University Library's service item series was denoted as $S_{1,3}$, with $s_{1,1}$

representing collection layout, $s_{1,2}$ representing opening hours notification, and $s_{1,3}$ representing book recommendations.

Second, we standardized synonyms: collection search and collection query were unified as "collection query"; binding & unbinding, binding/unbinding campus card, and binding/unbinding were standardized as "binding & unbinding"; book recommendation and reading recommendation were standardized as "reading recommendation". When service content was essentially identical with inclusion relationships, we unified them under broader categories (e.g., renewal and scan-to-renew were both recorded as renewal). This produced standardized item series S , = {s , }.

Third, we determined co-occurrence relationships by recording items within the same dropdown menu of a library's WeChat official account as co-occurring. For instance, Peking University Library's user information includes binding & unbinding, borrowing & renewal, and reservation—three service items with co-occurrence frequency recorded as 1. The total co-occurrence frequency was calculated as the sum of simultaneous appearances across different official accounts. If binding & unbinding and borrowing & renewal co-occurred in five official accounts' dropdown menus, their co-occurrence frequency was recorded as 5.

Fourth, we constructed a service item co-occurrence network matrix. The node set V represented the union of service items from all nine libraries: V = {S $_{1,3}$ S $_{2,8}$ S $_{3,15}$ … S $_{9,27}$}, yielding 83 service items. The co-occurrence relationship matrix for the nine official accounts is shown in Table 2 .

To further analyze associations among service items, we constructed an information service item association network based on the co-occurrence matrix and content relationships. To compare node importance, we calculated each node's closeness centrality, which indicates how close a node is to the network center. Higher values signify greater node importance[30], calculated using formula (1):

$$C_c(v_i) = \frac{N-1}{\sum_{j=1,j\neq i}^{N} d_{ij}} \quad (1)$$

where C_c(v_i) represents node v's closeness centrality value, d denotes the shortest path between nodes i and j, and N represents the total number of nodes in the network.

In visualizing the network, node size reflects closeness centrality values, with colors indicating service categories: red nodes for user information services, yellow for resource retrieval, blue for information delivery, green for interactive consultation, and cyan for other services, as shown in Figure 1 [FIGURE:1].

Figure 1 demonstrates that similar services are not necessarily grouped within the same dropdown menu, indicating no unified standard for menu design. However, high-frequency services such as borrowing services, reading recommenda-

tions, binding & unbinding, resource updates, and borrowed & renewal occupy relatively important positions and serve as connectivity hubs in the network. Some unique service items are separated, such as “Book of the Year,” “Closing Music,” “Past Highlights,” campus maps, and campus scenery. Certain library-specific services are connected through high-frequency nodes, such as USTC’s department navigation and USTC news.

To analyze node importance, we ranked nodes by closeness centrality values, as shown in Table 3 . Table 3 shows 14 nodes with closeness centrality > 0.40 (16.87% of total nodes), mostly user information service items, indicating that user information services constitute key elements in the C9 League library WeChat service content association network. Twenty-seven nodes (32.53%) fall between 0.30-0.40, primarily resource retrieval and information delivery services, with only two interactive services (online Q&A and library hotline). Thirty-seven nodes (44.57%)—the highest proportion—range between 0.20-0.30, encompassing all five service types, demonstrating hierarchical importance within service categories. Five nodes (6.02%) fall below 0.20, mostly other services, reflecting that differential service content across the nine libraries holds relatively low importance in the overall network, with some isolated items like “Book of the Year” and “Closing Music,” also showcasing service innovation.

Overall, user information, resource retrieval, and information delivery services constitute the main service content of C9 League library WeChat official accounts, significantly outnumbering interactive consultation and other services, resulting in relatively higher closeness centrality values without isolated nodes.

4 Analysis of Information Service Dissemination Influence

For calculating library WeChat official account information dissemination influence, we adopted the WCI index following Zhou Haichen and Lu Hejian[22], Cai Liping and Kong Dechao[23], and Wan Muchen and Ou Liang[31]. The index comprises reading and liking indices with corresponding indicators, weights, and standardization methods shown in Figure 2

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We calculated the WCI for each library’s WeChat official account using formula (2):

$$WCI = \{80\%\cdot[40\%\cdot\ln(R/d+1)+45\%\cdot\ln(R/n+1)+15\%\cdot\ln(R_{max}+1)]+20\%\cdot[40\%\cdot\ln(10\cdot Z/d+1)+45\%\cdot\ln(10\cdot Z/n$$

During March 23-25, 2019, we collected data on total posts (n), per-article reads (r), and likes (z) for 2018 from the nine C9 League libraries, identifying maximum reads (R_{max}) and maximum likes (Z_{max}). Total reads and likes were divided by 365 days and post volume to obtain daily average reads (R/d) and per-article average reads (R/n). The WCI values are shown in Table 4 .

Figure 1: Figure 2

Tsinghua University Library's official account achieved the highest WCI (520.664), significantly exceeding the other eight libraries. Harbin Institute of Technology Library's account scored the lowest (164.423), ranking last across all six indicators. The remaining seven libraries' WCI values ranged between 350-500, with some showing close scores (e.g., Zhejiang University and Xi'an Jiaotong University; Shanghai Jiao Tong University and University of Science and Technology of China).

Prior research indicates that post volume does not correlate with influence, while reads and likes significantly impact WCI[2], with article content being the primary factor affecting reads and likes. Therefore, we analyzed articles with >3,000 reads from the nine libraries, categorizing them by service type as shown in Table 5 .

Table 5 reveals that the ranking of high-readership article counts and total reads aligns with WCI rankings for all libraries except Xi'an Jiaotong University, confirming that high-readership articles constitute important influence factors, consistent with Jia Wenlong's findings[2]. Further analysis of Xi'an Jiaotong University's six indicators shows its daily average likes ranked 8th, and since this metric carries substantial weight in WCI calculation, its overall WCI ranking diverged from its high-readership article performance.

To further examine how different service contents affect dissemination influence, we selected high-readership articles for detailed analysis following Yang Yanni

and Ming Junren's classification[15], as shown in Table 6 .

High-readership article analysis reveals that information delivery service articles constitute the vast majority, with all articles exceeding 10,000 reads belonging to this category. Resource retrieval articles rank second, while user information and other services appear less frequently, and interactive consultation articles all fall below 3,000 reads. Thus, information delivery services exert the greatest influence on information dissemination, while interactive consultation services have minimal impact.

We also found that information dissemination influence does not directly correlate with the number of service columns. Tsinghua and Peking University libraries offer relatively few service items (see Table 1) yet achieve high WCI scores, while Harbin Institute of Technology provides more services but scores lowest. Therefore, service configuration should align with actual user preferences and leverage institutional strengths to enhance influence[31].

Additionally, high-readership articles demonstrate innovation in title design and content presentation. For example, Peking University's 2017 reading report introduced with poetic language ("未名春意又如许，博雅书香正当时") significantly enhanced reader interest. Fudan University used trendy, engaging terms like "lucky draw" and "incubation" to attract attention. Content combining images with text, accompanied by emoticons and background colors, increased reading enjoyment and generated higher reads and likes, thereby boosting official account influence.

5 Conclusions and Discussion

WeChat official accounts have become important channels for users to access service information. Scholars have long focused on university library WeChat service content and operations[8–9],[24], developing classification frameworks[15], but have not examined service item associations from a content co-occurrence perspective or established criteria for evaluating content importance. Building on prior research[15], this study categorized C9 League library WeChat service content, innovatively constructed a service item association network using co-occurrence relationships, and combined service types with information dissemination influence to explore how different services affect influence, providing references for service item configuration.

Through closeness centrality calculations, we found user information and resource retrieval services occupy relatively important network positions, followed by information delivery and interactive consultation services, while other services remain at the network's periphery or isolated. By calculating WCI and analyzing high-readership articles, we identified information delivery services as having the greatest impact on dissemination influence, while resource retrieval, user information, other services, and interactive consultation have smaller effects. Thus, for university libraries, basic services exert relatively minor influence on dissemination impact.

We also discovered that influence magnitude does not directly correlate with the number of service columns. Tsinghua and Peking University libraries' official accounts contain fewer service items (Table 1) but achieve higher WCI scores, while Harbin Institute of Technology's account offers more services but scores lowest. Service configuration should therefore combine user demand preferences with institutional advantages to enhance official account influence[31].

Furthermore, during analysis of different service content readership, we found that database usage instructions, collection layout introductions, and document delivery content generated low reads, with only 8 of 1,815 articles published in 2018 across the nine libraries exceeding 3,000 reads. Consequently, we argue that while improving information dissemination influence, university library WeChat official accounts should prioritize enhancing basic service content and its functions, avoiding the pursuit of influence at the expense of core library service values.

Based on these findings, we propose the following recommendations for university library WeChat official account development:

1. **Simplify service content and optimize key items.** Our co-occurrence analysis revealed that some libraries offer numerous service items with redundancy, such as "My Borrowing Information" and "My Library Status," or "Database Map" and "Collection Layout." Consolidating these items can simplify dropdown menus and improve usability.

2. **Strengthen basic function promotion to increase user engagement.** University library user bases are relatively concentrated. While enhancing official account influence, libraries should prioritize cultivating user awareness and habits regarding proper library utilization for academic support, rather than pushing content unrelated to core library services merely to boost influence.

3. **Emphasize service innovation to enhance user attraction.** Improving content readability, interest, and interactivity represents an important approach for university libraries to enhance information promotion capabilities[32]. Service content can be made more attractive through innovative formats, editing, and layout design[15].

This study has limitations, having examined only service item design and co-occurrence relationships and their impact, while user demand satisfaction also constitutes an important influence factor. Future research should integrate user needs with official account service design for more comprehensive analysis.

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Information Service, Relationships and Influences of University Libraries' WeChat Official Account—Libraries of C9 Leagues as Examples

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Abstract: [Purpose/significance] This paper aimed to analyze the information service contents, co-occurrence relationships and influences of universities libraries' WeChat official accounts. [Method/process] Firstly, this paper summarized the related research of information service and information diffusion influence. And then, analyzing the information service items and constructing a relationship network based on the co-occurrence matrix of nine famous university libraries' WeChat official account; in order to compare the importance of different nodes, the closeness centrality has been calculated. Finally, the WeChat influence index (WCI) of each WeChat official account have been calculated, the impact of different service on WCI has been compared by the analyzing of high-reading contents. [Result/conclusion] The results showed that user information, resource search and information delivery take the relative important positions in the network, but only information delivery service has the highest impact on WCI, resource search, user information, interaction & consultation, and other service have little impact.

Keywords: university libraries; WeChat official; information service; co-occurrence relationship; information diffusion; influence

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Figures

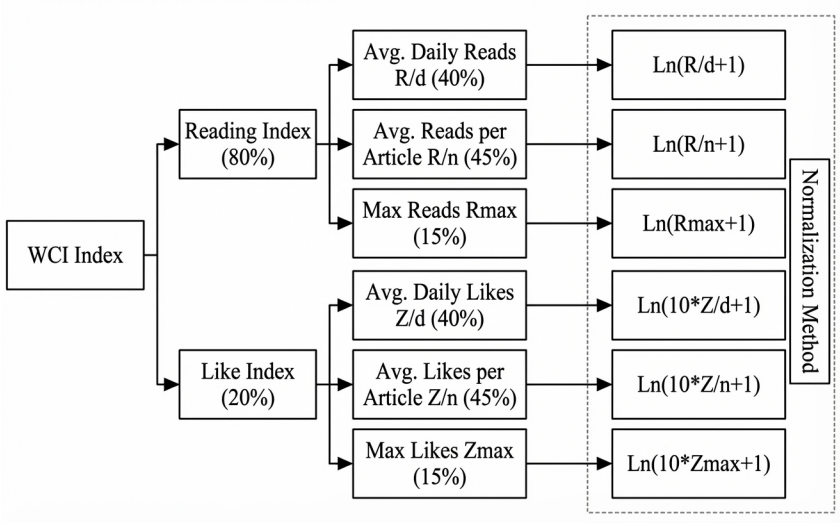

Figure 2: Figure 3