University Library Space Planning Methods: A Case Study of Tongji University Library (Post-print)

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Abstract

[目的/意义] Against the backdrop of the "Double First-Class" construction initiative, the fundamental elements of university libraries—"people, resources, and space"—have undergone significant transformations. The Tongji University Library investigates library space planning strategies based on user needs, thereby providing support and feasible solutions for service innovation and business transformation in libraries.

[方法/过程] This study explores analytical methods for library space planning and design requirements. Through content analysis, case studies, questionnaire surveys, and other approaches, it examines library development trends and user demands. Based on this requirement analysis, it proposes key elements, functional layouts, characteristics, and frameworks for new spatial configurations, offering feasible recommendations for the innovative development of the Tongji University Library.

[结果/结论] Space services have emerged as a pivotal service model for future library development. Exploring space planning methodologies and key elements for university libraries, and proposing a user-based space planning framework, contributes to enhancing libraries' service innovation capabilities.

Full Text

Preamble

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Abstract

[**Purpose/Significance**] Under the background of "Double World-Class" construction, the basic elements of university libraries—"people, resources, and space"—have undergone significant changes. Tongji University Library has explored library space planning strategies based on user needs to provide support and feasible solutions for library service innovation and business transformation. [**Method/Process**] This paper explores methods for analyzing the needs of library space planning and design. Through content analysis, case studies, and survey questionnaires, it examines library development trends and user needs. Based on this demand analysis, it proposes key elements, functional layouts, characteristics, and frameworks for new spatial arrangements, offering feasible suggestions for the innovative development of Tongji University Library. [**Result/Conclusion**] Space services have become an important service model for future library development. Exploring university library space planning methods and key elements, and proposing a user-based space planning framework, helps enhance library service innovation capabilities.

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Under the "Double World-Class" construction initiative, university talent cultivation models are undergoing transformation. To support the development of world-class disciplines [1] and advance the pace of building world-class universities, academic libraries urgently need to explore innovative services that enhance research standards and promote talent development. Driven by diversified user needs and the development of information technology and digitization, the key components of university libraries—"resources, services, space, and talent"—have all experienced major shifts. These changes will continue to deepen and accelerate with the evolving demands of the "Double World-Class" initiative, profoundly influencing future library service transformations. The transformation of university library spatial layout, which is inseparable from service transformation, is also being vigorously pursued, with library space reconstruction becoming an important foundation for service transformation.

Literature review reveals that existing research primarily focuses on conceptualizations of space planning, case studies of newly built libraries at individual universities, and comparative analyses of newly constructed library buildings across different regions. For instance, Xiao Long's "Library Space Functions and Layout Design in the Post-Digital Library Era" [3] explores spatial development trends and layout planning. Chen Wei's "Research on the Design of New Library Service Functions and Spatial Layout—A Case Study of the New Qinghai University Library" [4] and Liu Shaorong's "Design of User Flow in

University Library Spatial Layout—A Case Study of Hebei Normal University Library" [5] both use library construction cases to discuss spatial layout design. Cheng Junying et al.'s "Research on New Space Planning in University Libraries—Based on a Survey of New Spaces in Fudan University Library" [6] and Pan Ying et al.'s "Research on Spatial Function Layout of University Libraries in the Digital Environment—Taking Newly Built Libraries in Beijing, Jiangsu, and Shanghai as Survey Objects" [7] are both based on survey data to analyze spatial planning elements, characteristics, and user needs, exploring new approaches to space planning. These studies demonstrate that university libraries need to analyze domestic and international academic research and cases concerning library service transformation and space reconstruction to identify key factors, consistent directions, and core concepts as theoretical guidance for transformation. Simultaneously, they should explore future library business transformation models centered on these concepts and examine implementation strategies and cases of space reconstruction to help university libraries seek transformation.

Library space reconstruction is a crucial foundation for promoting service transformation, a necessary guarantee for expanding the content and scope of service innovation, and a core system for building new library service values [8]. Therefore, Tongji University Library established a space planning group in 2014 to specialize in space reconstruction work. In spatial planning, the library has consistently adhered to a user-centered approach. Based on sorting out core business processes, it has designed new spatial zones from the perspectives of collection space, service space, and business space, coordinated the reasonable proportion between collection space and service space, and emphasized thematic matching of environments and supporting equipment. This paper employs content analysis, case studies, and survey questionnaires to understand library development trends and user needs, summarizes space reconstruction planning and design methods, and proposes key elements, functional layouts, characteristics, and frameworks for new spatial arrangements based on demand analysis, offering feasible suggestions for the service innovation of Tongji University Library.

2. Analysis of Current Space Planning Status and Necessity

Tongji University Library covers three campuses: Siping Road Campus, Jiading Campus, and Hubei Campus, with Siping Road and Jiading being the main campuses. The library's total building area is 68,000 square meters, with a collection of over 4 million volumes and nearly 6,800 reading seats. The general overview of library space is shown in Table 1 .

Table 1 Overview of Tongji University Library Space by Campus

The current spatial status of Tongji University Library is as follows: (1) Uneven campus distribution: The ratio of library building area and reading seats to student population between Siping Road Campus and Jiading Campus is unbalanced, objectively causing a severe shortage of reading seats at the Siping

Road Campus Library. (2) Lack of personalized spaces: As the library faces increasing demands for personalized reader services, readers at the Siping Road Campus Library have shown growing needs for personalized learning spaces, but the library cannot provide corresponding personalized services due to its own space limitations. (3) High building maintenance costs: As a building with a 50-year history, the Siping Road Campus Library's maintenance issues have become increasingly prominent, including limited elevator capacity and poor performance of reading space facilities, requiring substantial maintenance costs.

In recent years, libraries as learning spaces, information commons, and maker spaces have become hot topics in the library community. Strategic plans for the next 3-5 years from the world's top 100 university libraries all mention spatial planning, with frequently occurring descriptions such as serving teaching and research, being more comfortable, convenient, flexible, intelligent, interactive, communicative, and mobile. University library building construction in the UK and US is adapting to the lifestyle and learning patterns of contemporary university students, conforming to learning-centered education models and the trend of global competition in higher education. In summary, driven by both external environment and internal needs, the necessity for renovating Tongji University Library's facilities has become prominent. In 2014, Tongji University Library established a space planning group, led by the deputy director in charge of operations, specializing in space transformation work. The library has consistently maintained a user-centered approach in spatial planning, designing new spatial zones from the perspectives of collection space, service space, and business space based on core business process analysis, coordinating reasonable proportions between collection and service spaces, and emphasizing thematic coordination of environments and supporting equipment.

3. Space Reconstruction Planning Methods

3.1 Space Reconstruction Planning Demand Analysis Methods

Demand analysis is central to space reconstruction planning. Perfect demand analysis can make planning a strategic and forward-looking programmatic document while avoiding repeated modifications due to inadequate demand verification or insufficient 论证. Based on library space reconstruction practice, we have summarized the most commonly used and typical demand analysis methods, including content analysis, case studies, surveys, and expert consultation. Combined application of these four methods can comprehensively understand development trends and collect user needs. After completing demand collection, repeated verification and user feedback are conducted before finalizing the most effective demand analysis.

3.1.1 Content Analysis Method Content analysis is a research method that primarily uses various documents as research objects, employing natural science research methods to analyze document content and obtain relatively reliable information. Library strategic planning is a programmatic document that

guides library transformation and development to continuously achieve goals. Foreign university libraries attach great importance to strategic planning formulation, and strategic plans of world-renowned university libraries all focus on space as a key component, conducting new spatial organization and planning around service transformation [9-10], emphasizing the construction of open, vibrant, and innovative spaces. Based on strategic planning content analysis to identify strategic priorities, analysis is conducted from collection development, research support, space, exchange and cooperation, etc., to understand future development trends [11-15], as detailed in Table 2 .

Through the above analysis, we can find that elements in foreign university library strategic plans include mission, vision, goals, action programs, etc., fully embodying a user-centered philosophy that emphasizes providing targeted, convenient, and seamless services for different user types. Keywords mainly include: user experience, open access, embedded services, research lifecycle, space, cooperation, etc. This demonstrates the importance of conducting library planning based on user needs, with spatial planning being an important foundation for various library services. There are many typical cases of foreign libraries carrying out space reuse and space-based services, such as the information commons at the University of Sheffield Library, the maker space at Fayetteville Public Library, and the technology and media space at North Carolina State University's Hunt Library [16].

3.1.2 Case Study Method The case study method uses existing library space reconstruction practices as material, employing specific visits, analysis, and dissection to enter specific spaces, establish real feelings, and seek problem solutions. The case study method is the most intuitive, rapid, and typical approach in space reconstruction planning. From 2016-2017, the library space planning group conducted field investigations of nine university libraries in Sichuan, Guangdong, and Hong Kong, all representing cases of newly built libraries or space reconstruction within the past three years, with certain representativeness and innovation. Particularly, university libraries in Hong Kong have relatively advanced concepts in space reconstruction philosophy, supporting furniture and equipment design, and characteristic spaces that are worth learning from [17-18]. Typical case analyses of space reconstruction are shown in Table 3 .

Through field investigation of cases, we can find that newly built university library spaces basically divide spatial layouts according to user needs to support users' research and learning requirements, such as 24-hour learning areas, seminar rooms, and information commons. Simultaneously, they highlight the concept of meeting personalized needs by setting up characteristic spaces and services such as audio-visual rooms, maker spaces, and coffee bars, ultimately forming inspiring and vibrant spaces that are welcomed by users. Library space is also provided as a resource for users to use, and services developed based on needs are more easily accepted by users, such as research consultation services,

learning skills training services, and entrepreneurship training.

3.1.3 Survey Questionnaire Method The survey questionnaire method expresses questions through inquiry, using controlled measurement methods for different users to measure the research problem and collect reliable data. For understanding user needs, the survey questionnaire method should be a relatively reliable approach. Therefore, the library space planning group organized surveys on space needs of teachers and students, with a total sample of 1,287 people, including 15% teachers, 21% graduate students, 57% undergraduates, and 7% international students. We divided users into institutional users and individual users. Institutional users include administrative departments, faculties, student associations, student unions, graduate student unions, etc., while individual users include teachers, graduate students, undergraduates, and international students. Through focus group interviews and questionnaire surveys, we fully understood the space needs of different user types. In focus interviews, heads of institutional users expressed hopes that the library would provide auditoriums for large lectures and spaces for disciplinary achievement displays. Some faculties proposed specialized space needs, such as the School of Media and Communication requesting small music performance venues and spaces for students to complete recording assignments, and the Medical School requesting spaces for medical technology display and experience. Among individual users, graduate students mainly expressed needs for spaces to conduct seminars and team assignments, primarily requiring enclosed seminar spaces; undergraduates expressed greater needs for reading spaces, reading-aloud spaces, and drawing spaces; teachers expressed needs for study rooms (for about 10-20 people) to conduct small-scale tutoring and training for students, as well as spaces for leisure reading or chatting.

Regarding surveys on new library spaces, users showed certain demand levels for new space areas such as self-study areas, reading areas, leisure areas, discussion areas, individual silent study areas, vocal reading areas, laptop-specific areas, and drawing-specific areas, with specific statistics shown in Figure 1 [Figure 1: see original paper]. Overall, institutional users generally use library spaces to hold medium or large-scale activities such as lectures, seminars, training, association activities, art performances, and cultural exhibitions, primarily using auditoriums, exhibition spaces, and large seminar rooms. Individual users generally use library spaces for group discussions, individual study, interactive communication, academic research, and drawing assignments, primarily using reading spaces, small seminar rooms, leisure spaces, and reading-aloud spaces. In service delivery, we can adopt different space reservation forms according to different user purposes. For institutional users, libraries currently mostly use venue reservation forms requiring relevant institutional approval and seals. For individual users, reservation systems are currently used, including existing seminar room reservation systems and seat management machine reservation systems, which are very convenient, fast, and easy to operate. In the future, a library space reservation platform could be established to integrate all applica-

tion processes into one network platform based on user types and space types, improving efficiency.

3.1.4 Expert Consultation Method The expert consultation method seeks expert opinions and positions on objective matters or issues, using sufficient and powerful evidence to directly prove viewpoints from the positive side. Consulting expert opinions on library space planning is a very effective method. The space planning group generally invites experts from Tongji University Architectural Design and Research Institute to participate in spatial layout and design during the early stages of space design. During space reconstruction, regular expert consultation meetings are organized. The library proposes specific space reconstruction needs based on actual conditions, including space functions, people flow, environmental themes, etc. Experts then design spatial layout drawings based on experience, and through repeated on-site verification, effective space planning schemes are finally formed.

3.2 Analysis of Key Elements in New Space Layout

In the digital environment and with the needs of "Double World-Class" construction, libraries have evolved from service systems focusing on documents to service systems focusing on users. Space services have become composite services integrating space, technology, equipment, and people, aiming to provide venues for user learning, research, communication, and innovation. Through demand analysis, we can see that future library space functional layout development trends have the following characteristics: (1) compressing collection space and increasing new types of spaces that support user learning, communication, and interaction; (2) spatial layout development trends moving from static to dynamic, interactive, multifunctional, and thematic; (3) library businesses closely connected with users gradually integrating into user service spaces, forming a five-in-one hybrid space service model that integrates academic research, learning support, information sharing, communication and interaction, and social leisure. The key elements of new space layout are shown in Table 4 .

3.3 Library Space Planning Layout Framework

After future library service innovation and business transformation, user orientation will be the philosophy of space services. With everything centered on users, the basic principles of new space layout include: (1) User convenience principle: adhering to the core concept of user service orientation, considering the usage habits of various users, and improving their convenience in obtaining services. This means placing businesses with high user frequency on lower floors, closest to users, and easiest to find. (2) Business interaction convenience principle: placing 相关业务 that need cross-interaction on the same floor or nearest locations to facilitate business interaction. Simultaneously, library business spaces should be embedded into collection spaces and service spaces to provide services to readers at the first time. (3) Multifunctional principle: implementing

multiple service contents in some spaces to maximize space utilization, providing one-stop services, minimizing user movement time between business areas, and improving service experience. (4) Quiet-noisy zoning principle: separating quiet learning areas from discussion areas, exchange areas, and other noisy spaces to meet the needs of different users. (5) Modular zoning principle: spaces should emphasize openness, flexibility, and autonomy, allowing rapid modular combination according to user needs to achieve diversified service functions.

User-based library space planning (see Figure 2 [Figure 2: see original paper]) can be analyzed from the perspectives of collection layout, service support, and business processes, dividing space into three types: collection space, service space, and business space, which are complementary and interconnected. Collection space and business space should both support service space, reducing collection space area, expanding user service space area, and embedding business space into user service spaces. New spaces should be a comprehensive space service system, providing one-stop, integrated spaces that combine resources, knowledge, services, technology, and culture, emphasizing user experience, cooperation, communication, creativity, and innovation. Space-based services have become one of the important service models for future libraries.

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Author Contribution Statement

Shi Yanfen: Responsible for overall framework design and writing of the entire paper.
Xu Zhongming: Responsible for overall conception of space planning methods and framework content in the paper.
Xu Yonghua: Responsible for writing space planning and layout content in the paper.

University Library Space Planning Method: Taking Tongji University Library as an Example

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Abstract: [Purpose/significance] Under the background of "Double World-Class," the basic elements of university libraries—"people, resources, and space"—have undergone major changes. Tongji University Library has explored library space planning strategies based on user needs to provide support and feasible solutions for library service innovation and business transformation. [Method/process] This paper explores library space planning and design requirement analysis methods. Through content analysis, case studies, and survey questionnaires, it examines library development trends and user needs. Based on demand analysis, it proposes key elements, functional layouts, characteristics, and frameworks for new spatial arrangements, offering feasible suggestions for the innovative development of Tongji University Library. [Result/conclusion] Space service has become an important service model for future library development. Exploring university library space planning methods and key elements, and proposing a user-based space planning framework, helps promote library service innovation capabilities.

Keywords: library, space planning, spatial layout, key elements

Note: Figure translations are in progress. See original paper for figures.