An Empirical Study on Spatial Cognition in University Libraries from a Stakeholder Perspective: Postprint

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Abstract

[Purpose/Significance] This study aims to understand librarians' and readers' perceptions of library space, providing reference and guidance for university library space renovation practices. [Method/Process] Employing interview and questionnaire survey methods, the research investigates perceptions of library space among librarians and readers from university libraries in Guangdong Province. From a stakeholder perspective, it comprehensively utilizes research methods including literature review, interdisciplinary research, statistical analysis, and descriptive analysis to examine their perceptions and differences regarding library space evaluation, space requirements, and space renovation. [Results/Conclusions] Both librarians and readers generally recognize the value and functions of library space. Readers believe that library space should possess attributes such as socialization, discussion, and self-study. Librarians advocate for establishing group (team) study spaces and providing diversified space services. Their spatial perceptions exhibit distinct differences while complementing each other, collectively constituting and refining the direction and path for library space renovation.

Full Text

An Empirical Study on Spatial Cognition of University Libraries: From the Perspective of Stakeholders

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Abstract: [Purpose/Significance] This study aims to understand librarians' and readers' cognition of library space, providing reference for university library

space renovation practice. [Method/Process] Using interview and questionnaire methods, this paper investigates the spatial cognition of librarians and readers in university libraries across Guangdong Province. From the perspective of stakeholders, it comprehensively employs literature investigation, interdisciplinary research, statistical analysis, and descriptive analysis to examine their cognition and differences regarding library space evaluation, space demand, and space transformation. [Result/Conclusion] Both librarians and readers generally agree on the value and function of library space. Readers believe that library space should have attributes of social interaction, discussion, and self-study, while librarians advocate establishing group (team) study spaces and providing diversified space services. Their spatial cognition differs yet complements each other, jointly constituting and improving the direction and path of library space renovation.

Keywords: university library; spatial cognition; stakeholders
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With the academic community's increasing recognition and emphasis on the value of library space in recent years, research on university library space renovation and transformation has attracted widespread attention and discussion. These discussions generally agree that the core issue of current research on library "space turn," "space renovation," and "space reconstruction" is to build a new cognitive system for library space [1-2]. At present, academic cognition of library space transformation mainly includes three perspectives: (1) Leisure space perspective, which advocates providing recreational spaces such as tea rooms, coffee shops, and cultural leisure bars to attract users into the library [3-4]; (2) Collaborative space perspective, which suggests using cooperative operation models like "library + bookstore" to achieve mutual promotion and common development among multiple parties [5-7]; (3) Learning space perspective, which advocates integrating service concepts such as "smart library services" [8-9] to establish diverse learning spaces like "maker spaces" [10-11], "multidimensional cultural spaces" [12], and "active learning spaces" [13], enabling library space transformation and services to return to human-centered knowledge learning and safeguarding the spatial interests of ordinary users and disadvantaged groups [14]. These research perspectives provide rich theoretical guidance for library space renovation but to some extent neglect the importance of spatial cognition among stakeholders such as librarians and readers. On one hand, librarians' spatial cognition influences the content and scope of their services to some extent; on the other hand, readers' cognition of library space determines whether they will seek services from the library when certain needs arise (such as knowledge needs, social needs, and entertainment needs). Based on this, some researchers have begun to incorporate readers' spatial cognition into their studies. For example, Yan Dayuan and Zhang Xiaoying investigated the usage habits and cognitive status of readers at H University through questionnaire surveys, finding

that users primarily view university libraries as learning venues and information query places, followed by social venues, and finally leisure venues [15]; Xiao Ping and Yang Xiaona proposed in their study on users' willingness to use information commons in university libraries that differences in users' spatial cognition significantly affect usage intention [16]; other scholars such as Wang Jing and Lu Yonghong analyzed the cognitive status of library internal spaces using schema models and linguistic models [17], and examined the cognition of communication spaces in university libraries under the digital background [18]. However, overall, existing research and surveys on spatial cognition are mostly limited to readers' spatial cognition, neglecting the specific spatial cognition and service demands of other important spatial stakeholders such as librarians. Therefore, this paper analyzes the classification of major stakeholder types in library space, investigates the spatial cognition of librarians and readers—the two main stakeholder groups—in selected university libraries in Guangdong Province through interviews and questionnaires, and uses SPSS analysis software and descriptive analysis to examine their cognitive differences, aiming to provide reference for library space renovation and transformation.

This study is one of the research outcomes of the National Social Science Fund General Project "Research on University Library Space Renovation and Evaluation Based on User Behavior" (Project No.: 17BTQ018).

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3 Questionnaire Design and Survey Respondent Demographics

3.1 Questionnaire Design

Based on perspectives from cognitive psychology, library spatial cognition is an internal cognitive process driven by the psychological activities of spatial stakeholders when they process and manipulate information about the library space environment—a systematic information processing procedure occurring between input and output. In empirical research, observation, interview, and questionnaire methods are typically used to collect information for analysis. Therefore, this study primarily employs interview and questionnaire methods to investigate the spatial cognition of librarians and readers in selected university libraries in Guangdong Province. Building on the research group's previous studies, practitioners and experts in this field were invited to revise questionnaire items multiple times. The final questionnaire on spatial cognition for librarians and readers was developed from dimensions including library space value cognition, space renovation cognition, and space demand cognition. The questionnaire consists of two parts: The first part covers personal information: the librarian questionnaire includes 7 items (gender, age, position, years of service, workplace, and nature of institution); the reader questionnaire includes 6 items (gender, education level, major, library usage frequency, purpose, and duration of stay). The second part is the library space cognition evaluation questionnaire, com-

prising 12 items covering agreement levels with statements such as libraries as important "third spaces," reducing paper collections, providing diversified space services, designing library space based on student needs, establishing (group) learning research spaces, social spaces, and 24-hour self-study rooms.

3.2 Overall Survey Respondent Analysis

From late 2018 to early 2019, I conducted interviews and distributed questionnaires to librarians and readers in selected university libraries in Guangdong Province, collecting 209 valid questionnaires—117 for librarians and 92 for readers. To ensure data reliability and validity, Cronbach's alpha coefficient methods were used to test the reliability and validity of questionnaire items, indicating that the questionnaire has certain credibility and reference value.

3.2.1 Respondent Gender A series of studies on gender differences in psychology have shown that males outperform females in spatial cognition abilities during youth or adulthood [22], indicating that gender differences among stakeholders also affect their spatial cognition. Survey data shows that female respondents outnumbered male respondents, with female readers accounting for 66.3% of total readers and female librarians accounting for 65.81% of total librarians. However, the gender difference in the sample is not substantial, allowing for a better revelation of overall spatial cognition levels between librarians and readers.

3.2.2 Respondent Identity and Role Early life experiences and knowledge structures affect individuals' cognitive processing, causing varying degrees of cognitive bias [23]. Therefore, studying spatial cognition of specific populations requires understanding their identity and role. The survey reveals that readers were primarily undergraduate students (98.91%), who share common knowledge backgrounds and learning experiences, thus obtaining relatively consistent impressions and cognition of library space. Among surveyed librarians, ordinary staff accounted for the largest proportion (44.44%), followed by directors and deputy directors (28.2%) and department heads (25.64%). This relatively balanced position distribution provides a good research foundation for understanding librarians' spatial cognition.

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4 Spatial Cognition of University Library Stakeholders

Librarians and readers are the most important spatial stakeholders, and their cognition of library space serves as the basis and reference for library space renovation practice. By analyzing questionnaire items on library space renovation cognition (questions 3, 4, 7, 8, 9, and 12), librarians' cognition of library space renovation is found to manifest in several aspects:

4.1 Librarians' Evaluative Cognition of Library Space

Librarians' evaluative spatial cognition is a psychological cognition formed based on cognitive information such as vision, perception, attention, and short-term memory that the library space provides and can be processed by their brain's processing systems. According to Lazarus's appraisal theory, evaluative cognition always plays a crucial role in emotional experience, meaning that appraisal factors are key determinants of emotional experience [25], thus enabling librarians' spatial evaluative cognition to influence the quality and level of user information services they provide based on space and offering reflective significance for library space renovation. Analysis of relevant questionnaire items on librarians' spatial evaluation reveals their evaluative cognition as shown in Figure 1 [Figure 1: see original paper].

As shown in Figure 1, librarians show high agreement (agree or above) with the cognitive views that libraries serve as important "third spaces" (94.03%) and "service content" (90.59%). However, some librarians remain uncertain about space layout and attractiveness, believing that their library's spatial layout is unreasonable. This indicates that in librarians' spatial cognition, university library space plays an important role but still needs further improvement in spatial layout to become a comfortable and attractive place. Part of the reason for this cognition may be due to professional sensitivity, which also highlights the urgency and necessity of library space renovation.

4.2 Librarians' Renovation Cognition of Library Space

Surveyed librarians came from libraries of undergraduate institutions, vocational colleges, and independent colleges in Guangdong Province (see Table 2), with most librarians (64.6%) having 16 or more years of library work experience and possessing a solid foundation in library space practice.

4.2.1 Providing Diversified Space Services and Establishing 24-Hour Self-Study Rooms In this survey, 62 librarians strongly agreed (very much in favor) that libraries should provide diversified space services, accounting for 52.9% of all librarians; 45 librarians agreed with this view, accounting for 38.4%. This shows that "providing diversified space services" has become an important consensus among librarians regarding library space renovation direction. However, establishing 24-hour self-study rooms received considerable skepticism and opposition from librarians, with nearly 29.05% expressing doubt and uncertainty, and 23.9% opposing (disagreeing or strongly disagreeing) this practice. Some librarians' uncertainty and opposition stem from their belief that 24-hour self-study rooms should be the responsibility of the university classroom management center.

4.2.2 Reducing Paper Collections and Designing Based on Student Needs The survey found that over 40% (41.8%) of librarians believed libraries should reduce paper collections, while over 30% (31.6%) disagreed with this

approach, indicating inconsistent and divided opinions among librarians on reducing paper collections. Meanwhile, 25.6% of librarians strongly agreed that library space layout design should be based primarily on student needs, and 61.53% agreed with this view, showing that "designing based on student needs" should become one of the important principles to follow during space renovation.

4.2.3 Establishing Group (Team) Study Spaces and Social Spaces Establishing interactive discussion spaces is currently an important component of university library space construction in China, with Tsinghua University Library, South China Normal University Library, and East China Normal University Library having made extensive practical explorations in this area. This approach has also received approval from the vast majority (95%) of surveyed librarians. However, regarding transforming libraries into social spaces for readers, while 76.06% of librarians supported it, a certain proportion (23.94%) expressed doubt, disagreement, or strong opposition, indicating that the social attribute of library space has not been highly recognized by librarians.

4.3 Readers' Evaluative Cognition of Library Space

Readers' spatial cognition is often defined as a cognitive process of acquiring, organizing, and utilizing the spatial structure of the external environment and the relationships among objects within it [26]. Readers' unique spatial experiences form evaluative spatial cognition, which is the dominant factor influencing this cognitive process and an important basis for libraries to renovate their spatial layout and enhance user experience. Statistics on the reader spatial evaluation portion of the questionnaire show results as in Figure 2 [Figure 2: see original paper].

As shown in Figure 2, readers strongly identify library space as an important "third space" (82.84%) and service content (89.01%) beyond "dormitory" and "classroom." They also relatively agree that library space layout is reasonable (53.01%) and comfortable and attractive (67.41%). These results suggest that libraries need to construct service spaces that better match reader needs and enhance user experience to align with readers' recognition of library space value. Additionally, combined with survey results on readers' space usage (see Table 3), library space environment and atmosphere have become important factors affecting readers' usage frequency and duration. Research indicates significant positive correlation between usage frequency, average duration of stay, and users' cognition of libraries as learning spaces [15]. This reveals readers' cognitive path regarding library space: library space configuration conditions → reader usage frequency and duration → reader spatial cognition, meaning that library space configuration conditions form the basis for readers' spatial cognition.

4.4 Readers' Demand Cognition of Library Space

Zhang Zhizhong pointed out that in constructing university town libraries, more attention was paid to architectural appearance while neglecting actual users, re-

sulting in libraries that cannot well adapt to usage needs [27]. Therefore, it is urgent to understand readers' specific spatial demand cognition to provide reference for library space renovation. Through analysis of survey results, readers' demands for library space mainly concentrate in three aspects: social space demand, discussion space demand, and self-study space demand.

4.4.1 Social Space Demand The survey found that 45.05% of students agreed that university libraries should become social spaces for readers, with 8.79% strongly agreeing, while only 14.29% disagreed, indicating that readers believe libraries need to provide spatial support and environmental conditions for their social activities. This suggests libraries need to reposition and examine the social value of library space as a resource platform, conducting more construction, renovation, and innovation of library physical and virtual spaces based on social interaction, binding services with social interaction and transforming resources into knowledge [28].

4.4.2 Discussion Space Demand Among surveyed readers, 38 readers (41.76% of total readers) agreed that university libraries should establish group (team) learning and research spaces, and 18 readers (19.78%) strongly agreed, showing that readers have certain demands for discussion spaces. Therefore, libraries need to assess users' learning needs to adapt space design to users' changing demands, making libraries valuable informal learning spaces [29].

4.4.3 Self-Study Space Demand Investigation of readers' space utilization purposes found the top four purposes were self-study (75%), borrowing books (16.3%), finding materials (6.52%), and internet access (2.17%). Combined with the fact that most readers (41.76%) supported establishing 24-hour self-study rooms, self-study space demand has become an important reader demand for library space. Libraries should attach importance to this demand and satisfy it by establishing various types of self-study spaces.

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5 Cognitive Differences Among University Library Spatial Stakeholders

5.1 Descriptive Analysis of Spatial Cognitive Differences

Librarians and readers are the two core stakeholder groups in library space, and their cognition of library space serves as the basis and reference for library space renovation practice. Based on questionnaire survey results, this paper presents the overall cognitive situation of both groups regarding library space evaluation cognition and renovation cognition, as shown in Figure 3 [Figure 3: see original paper].

Figure 3 shows the first and second items list librarians' and readers' cognition of library space value: both strongly agree that library space is an important

"third space" and service content, showing positive attitudes toward spatial significance. The third and fourth items list both groups' cognition of current library space status: both believe library space has unreasonable layout issues and needs replanning to enhance comfort and attractiveness. These findings differ somewhat from other scholars' research conclusions [30], possibly because university libraries are at different development levels.

Regarding library space renovation cognition, librarians and readers show different attitudes toward different renovation approaches: (1) "Reducing paper collections" received strong opposition from both groups, with readers showing even stronger opposition; (2) Regarding "establishing 24-hour self-study rooms," most librarians expressed uncertainty or opposition, while the vast majority of readers expressed support, showing obvious conflict and even opposition between the two groups; (3) "Providing diversified space services" and "designing based on student needs" received high approval from both groups with little cognitive difference; (4) Regarding "establishing group learning and research spaces" and "becoming social spaces for readers," both groups relatively agreed, but librarians showed more obvious support.

5.2 Statistical Analysis of Spatial Cognitive Differences

To understand cognitive differences between librarians and readers regarding library space, simple descriptive statistics are insufficient; certain mathematical statistical methods are needed to explore reasons behind phenomena and reveal potential relationships among variables [31]. This paper uses SPSS software to analyze cognitive differences between librarians and readers regarding space evaluation cognition and space renovation cognition.

5.2.1 Space Evaluation Cognitive Differences To examine and compare differences in space evaluation cognition between librarians and readers, this study investigates four dimensions: libraries as important "third spaces," service content, reasonable space layout, and attractiveness, as shown in Table 4 .

Table 4 shows that both groups' mean scores for the first two dimensions are below 2.0, while the latter two dimensions have means above 2.0, indicating that both groups recognize library space value but are dissatisfied with current space status. Both groups have a mean score of 1.56 for the second dimension with standard deviations around 0.8, showing no significant difference in cognition of "space as important service content"—their evaluative cognition is basically consistent. However, there is a certain gap in mean scores for the first dimension, indicating cognitive differences regarding "libraries as important 'third spaces'."

5.2.2 Space Renovation Cognitive Differences As libraries are important links connecting users and services, university libraries must continuously renovate their physical spaces to meet stakeholders' spatial demands. Based on interview and questionnaire data, SPSS software was used to analyze cognitive

differences between librarians and readers regarding six library space renovation approaches, as shown in Table 5 .

Analysis of Table 5 data reveals that librarians' and readers' cognition of library space renovation shares commonalities and differences. Both groups consistently agree on reasonable renovation approaches such as "space service diversification" and "designing based on student needs." Both disagree with "reducing paper collections," with readers more inclined to view libraries as important places for preserving paper collections. Regarding "establishing 24-hour self-study rooms," readers unanimously agree while librarians show low agreement, because the two stakeholder groups have different interests: readers need quiet study spaces with sufficient time due to academic pressure, while librarians worry about student safety and duty responsibilities.

To further illustrate the degree of cognitive differences between librarians and readers regarding these six renovation approaches, one-way ANOVA analysis was conducted on relevant items, with results shown in Table 6 .

Table 6 shows that at the 0.05 confidence level, librarians and readers have significant cognitive differences in the six dimensions, with difference degrees ranked as: dimension 2 > dimension 3 > dimension 6 > dimension 4 > dimension 1 > dimension 5. Specifically, designing based on reader needs and providing diversified space services received high agreement from both groups. However, the two groups had major disagreements about increasing space capacity by reducing paper collections. These conclusions are consistent with previous analyses.

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6 Reflections and Recommendations

6.1 Focus on Stakeholders' Demand Motivation and Behavioral Experience

As analyzed above, library spatial stakeholders' demand cognition mainly manifests in readers' demands for social discussion and self-directed learning, and librarians' demands for work-leisure balance and self-development. These demand motivations are the foundation and basis for libraries to redesign their resource spaces, research spaces, and public activity spaces, and represent the proper meaning of building "third-generation university libraries" [32]. Examining space service development trends from the perspective of reader and librarian demand cognition, library space will be a "dynamic pluralistic space" [33]. Because no single type of space can meet all user needs or suit various activities, successful library spaces are constantly changing [34]. Future library spaces will inevitably have multiple dimensions of value including resource preservation, social sharing, self-study discussion, and innovation cooperation. The overall development trend is to continuously incorporate various elements conducive to readers' personal development while ensuring sufficient paper collections, transforming library space into a growing organism that serves higher education,

promotes knowledge flow, and supports teaching, research, and talent cultivation.

Furthermore, we must recognize that library "space renovation" is a creative activity that is both rational and emotional, based on users' spatial awareness and cognition, centered on spatial needs and motivations, and encompassing multiple factors including physiological, psychological, material, and spiritual aspects of stakeholders such as librarians and readers. Therefore, focusing on users' spatial utilization demand motivation, behavioral experience, and changing trends is always the core link in library space renovation and space services. Libraries must not only meet users' requirements for convenience, comfort, safety, privacy, and confidentiality during usage, but also examine and arrange details such as appropriate lighting, noise isolation, overall color, furniture materials, smell, temperature, and ventilation with professional vision. They should also strengthen readers' spatial cognition education, improve evaluation and assessment systems for readers' spatial utilization behavior, and accelerate the mining and application of user spatial behavior data to establish library spaces that meet stakeholders' needs.

6.2 Strengthen Interaction and Communication Among Spatial Stakeholders

Space-based services are one of the important service contents for future libraries. University library space is not only the physical foundation and practical cornerstone for librarians to carry out office service activities but also the venue for readers to achieve knowledge learning, information retrieval, leisure and entertainment, group research, and social activities. Combining this survey's results, in the shared cognition of librarians and readers, establishing various learning spaces such as group learning and research spaces and 24-hour self-study rooms, as well as providing diversified space services, will not weaken the traditional status of university libraries as resource centers but will highlight the importance of libraries as "third spaces" and "important service content." Regarding establishing 24-hour self-study rooms, although this aligns with readers' needs and cognition, it has not gained librarians' recognition. Therefore, libraries need to strengthen communication and interaction between the two groups, enhance mutual trust and understanding to meet their common spatial interests, and achieve mutual promotion and common development.

Establishing correct cognition of library space is the ideological foundation for space renovation [35]. In practice, because different types of universities have different positioning and development levels, and libraries differ in funding, scale, resources, and environment, librarians and readers as spatial stakeholders have varying degrees of differences in spatial cognition and evaluation across different institutions. This requires us to help librarians and readers form spatial cognition that matches actual library conditions when conducting space renovation practice, and to build library spaces that align with the shared spatial cognition of stakeholders. Additionally, libraries should fully consider users'

demands and opinions during space construction, attracting readers to participate in the library space renovation process through measures such as holding symposiums for different stakeholder groups, broadening channels for collecting reader opinions, and organizing library space design competitions for all faculty and students, while fully balancing and coordinating the spatial interest demands of librarians and readers to enable users to obtain good spatial utilization experiences.

6.3 Enhance Professionalism and Targeting of Library Space Configuration

In the past two to three decades, most university libraries in China have built new and larger facilities, showing an overall trend of expanding area. Statistics show that by 2017, the total area of university library buildings in China had reached 19.617 million square meters, with an average of 25,200 square meters per library. The total building area of libraries at Shandong University, Sun Yat-sen University, and Xiamen University all exceeded 100,000 square meters [36]. Combined with the aforementioned shared cognition that library space is an important third space and service content, compressing collection space and expanding discussion space is a common trend in university library space renovation in China. However, the transplantation of space names, configurations, and functions by active contractual spatial stakeholders during renovation has led to weak targeting of equipment configuration in renovated spaces, limited service efficiency, and homogenization.

Libraries should fully understand users' cognitive levels and professional needs during preliminary research for space renovation, and accordingly configure specialized service supports and facilities for various disciplines and faculty-student groups. For example, Wuhan University Information Branch Maker Club provides users with VR experience equipment and various VR resources: games (shooting, flight, etc.), videos (various formats of 3D videos, 360-degree videos, etc.), sports, and intelligence categories. Other renovated spaces also provide specialized computers, large tablet computers, and touch-screen computers for professional design and processing of graphics, images, and videos. Additionally, libraries can appropriately place colorful, variously shaped and textured, and pleasantly scented plant communities to provide comfortable spatial environments for users' dining, rest, and leisure and entertainment.

6.4 Strengthen Organization, Coordination, and Management of Renovated Library Spaces

Library space is an important link connecting resources and user services, independent of library "resources" and "people," and should be specially organized, coordinated, and managed. In terms of management methods, Chinese university libraries currently mainly use "space reservation management systems" for comprehensive organization, coordination, and management of renovated space usage, supplemented by other space service and management methods (WeChat,

mobile apps, on-site form filling, reservation machines, etc.) for networked coordination and management. Readers can access the library's official website or directly log into the "Library Space Management System" to make various forms of information commons reservations. Applicants or reservation group members swipe cards at access terminals within specified time limits or sign in at duty desks to receive keys and enter shared spaces, where they can freely engage in open interaction, communication and sharing, discussion and cooperation, and academic research.

These space user management systems provide excellent management tools for library space utilization and management. In the next stage, libraries should also enrich functional designs of space reservation systems, provide more personalized and user-need-specific characteristic service content (such as viewing real scene pictures and facility configurations of spaces, reserving one-on-one librarian services, applying for professional equipment, space screening and searching, etc.), conduct integrated comprehensive management based on user behavior characteristics and patterns, and improve user space utilization efficiency by providing detailed opening hours, utilization requirements, usage policies, and usage process assistance for each space, thereby enabling users to obtain good space usage experiences and promoting efficient and orderly utilization of renovated spaces. Additionally, allocating responsibilities and coordinating among various departments and positions within the library, and organizing and establishing sound space management systems and mechanisms are particularly important for ensuring orderly and efficient utilization of renovated spaces and should receive continuous attention and maintenance throughout the entire process.

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