

Postprint of the Integration Study on Knowledge Flow in Discipline Service Systems Based on Dissipative Structure Theory

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Abstract

[Purpose/Significance] To analyze the dissipative structure characteristics of library subject service systems and discuss strategies for enhancing system dynamic equilibrium.

[Method/Process] Based on dissipative structure theory, we propose strengthening the functions of openness, self-organization, synergy, and innovation in subject service systems to ensure effective knowledge flow and integration under non-equilibrium states.

[Results/Conclusion] Through in-depth analysis and research on the dissipative structure and characteristics of subject service systems, this can effectively guide subject service practices, service expansion, and service innovation.

Full Text

Research on Knowledge Flow Integration in Subject Service Systems Based on Dissipative Structure Theory

Abstract:

[Purpose/Significance] This paper analyzes the dissipative structural characteristics of library subject service systems and discusses strategies for strengthening system dynamic equilibrium. [Method/Process] Based on dissipative structure theory, it proposes enhancing the functions of openness, self-organization, coordination, and innovation in subject service systems to ensure effective knowledge flow and integration in non-equilibrium states. [Result/Conclusion] Through in-depth analysis and research on the dissipative structure and characteristics of subject service systems, we can effectively guide subject service work and promote service expansion and innovation.

Keywords: dissipative structure, subject service system, knowledge service, knowledge flow, knowledge integration, university library

Classification: G250

Subject services refer to high-level services provided by libraries to meet the needs of scientific research users or the teaching, research, and learning needs of university faculty and students, including various knowledge push services and intellectual assistance. These services constitute the main content of information services and human resource development in research libraries.

Current practice and research on subject services in Chinese university libraries have mainly focused on: (1) exploring service forms, such as one-stop services, embedded services, virtual platform services, personalized services, and team services; (2) exploring service content, such as providing personalized information consultation, literature organization, knowledge transfer, and subject-specific research support based on library collections [1]; (3) examining human resource aspects, including the required competencies of subject librarians, basic service skills, and knowledge discovery and integration capabilities; (4) investigating user-related aspects, such as subject user needs, mutual trust and communication between users and librarians, and knowledge flow and sharing between users and subject librarians; and (5) discussing knowledge management in subject services. Although these studies touch upon subject service systems and knowledge flow/integration, a deeper investigation through the lens of dissipative structure theory is needed. Such research offers valuable reference for libraries in establishing and managing subject service teams, and is significant for integrating internal and external subject service resources to promote knowledge flow, integration, and service innovation within subject service systems.

2. The Dissipative Structure of Subject Service Systems and the Connotation of Knowledge Flow Integration

2.1 The Dissipative Structure of Subject Service Systems

Dissipative structure theory is used to study how changes in relevant conditions affect the development trends of an open system. Such systems can be found in both natural and social sciences. The formation of a dissipative structure depends on several key conditions: being far from equilibrium, openness, nonlinear structure, and fluctuation. For an open system far from equilibrium, when a major condition changes or is influenced by external factors, non-equilibrium changes are propelled through fluctuations of varying magnitude, causing the system to transform from a chaotic, disordered state to a new ordered state, or from a lower-order state to a higher-order state [2], ultimately maintaining relative balance and stability.

Library subject services primarily manifest through sufficient communication between subject users and a particular subject librarian or team, where the librarian or team employs effective methods to promptly discover relevant in-

formation clues or knowledge for users. This includes providing literature investigation and organization for project proposals, knowledge transfer and integration throughout the research process, and social demand information for later-stage achievement transformation. This represents the main form of library knowledge services, with distinct intellectual and social characteristics. Subject services can operate as individual or team-based systems, with internal elements that are interrelated and work together. However, due to various influencing factors—such as insufficient knowledge and intellectual resources, inadequate professional knowledge among subject librarians and slow supplementation of interdisciplinary knowledge, information loss and misinterpretation of user requirements, repetitive and tortuous service workflows, and delays in coordination—the system may experience slowdowns, creating fluctuations or perturbations. To enable rapid adaptation to new changes, demands, and situations, the system must quickly coordinate during fluctuations, promptly adjust internal elements and structures, continuously enhance various dynamic factors and their mutual support, constantly absorb relevant resources and energy from external sources, and continuously improve the service system or pattern to form a new relatively balanced and stable subject service system. Evidently, subject service systems exhibit open characteristics, exist far from equilibrium, and feature nonlinear interactions and fluctuations, making them open systems that conform to dissipative structure theory.

2.2 The Connotation of Knowledge Flow and Integration in Subject Service Systems

Knowledge integration in subject service systems involves using scientific methods, centered on the core knowledge of the subject service team, to cross-fuse and reconstruct the flow paths and content of internal and external knowledge. System knowledge includes internal individual knowledge, team knowledge, external expert knowledge, user knowledge, and broader external knowledge. Essentially, knowledge integration encompasses multi-level knowledge flows and cross-fusion among subject librarians, subject teams, subject users, and relevant campus and external resources. This dynamically fused knowledge serves as a crucial driving force for system development and service quality improvement.

3. Analysis of Dissipative Structure Characteristics and Knowledge Flow in Subject Service Systems

3.1 Openness of Subject Service Systems and Knowledge Entropy Change

Subject service systems are inherently open. Subject services typically focus on new tasks from subject users as nodes and objectives for knowledge exchange, thereby establishing extensive connections both within and outside the system. Whether among subject librarians, between various subject service teams, or between the subject service system and other external individuals or systems,

internal and external communication occurs, creating information flow that promotes the exchange and sharing of knowledge and energy within and outside the system. This inherent openness provides platforms and channels for knowledge flow among all relevant elements during service delivery, enabling continuous inflow of necessary knowledge and energy into the system. Through absorption and integration by librarians and teams, this increases knowledge negative entropy and gradually moves the system toward new balance and stability.

Subject service systems are also open in terms of resources. To facilitate better understanding and selection of library subject service projects by users, dynamic resources such as information resources, human resources, methodological tools, and intellectual resources must be open to subject users. Subject librarians themselves must continuously learn new knowledge to adapt to disciplinary development. Simultaneously, to meet diverse user needs and provide better services, the system must constantly adjust its internal and external resources and strengthen the input of external information and intellectual resources to alter internal knowledge entropy changes.

Therefore, subject service systems are continuously open, with objective and subjective connections to the external world, making knowledge entropy changes likely at any time. To maintain dynamic balance, knowledge flow through open channels is essential to change the system's total entropy.

3.2 Far-from-Equilibrium State and Knowledge Complementarity in Subject Service Systems

In constantly evolving social demand and knowledge environments, subject service systems must change and develop due to various destabilizing internal and external factors, such as imbalances between user needs and resource support, imbalances between subject service capabilities, and mismatches between interdisciplinary user demands and cross-disciplinary team integration. These imbalanced factors continuously disrupt the system's original balance and stability, compelling it to acquire, exchange, and supplement resources, knowledge, and energy from external sources to transition from a newly departed equilibrium state toward a new balanced state.

Within subject service systems, subject librarians and teams exhibit significant variations in disciplinary knowledge reserves, creating inconsistencies that can lead to knowledge entropy increase and temporary far-from-equilibrium tendencies. Since these elements intersect and connect during service processes, knowledge complementarity among librarians can provide temporary relief. However, once the far-from-equilibrium state becomes pronounced, complete contradictions and interactions emerge among all internal and external elements, making knowledge flow more frequent and rapid. These dynamics promote knowledge complementarity and sharing among librarians, between users and librarians, and among teams, ensuring smooth service delivery and knowledge innovation. Therefore, it is necessary to continuously cultivate environments for knowledge

flow and complementarity, improve various unstable factors, tap into intellectual resources and latent user needs, and increase dynamic factors to enhance knowledge flow and complementarity, driving the subject service system toward new ordered states.

3.3 Nonlinear Characteristics and Knowledge Coupling in Subject Service Systems

The degree of association and interaction among internal and external elements in subject service systems constantly changes, often evolving from simple, logically corresponding relationships into complex, variable coherent associations and nonlinear relationships. These elements mutually disturb, depend on, and constrain each other, which may temporarily create imbalance and negativity, affecting the system's temporary relative balance and linear change trends. However, from a long-term perspective, the relevant elements and their associative structures will, through continuous openness, self-organization, and coordination, create an environment and operational mechanism for element coupling, generating knowledge coupling that plays a prominent role in propelling the system toward higher-order states [3].

Since subject services are primarily driven by the higher demands of high-level intellectual users, the system imposes more stringent requirements on its internal elements and structures, while external environmental impacts and various demands exhibit greater complexity. When nonlinear complex changes occur—such as between subject librarians and corresponding projects, service items and user needs, or subject teams and disciplinary knowledge—relevant elements and knowledge must interconnect, permeate, complement, and couple. The subject service process requires not only knowledge complementarity and integration but, more importantly, knowledge coupling. Once coupling occurs among relevant elements and knowledge, it generates an overall multiplier effect, driving the system toward higher-order evolution [4], which in turn continuously affects system elements through optimized allocation and structure. Only by continuously creating and improving environments and conditions for knowledge coupling can internal and external knowledge generate continuous coupling and produce nonlinear positive effects that drive the subject service system forward [5].

3.4 Fluctuation Characteristics and Knowledge Innovation in Subject Service Systems

In the far-from-equilibrium nonlinear region, internal elements of subject service systems are often disturbed and decay due to external fluctuations, engaging in resource and energy exchange with the external environment that causes sudden state changes—fluctuation movements that are random and accidental. In the dynamic balance of the existing service pattern, even small fluctuations become amplified through nonlinear effects to adapt to environmental changes, inevitably triggering a significant fluctuation that drives the subject service

system to evolve toward a new balance and order under the positive influence of internal and external dynamic factors.

Subject service work is intellectual labor with strong academic and professional characteristics, requiring profound expertise and rich experience. Even minor gaps with external environments such as disciplinary development and user needs can cause the system to evolve toward temporary instability, creating fluctuations. These fluctuations inevitably induce changes in relevant service elements and knowledge, providing opportunities for intellectual investment and knowledge innovation. Combined with continuous changes in external environmental factors, the system constantly increases knowledge negative entropy, upgrading simple knowledge flow. Particularly when facing interdisciplinary or new fields, cross-integration of internal and external knowledge from various disciplines forms logically coherent and systematic fused knowledge or new knowledge. This drives internal knowledge to flow outward and, when internal knowledge fails to meet user requirements, forces the system to become more open to promptly supplement needed knowledge from external sources. This necessitates timely adjustment of elements that facilitate the absorption of knowledge negative entropy from outside. The more open the subject service system, the more conducive it is to knowledge and energy flow and exchange, resulting in smoother service operations, increasing numbers of subject users, more diverse and continuous user demands, and continuous strengthening of element adjustments and improvements. This accelerates internal and external knowledge flow and promotes round after round of knowledge integration, transformation, and upgrading of the system's integrated knowledge and element structures.

4. Strengthening Knowledge Flow and Integration in Subject Services Based on Dissipative Structure Theory

4.1 Enhancing Required Knowledge Flow Through Opening Subject Service Systems

Due to varying service scope, depth, and methods required by different disciplinary users, the service process involves not only outward flow of internal system knowledge but also forces the system to become more open when internal knowledge fails to match user requirements, aiming to promptly supplement needed knowledge from external sources. This requires timely adjustment of elements that facilitate the absorption of knowledge negative entropy from outside. Greater openness in subject service systems enhances knowledge and energy flow and exchange, resulting in smoother service operations, increasing user numbers, more diverse and continuous demands, and continuous strengthening of element adjustments and improvements. This accelerates internal and external knowledge flow and promotes successive rounds of knowledge integration, transformation, and upgrading of the system's integrated knowledge and element structures.

The openness of subject services determines that they must address not only

the teaching and research needs of internal faculty and students but also the diverse needs of users across all social sectors, particularly providing corresponding services for local technological innovation and regional economic development. During external service provision, bidirectional flow and permeation of internal and external knowledge occur, with subject services delivering knowledge negative entropy to service targets and other external systems while simultaneously introducing knowledge negative entropy from other external systems.

Since subject service content covers all aspects—theoretical and applied, single-disciplinary and interdisciplinary, traditional and emerging fields—and subject librarians constitute a crucial factor in knowledge flow, serving as both disciplinary trackers and project researchers as well as knowledge absorbers and transmitters, more open personnel selection and employment mechanisms are needed to strengthen multidisciplinary, high-level service team construction. Concurrently, combinations of self-improvement and external talent introduction, full-time and part-time librarians, and campus-based and social hiring should be implemented. Inter-university subject service exchange network platforms can also be utilized for resource complementarity and sharing to ensure the inflow, outflow, and integration of relevant knowledge during service processes.

4.2 Promoting Self-Organization and Innovation in Subject Service Systems Through Fluctuations

Subject service systems are constantly affected by internal and external adverse factors, gradually departing from previous equilibrium states and experiencing significant fluctuation movements. This chaotic tendency or unbalanced state caused by internal and external factors is random and temporary. Through timely and effective self-regulation, self-organization, and innovation of elements and structures, along with increased inflow of knowledge negative entropy, the system can be propelled toward new balance and order. Therefore, continuous adjustment of internal structures is needed to strengthen positive and stable elements while eliminating negative and discrete ones, smooth knowledge flow channels, enhance internal and external communication, intensify element coordination, and ensure effective self-organization and innovation.

Differences in subject librarians' self-cognition capabilities and knowledge reserves among various services and teams inevitably generate contradictions and interactions that become fluctuation-inducing factors. Meanwhile, expanding user demands and continuous disciplinary development constitute another major fluctuation-inducing factor. Therefore, we must address self-organization and innovation in subject service systems through several key aspects: (1) Strengthening subject librarians' self-improvement. Asymmetry and asynchrony exist to varying degrees between librarians' and users' professional knowledge, requiring librarians to keep pace with disciplinary frontiers, continuously absorb relevant expertise, and improve their personal knowledge systems. (2) Enhancing the team role in subject services. By fostering a collaborative atmosphere, knowl-

edge flow and sharing among librarians can be promoted, driving team and knowledge reorganization and innovation to better fulfill team functions. (3) Conducting in-depth research and innovating services. Users' emerging new demands represent an inexhaustible driving force for service innovation. Only when user demands continuously change will subject services alter their original models and habits, prompting corresponding improvements or fundamental innovations in system elements and organizational structures, and continuously launching new service projects to meet evolving user needs [6]. (4) Establishing and improving user evaluation and feedback mechanisms. Such mechanisms can both control and evaluate services while promoting continuous summarization and innovation within subject service teams. They enable comprehensive sorting of user suggestions, timely identification of problems and new demands, and serve as effective methods for predicting and adjusting fluctuations.

4.3 Optimizing System Environment to Accelerate Tacit Knowledge Externalization and Sharing

Tacit knowledge is personalized knowledge accumulated by individuals through long-term practice [7], including unique personal experiences, consciousness, metaphors, judgments, tendencies, attitudes, and preconceptions. Such tacit knowledge features privacy, context-dependency, and experiential characteristics, making its externalization, documentation, and preservation difficult—sometimes even inexpressible [8]. Individual tacit knowledge related to subject services can only be discovered, externalized, and mobilized through intimate cooperation and thorough communication and deliberation. Therefore, environments for tacit knowledge exchange must be created and optimized, such as building communication and management platforms, to enhance deep exchanges among subject librarians, between librarians and users, and with experts [9]. Special attention must be paid to the correspondence and non-logical relationships between relevant tacit knowledge and work contexts/task conditions. Advanced tacit knowledge discovery and management tools should be employed to externalize and solidify important tacit knowledge, such as establishing multifunctional tacit knowledge databases and compiling subject service knowledge manuals, ensuring long-term preservation and sharing of relevant tacit knowledge.

In subject service work, sound institutions and a positive atmosphere inevitably stimulate people's enthusiasm and initiative. Therefore, to accelerate tacit knowledge externalization and flow, not only should a climate for tacit knowledge exchange be continuously fostered, but relevant learning incentive and evaluation mechanisms should also be established, such as rewarding individuals who actively share their tacit knowledge. Targeted optimization of personnel, financial, and institutional elements related to libraries and subject services can stimulate subject librarians' subjective initiative in discovering, absorbing, and sharing relevant tacit knowledge [10], enhancing the willingness and motivation of librarians, users, experts, and other stakeholders to present, transfer, and mo-

bilize tacit knowledge, and improving librarians' abilities to accumulate, apply, and innovate with tacit knowledge.

4.4 Promoting Knowledge Integration and Service Innovation Through Exchange and Sharing

Although the various knowledge elements in subject service systems differ in level and capability, they are not isolated or independent but rather interconnected and mutually influential. Consequently, knowledge exchange and sharing between internal and external elements, individuals and teams, occur constantly and everywhere, providing opportunities for knowledge integration. Despite being a highly complex dynamic process [11], cross-fertilization, absorption, fusion, integration, and innovation among subject librarians' personal knowledge, service teams' collective knowledge, users' tacit knowledge, and external relevant knowledge can form or create new types of knowledge.

Therefore, regularly organizing various activities among internal and external subject librarians, subject users, and relevant experts can facilitate timely experience exchange and knowledge flow while promoting interaction and sharing of tacit knowledge, users' latent needs, and related knowledge, enabling maximum fusion and reconstruction with existing system knowledge. The more frequent and profound such exchanges and sharing become, the more active knowledge flow and integration will be, continuously improving overall service levels and capabilities, ensuring quality completion of service tasks, and maximizing satisfaction of actual user needs. Clearly, knowledge exchange and sharing in subject service processes play a positive role in promoting knowledge integration and innovation, with external knowledge being irreplaceable for knowledge renewal and reconstruction in subject services. Thus, regular exchanges with and guidance from external subject service experts, disciplinary leaders, and subject users should be arranged for in-house librarians. Proactive follow-up with subject users and projects is essential, as is establishing and maintaining long-term, stable, and close interactive cooperative relationships with users to fully grasp cutting-edge disciplinary knowledge and various latent needs, enabling timely knowledge integration, service expansion, and innovation for better deep-level and value-added services [12].

4.5 Leveraging Synergistic Effects to Maximize Subject Service System Functions

The dynamic stability and rapid development of subject service systems require attention to interconnections and interactions among internal elements and between internal and external elements. Cross-complementarity and coordination among subject librarians and between subject teams must be emphasized, as must communication, exchange, and coordination between librarians and external experts, between teams and users, and between disciplines for mutual inspiration and internal connections. Additionally, the complementary relationship between physical subject service teams and virtual network platform teams

should be highlighted. All these aim to ensure the diversity, complementarity, and coordination of the system's knowledge structure, making knowledge flow and integration in subject service processes more rapid, rational, and effective. Therefore, establishing a comprehensive subject service coordination mechanism is essential.

Such coordination mechanisms can create favorable operating environments for service delivery and upgrading, timely coordinating internal and external elements to form optimal driving forces that promote supplementation and renewal of various relevant resources and knowledge, achieving optimized knowledge flow, sharing, integration, and innovation. Subject service coordination encompasses multiple dimensions, including knowledge resource coordination, intellectual resource coordination, and methodological process coordination. First, human resource coordination is particularly important, requiring rational division of labor both inside and outside the system to maximize talents through both division and collaboration, fully stimulating human passion and vitality in subject services and ensuring continuous knowledge cross-fertilization, timely complementarity, and optimal coordination. Second, cross-university and cross-border subject service alliances should be established via networks to facilitate multicultural exchange and complementary advantages. Finally, interaction and even coordination with other alliances and their users should be developed as a larger-scale macro-level coordination. Through coordination, deep exchanges among internal and external elements can be promoted for mutual supplementation and enhancement, forming ideal coupling dynamics that collectively boost the overall functional performance of subject service systems.

5. Conclusion

Library subject services constitute a crucial business component of university library knowledge services and represent one of the best manifestations of high-level intellectual labor. Through in-depth analysis and research on the dissipative structure and characteristics of library subject service systems, this study contends that dissipative structure theory can guide subject service work and promote service expansion and innovation. It is essential to consistently maintain system openness, continuously invest in and enhance relevant dynamic factors, strengthen the transformation and upgrading of internal system elements, and enhance knowledge exchange and sharing between internal and external systems, particularly communication and exchange with other users and systems in society, thereby increasing system knowledge negative entropy and knowledge flow. Concurrently, continuous strengthening of the subject service system environment, improvement of institutional safeguards, perfection of knowledge management strategies, and enhancement of subject librarians' initiative and creativity are necessary. Only through these measures can knowledge flow, integration, and service innovation in subject service systems be more effectively promoted, enabling the system to steadily advance toward higher service standards while continuously moving away from equilibrium.

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