Research on Cross-Boundary Collaboration Mechanisms in Next-Generation Library Services Platforms (LSP): A Case Study of the FOLIO Project Deployment at Duke University Library (Postprint)

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Abstract

[Purpose / Significance] From an inter-institutional cooperation perspective, this study explores the cross-boundary collaboration phenomenon among library stakeholders, and investigates how libraries can adapt to service upgrades in the new era by examining the development and deployment process of the next-generation Library Services Platform (LSP).

[Method / Process] The study first proposes the concept of cross-boundary collaboration and analyzes the collaboration subjects and their characteristics. On this basis, it summarizes the cross-boundary collaboration mechanism in LSP construction and analyzes its constituent elements. Taking the deployment of the FOLIO project at Duke University Library as a case study, it demonstrates the actual operation of the mechanism and discusses its implications, referential value, and future development trends.

[Results / Conclusion] LSP will exert a profound impact on next-generation library service models. A cross-boundary collaboration mechanism exists in LSP development, which is ubiquitous in platform development based on microservices architecture. When developing LSP, domestic libraries should improve organizational structures and coordination mechanisms, construct diversified participation channels to ensure library service innovation and resource sharing, and formulate various standards and specifications, deepen technical cooperation, and provide sufficient human resources support for the implementation of FOLIO in China.

Full Text

Cross-Border Collaboration in Next-Generation Library Service Platforms (LSP): A Case Study of the FOLIO Project Deployment at Duke University Library

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Abstract:
[**Purpose/Significance**] From the perspective of inter-institutional cooperation, this paper explores the cross-border synergy among library stakeholders and examines how libraries can adapt to service upgrades under new circumstances by analyzing the development and deployment process of next-generation library service platforms (LSP). [**Method/Process**] The study first proposes the concept of cross-border collaboration, analyzes its participants and characteristics, and summarizes the cross-border collaboration mechanism in LSP construction with an analysis of its constituent elements. Using the FOLIO project deployment at Duke University Library as a case study, the paper demonstrates the actual operation of this mechanism and discusses its implications, reference value, and future development trends. [**Result/Conclusion**] LSP will have a profound impact on next-generation library service models. A cross-border collaboration mechanism exists in LSP development, which is common in microservices architecture platform development. When developing LSP, domestic libraries should improve organizational structures and coordination mechanisms, build diverse participation channels to ensure library service innovation and resource sharing, formulate various standards and specifications, deepen technical cooperation, and provide sufficient human resources to support the implementation of domestic FOLIO.

Keywords: library service platform; LSP; FOLIO; cross-border collaboration

1 Introduction

Library services have iteratively evolved with changes in resource volumes, user demands, and social environments, transitioning from paper-based materials management and card catalogs to bibliographic data and MARC (Machine-Readable Catalogue) centered cataloging and retrieval. From a service philosophy perspective, related systems can be divided into three generations centered on different management objects: The first generation (pre-1995) focused on print resource management. During this period, standardized business norms and service processes gradually formed, known as the Integrated Library System (ILS) [1], which remains the most widely accepted library service system today. The second generation (1995-2010) centered on business management.

Influenced by digitization and increasingly diverse resource types, ILS coexisted with various digital resource management systems, forming multiple symbiotic systems such as OPAC (Online Public Access Catalog) systems, resource discovery systems, special resource systems, e-journal databases, and multimedia management systems. While these systems improved ILS management quality and expanded library service boundaries, they also created digital silos to some extent [2]. After 2010, as large volumes of digital resources no longer required fixed physical locations, the boundaries of "collection resources" became increasingly blurred. Simultaneously, under the influence of big data, cloud computing, and artificial intelligence technologies, the library community formally proposed the concept of the third-generation library service platform, LSP (Library Service Platform) [3].

Among numerous library service platforms, scholars generally agree that the next-generation LSP can be glimpsed in FOLIO (the Future of Libraries is Open), which is based on microservices architecture. FOLIO, launched by EBSCO in 2016, redefines library services through open-source technology and community building [4]. Foreign institutions are gradually advancing FOLIO product development and implementation. Since 2019, institutions of various scales have implemented FOLIO. Chalmers University of Technology in Sweden was the first library to use FOLIO, while Missouri State University was the first U.S. academic institution to launch FOLIO [5]. Depending on implementation strategies, some libraries choose to implement individual FOLIO applications first. For example, Leipzig University Library, Duke University Library, and Cornell University are implementing the Electronic Resource Management (ERM) application in FOLIO, while the University of Chicago participates in metadata management application development focusing on inventory and MARCAT [6]. Simmons University, Warner University, and the University of St. Thomas have fully implemented FOLIO.

Domestic scholars' research on FOLIO has primarily been introductory, focusing on project overviews and progress, platform architecture and key technologies, and how FOLIO can be implemented domestically. Sun Yu and Zhou Gang designed and constructed a new-generation library resource discovery system architecture that integrates data harvesting and federated search technologies to achieve unified discovery and access of collection resources, and introduced system localization application scenarios and service models [7]. Cao Qi conducted an in-depth study of the FOLIO application lifecycle and sample code, analyzing FOLIO' s improvements to library industry services from both librarian and patron perspectives [8]. Additionally, unified workflows across formats, flexible and scalable metadata management, interoperability brought by open APIs (Application Programming Interfaces), and the convenience of shareable and customizable service modules will gradually diminish the advantages of traditional "all-in-one" ILS based on standard business flows and unified business sets [9-10]. Meanwhile, amidst the vigorous LSP development and construction abroad, many domestic libraries are also attempting to implement FOLIO-based application development, such as Shanghai Library and Shenzhen Library [11].

To promote, popularize, and apply the FOLIO platform and technology, and to help various libraries apply, upgrade, or migrate to the FOLIO platform, Shanghai Library established the Shanghai Library Industry Association FOLIO Technology and Application Alliance, comprising system developers and integrators engaged in FOLIO technology and development applications, as well as libraries and organizations interested in FOLIO technology and applications [12].

The cross-production chain, cross-domain, and cross-departmental collaboration brought by an open-source, modular library service platform will inevitably become a major feature of next-generation library construction. The traditional client-vendor delivery relationship between platform developers and users will disappear, replaced by team-based, modular, ecological, and diversified delivery and production models. Embracing the philosophy of "everyone develops, everyone serves, everyone benefits," libraries, software developers, data providers, service providers, publishers, universities, and various stakeholders will extensively participate in LSP construction, forming an open community software production model characterized by technology sharing and user-driven development, which will evolve into a software ecosystem. In this model, basic functional units of projects are typically completed by technical teams composed of members from across domains. All project documentation, development progress, meeting schedules, meeting recordings, user guides, and code are published and updated through online tools such as Wiki, Github, Discuss, Slack, and Zoom, enabling orderly progress driven by all parties.

In fact, this cross-border collaboration model has precedents in other fields. The most typical examples include the Android market and microservices architecture platforms in various domains, as well as the open-source MOOC platform edX, which achieves modular functions through open-source and complex underlying code while organizing global teachers and technical personnel to share and build communities [13]. In the library field, there are currently few microservices architecture platforms available in domestic and international markets, and most platforms still lack the required characteristics of business module customization, functional decoupling, and high marketization. However, it is undeniable that cross-border collaboration in the development process is ubiquitous in such platform development. From a horizontal industry comparison perspective, microservices architecture and community-driven construction models may become the most advantageous option for future library system construction and could revolutionize the entire library industry service system.

2 Cross-Border Collaboration in LSP Development

2.1 Connotation of Cross-Border Collaboration

"Cross-border synergy" in microservices platforms refers to the horizontal cooperation among different institutional entities within the same industry chain, crossing their traditional service boundaries to collaborate on the same project. Some literature also defines it as "cross-border cooperation" or "cross-border

integration" [14]. Through this approach, collaborative entities can maintain advantages in their products and services. This phenomenon arises because increasingly fierce market competition has led to mutual penetration of business standards and service content across industries, making it difficult to clearly define an institution' s service boundaries [15]. Meanwhile, with the emergence of cloud architecture platforms, upstream and downstream institutions can integrate their businesses into unified cloud-based microservices, achieving product service module decoupling and higher degrees of concurrency.

The LSP in the library field adopts this construction model [2]. Whether library systems (various types of ILS) or data provider systems (various types of databases), their decoupled basic functions all include metadata management, resource management, user management, and resource access [16]. These services are process-isolated and built on a unified open API gateway. Since different institutional entities have different business focuses (libraries understand resource management better, data providers understand metadata management better, and developers understand user management better), cross-border collaboration among them not only makes each service sufficiently flexible and independent but also enables high-level unification under the overall architecture. More attractively, any institution or individual can freely choose modules for application development based on underlying services, making each application optimally meet requirements.

2.2 Characteristics of LSP Cross-Border Collaboration

LSP development demonstrates cross-border collaboration in three aspects: team organization, process control, and application ecology. In team organization, development team boundaries no longer remain within institutions: individuals from different institutions first identify with this microservices architecture, then semi-freely form teams oriented toward specific service modules for development. Second, service decoupling across teams is key to microservices development, requiring teams to master all skills within their scope, such as databases, user interfaces and experiences, and project management. Third, open discussion is an important form of communication within and between teams. Finally, since most team members come from libraries, they can provide immediate feedback and adapt to agile development.

In process control, the development process adopts a product-based rather than project-based system. Teams are responsible for their products throughout the entire lifecycle, unlike project-based systems where responsibility ends after acceptance. This results in an open cloud architecture: for information exchange, all documents (including audio, video, code, files, etc.) are publicly published, managed, and stored through regular meetings for discussion; for content management, microservices architecture facilitates independent deployment of each service, helps maintain link updates between databases, and achieves logical separation and interoperability through application programming interfaces; for system deployment, multiple deployment modes are available for institutional

users to choose from [17].

In application ecology, open communities are a widely recognized communication model that breaks through the traditional "main-branch library" hierarchical cooperation model and adopts a vertically and horizontally integrated cooperation model [18]. An open and shared community environment will form a sustainable application ecology integrating requirements, development, deployment, application, and updates. Therefore, the cross-border collaboration phenomenon in LSP development is an inevitable outcome of achieving optimal balance among the interests and needs of all parties, representing a more advanced and advantageous approach than independent operations forming solid industrial chains.

2.3 Subject Classification in LSP Cross-Border Collaboration

The collaborative subjects in LSP development can be roughly divided into four categories: libraries and library consortia, service providers (including booksellers, data providers, equipment providers, and solution providers), publishers, and system developers (primarily downstream software companies for libraries).

2.3.1 Libraries and Library Consortia Libraries are the main participants in LSP projects. Library consortia are non-profit organizations composed of libraries related to the platform, providing infrastructure and business support for projects. For example, OLE (Open Library Environment), established in 2008, is a library organization dedicated to cooperatively developing open-source, extensible, and service-driven library management tools. Currently, renowned university libraries such as the University of Chicago, Duke University, and Cornell University participate in OLE. The Open Library Foundation (OLF), generally sponsored by the library consortium OLE, is primarily responsible for managing and executing LSP project investments.

2.3.2 Service Providers Service providers are mainly data providers and equipment providers with independent copyrights. In addition to providing financial and technical support, they also provide their digital resources and help improve product functions iteratively. Since LSP supports a "micro-application store," service providers should have diverse business channels: they can provide services on their own platforms, create new applications, or directly link existing applications to the platform to expand product sales channels. Some large service providers, such as EBSCO, SirsiDynix, Bywater, and Index Data, have greater opportunities to provide bundled services and support to libraries adopting LSP.

2.3.3 Publishers Publishers help libraries break through traditional book procurement models while also improving their own publishing quality and marketing efficiency. Based on LSP, the intermediary functions between libraries and publishers will be weakened. Publishers can timely release all bibliographic

data, and libraries can directly conduct bibliographic procurement on the platform according to their needs, enabling direct dialogue and improving service quality [19]. Additionally, the traditional digital publishing industry chain is relatively complex, with roles such as content providers, platform service providers, network operators, hardware manufacturers, and digital distributors making the business flow diversified and the market repetitive. Therefore, the emergence of LSP basic service modules (such as copyright standards) can integrate the scattered publishing industry chain, making publishers' roles in LSP more specialized and enabling them to lead initiatives such as digital transformation, digital publishing standards, and network publishing. Publishers can also effectively grasp overall market publishing information through LSP to adjust their publishing plans and ensure orderly and long-term publishing.

2.3.4 System Developers System developers are no longer solely responsible for single systems but focus more on frequent collaboration with interface designers, libraries, and service providers. The development teams they participate in update in real-time according to the needs of Special Interest Groups (SIGs), working with various social organizations to jointly create platforms and their modules through software development, hosting services, and technical R&D support, while ensuring compatibility among all components and 致力于 building an open platform and ecosystem.

2.4 Special Interest Groups (SIG)

As seen from the above classification of four types of LSP subject institutions, the types of participating institutions are not complex and basically constitute the main entities of the entire library and digital product industry chain. However, the basic unit of LSP development is not these institutions themselves, but the Special Interest Groups (SIGs) freely formed by personnel from these four types of institutions.

SIGs are formally approved by OLE. In the early development stage, various SIGs reach consensus on platform functional modules by creating documents, confirming prototypes, and writing code snippets. Typically, one SIG corresponds to the design and development of a specific module. SIG types basically include: Functional SIGs: including metadata management, resource management, user management, and resource access; Coordinating SIGs: including Forum Facilitators SIG, Consortium SIG, Reporting SIG, Privacy SIG, System Operations and Management SIG, Accessibility SIG, Public Libraries SIG, Support SIG, and Application Interaction SIG; Regional SIGs: such as Australia/New Zealand SIG, Italy SIG, Japan SIG, Israel SIG, and China SIG.

Functional SIGs are primarily composed of developers, User Experience (UX) designers, Product Owners (PO), and Subject Matter Experts (SME), responsible for developing specific functional modules and constituting the main development force. Other types of SIGs have their own positions and responsibilities. Typically, a functional SIG team has an independent microservices gateway,

and the team exposes interfaces to the outside through the gateway while connecting interface services to the upper-layer API service gateway. In another scenario, teams do not enable microservices gateways internally but connect all their microservice modules directly to the external API service gateway. Since teams often represent institutions in many cases, issues such as inter-team interaction, interface integration, and service exposure need to operate under a cross-border collaboration mechanism.

3 Cross-Border Collaboration Mechanism in LSP Construction

In traditional ILS, collaboration mechanisms among subjects also exist, but they are essentially simple client-vendor relationships: service providers offer resources and service solutions to libraries and assist with database construction, acquisition, cataloging, design, and operations; developers provide mature software products to all parties; and publishers are responsible for publishing and distribution, as shown in Figure 1 [Figure 1: see original paper].

However, in LSP, the business of the above subjects will be in a state of open integration: all businesses are built under a unified microservices architecture, each basic service module (such as resource management) is mapped and decoupled from the overall business flow, and developed by the team from the most advantageous entity (such as library consortia). This eliminates differences in data structures, standards, and processes caused by business overlap, while all parties can enjoy unified basic service modules. This requires teams to ensure both efficient collaboration and independent autonomy during development. Therefore, the collaboration mechanism includes not only technical issues such as external bus and API gateway deployment, service registration, and management, but also organizational management issues such as personnel organization, planning, communication channels, and incentive measures.

3.1 Roles and Tasks

As previously mentioned, LSP signifies not only a new service architecture and application ecology but also a transformation in the role relationships between libraries, suppliers, developers, and publishers—from previous delivery relationships to a symbiotic relationship characterized by open integration with distinctive features (see Figure 2 [Figure 2: see original paper]).

First, library consortia, as the most likely project initiators and investors, include several coordinating bodies such as the Product Committee (PC), Technical Committee (TC), and Execution Committee (EC), which typically represent the interests of all parties and are responsible for coordination. For example, PC represents OLE to determine platform development priorities and maintain organizational cohesion; TC provides technical guidance for all parties, deciding technical directions, formulating technical standards, and resolving technical

conflicts [21]; EC represents all parties in project supervision, supporting and assisting in formulating weekly meeting agendas.

Libraries can be project initiators, supporters, builders, participants, and executors, as well as platform service recipients. Librarians participate in the entire process of LSP requirements design, development, testing, deployment, and acceptance based on system usage needs and their professional experience [22]. SIGs from libraries typically share perspectives on how technology should support library development, participate in detailed project design, especially workflow design. In many cases, librarians familiar with library business are experts in certain fields and can contribute professional knowledge to LSP.

Service providers (including booksellers, data providers, equipment providers, and solution providers) primarily provided resources to libraries in traditional ILS. Since they are more proficient in book circulation and data management, they tend to provide unified interface-based service support from the backend. Service providers can also provide developers for various application projects. Due to achieved interoperability, they can directly link existing applications to the platform or create and sell new applications.

In traditional ILS, developers' main task was development, so a library' s service quality over a considerable period often depended on the developer' s technical level. In LSP, developers maintain their important role, but their composition and functions change: LSP team members no longer come solely from developers but from more diversified sources. Moreover, since LSP is an open-source platform, product owners are not necessarily developers.

The publishing industry chain is already complex in traditional ILS, with roles such as content providers, platform service providers, network operators, hardware manufacturers, and digital distributors making the business flow diversified and the market repetitive. Therefore, the emergence of LSP basic service modules (such as copyright standards) can integrate the scattered publishing industry chain, making publishers' roles in LSP more specialized, enabling them to lead initiatives such as digital transformation, digital publishing standards, and network publishing. Publishers can also effectively grasp overall market publishing information through LSP to adjust their publishing plans and ensure orderly and long-term publishing.

3.2 Process and Elements

During cross-border collaboration, institutions are organically organized to develop according to planned optimal paths. The author describes the general organizational approach among institutions (see Figure 3 [Figure 3: see original paper]) and identifies four major elements in the organizational process.

Element 1: Open Community Alliance. LSP primarily relies on communities to maintain platform development. An open community alliance can be seen as a guarantee for gathering resources from all parties, who no longer limit

themselves to closed internal communication processes but break through industry boundaries to communicate through open communities. The libraries, service providers, developers, and publishers in Figure 3 are the main members of the alliance, being both contributors and users, participants and beneficiaries [23]. External coordinating bodies manage the alliance, while internal task objective management ensures operation.

Element 2: Clear Collaboration Process. The collaboration process among roles is an iterative organizational process [24]. Before product release, users are primarily library staff, and SIG members invest weeks researching and discussing a topic; subsequently, concept maps are published; after concept map approval, coding begins; then user feedback is obtained; based on feedback, technical roadmaps are regenerated, and the above process cycles during roadmap execution. The entire collaboration process can be seen as iterations with very short cycles, allowing teams to re-examine requirements and correct technical routes at each time node.

Element 3: Diverse Participation Channels. Diverse participation channels are the guarantee for effective development operations. First, LSP development involves large amounts of personnel training, and offline communication methods can help participants timely understand the latest project progress and development trends, enabling all parties to express opinions and viewpoints without barriers and promoting teamwork and cohesion among collaborators. Second, according to actual development processes, website modules and specific content are established with different access permissions for managers, developers, and ordinary users. Participation channels can also include portals, mobile devices, and other terminals, such as social media like Slack and Wiki.

Element 4: Effective Coordination Mechanism. Reasonable arrangements and coordination are needed among developers and between developers and users regarding products, technologies, and timelines. Committees (PC, TC, EC, etc.) can timely and effectively identify and coordinate problems in the development process based on rules. For example, development committees can formulate personnel and schedules according to rules, and coordination mechanisms can promote more complete projects and smoother processes.

4 Case Study

During FOLIO development, all parties actively cooperate using agile development methods. By May 2021, the latest version Iris was completed abroad and began widespread deployment. Duke University Library, an early FOLIO participant, is a university research library. Due to common characteristics such as service scope (teaching and research), service objects (faculty, students, and researchers), talent teams (highly professional), and resource commonalities (strong academic nature), university libraries share similar pain points and needs in library service platform construction. The author selected Duke University Library to demonstrate the actual operation and advantages of the cross-border

collaboration model through case study, providing reference for domestic academic (university) libraries to carry out related practices.

4.1 Duke University Library' s FOLIO Deployment Process

Duke University actively promotes local project updates while following international FOLIO progress, consistent with the practical path of domestic libraries deploying FOLIO. The overall system operation timeline is shown in Figure 4 [Figure 4: see original paper].

4.1.1 Perfect Organizational Structure and Coordination Mechanism as the Foundation of Cross-Border Collaboration Under the supervision of the steering group, project development is driven by transparent collaboration among members of many related institutions and organizations. One group needs to complete a task, such as configuring locations, but must consult multiple groups to define requirements and understand configuration impacts. Duke University Library' s FOLIO deployment organizational structure fully reflects the community collaboration characteristics of an open community alliance.

The Library Service Platform Steering Group (LSPSG) serves as the coordinating body responsible for overall project execution, composed of Implementation Teams, Working Groups, and the Library Systems and Integrated Support (LSIS) group. Implementation Teams are basically responsible for the technical work of specific component deployment, with each team including product owners, business analysts, and subject matter experts. Working Groups are teams divided by business processes within the library, such as permissions teams, workflow teams, documentation and training teams, data teams, and testing and reporting teams. The library has each team focus on a specific business flow, allowing personnel familiar with the business to quickly integrate into the deployment environment.

4.1.2 Efficient Project Management as the Core of Cross-Border Collaboration Duke University achieved operation of the ERM-focused service module in summer 2020 and deployed the remaining service modules in summer 2021, thanks to successful and efficient project management. Duke University' s FOLIO deployment project management system is built through two approaches:

First, **clear work content**. Duke University Library follows the basic approach of "internal-external collaboration, with internal focus on business and external focus on technology" during FOLIO deployment. Implementation teams composed of subject matter experts are responsible for technically deploying loosely coupled functional units, while working groups composed of librarians familiar with specific businesses are responsible for business configuration and testing. The working process between subject matter experts and librarians is also an iterative organizational process, developing iteratively through user usage and feedback. Specific work adopts cross-departmental decision-making to

ensure all stakeholders are represented in decision-making, guaranteeing both expertise and open collaboration.

Second, **diverse participation channels**. In terms of collaboration methods, the library employs auditory learning (Duke Folio forums, open forums, and Wednesday technical sharing sessions), visual learning (quarterly presentations, slides, expert demonstrations), and kinesthetic learning (instance testing, staff training) to provide suitable communication methods for teams. Simultaneously, it actively participates in and leads international FOLIO activities, conducting regular problem and experience exchange activities with institutions such as WOLFcon (World Open Library Foundation Conference), Index Data, EBSCO, the University of Chicago, Texas A&M, and Shanghai Public Library.

4.2 Advantages of FOLIO Deployment

4.2.1 Support for Functional Iteration Based on advanced microservices architecture, FOLIO ensures rapid product function iteration. LSP will support traditional resource management functions and extend to newer programs and service areas. Its development modules are shown in Table 1 . While focusing on functional areas traditionally covered by ILS, Duke University separated ERM from resource management and implemented ERM-focused FOLIO applications in summer 2020. Before ERM implementation, Duke University used cloud-based Microsoft SharePoint to store license information, could not search licenses and view terms, and used other auxiliary products to manage daily workflows. The License APP in FOLIO serves as a tool for managing electronic resources, storing electronic resource licenses and full-text license documents, supporting changes in collection priorities, and enabling library staff to quickly retrieve and interpret information about current vendor agreements. After ERM implementation, Duke University plans to fully implement all FOLIO applications in summer 2021, such as eUsage for tracking electronic resource access and usage statistics, and Codex microservices domain queries. FOLIO' s interoperability also supports external function APIs, bringing new and improved functional experiences to users.

4.2.2 Reduced Operating Costs The new-generation library service platform is open-source as a service, allowing different users (developers, system administrators, commercial vendors) to choose installation types and components according to their needs and objectives, whether as a complete platform or platform core components. Therefore, libraries can select appropriate deployment methods and service providers as needed during procurement, training, and maintenance phases, while liberating library staff from cumbersome system maintenance work, improving capital use efficiency and reducing human resource investment. Duke University Library selected Index Data as its FOLIO implementation and hosting partner. Index Data provides complete SaaS services, implementation services, software support, and custom development services, offering Duke University Library professional teams, offloading data

migration or software installation, maintenance procedures, customizing existing modules or applications, and on-demand custom integration. Compared with traditional library automation systems that are monopolized in the market with high purchase and maintenance costs and miscellaneous but imprecise product function modules, FOLIO offers customized and flexible functional modules, providing libraries with higher cost efficiency.

4.2.3 Promotion of Resource Sharing The FOLIO framework includes microservices architecture and open APIs, whose characteristics facilitate deep sharing and value expansion of library resources. First, since FOLIO uses Vert.x and Stripes frameworks to encapsulate microservices and uniformly publishes and operates service modules in an app-store-like marketplace, Duke University Library can quickly find the distribution of collection resources across different institutions based on collection resource revelation, determine procurement methods, and avoid duplicate purchases. Second, after clarifying collection resource distribution, libraries can request different institutions' OKAPI gateways in the cloud through FOLIO for effective document delivery or joint electronic resource procurement.

4.3 Implications for Domestic Libraries

During FOLIO implementation, Duke University Library established an efficient project management system through improved organizational structures and coordination mechanisms, and collaboration among libraries, staff, and vendors, greatly expanding library functions and service choices beyond traditional library management systems and enhancing libraries' ability to manage book resources and expand library value.

However, while the FOLIO service platform brings advantages to libraries, risks in its deployment process must also be guarded against. According to the selected implementation plan, prerequisite assumptions for implementation, stakeholder impact assessments, and resolution measures must be prepared.

Currently, there are three possible FOLIO implementation plans: single-module-focused implementation (circulation, ERM, or inventory); single independent library FOLIO implementation; and all-library FOLIO implementation. During implementation of corresponding plans, issues such as FOLIO App availability at launch, integration with other systems, data migration, data synchronization with existing systems, and multi-tenant or single library configuration need to be considered. These issues will have varying degrees of potential impact on patrons, library staff, and implementation teams.

Main impacts include: **Impact on patrons**: User experience will change. As library staff participation in tasks increases their workload, patrons may face slow business processing speeds. Additionally, resource synchronization, configuration and notification changes, or functional completeness directly affect user experience quality. **Impact on library staff**: Specific function development

may increase workload and working hours. Staff must work in both existing systems (such as Aleph) and FOLIO, working closely with FOLIO implementation teams, including providing requirement feedback, testing functions, reporting errors, participating in training creation, and developing strategies for expected and unexpected problems during implementation. After implementation, staff may need to maintain data in both systems for an uncertain period. **Impact on implementation teams**: Need to run existing systems (such as Aleph) and FOLIO simultaneously; need to create data synchronization methods between the two systems; data export, editing, and import bring new complexities and potential errors; data integrity faces significant risks during integration with other systems.

Although library business processes differ between domestic and foreign contexts, the above issues in FOLIO deployment are also universal. Domestic implementation can target FOLIO implementation from three aspects: First, formulate various standards, specifications, and best practices for FOLIO development to ensure compatibility, unity, and interoperability in FOLIO implementation. For example, libraries can develop microservice applications compatible with FOLIO by creating RAML (RESTful API Modeling Language) standards and interfaces based on RAML [26]. Second, deepen technical cooperation to synchronize with FOLIO community technical standards. This requires China' s FOLIO community to actively conduct training and promotion, and developers to be familiar with mainstream open-source technologies and frameworks such as Vert.x, Restful, and Stripes. Finally, ensure sufficient human resources participate throughout the entire project process. New positions can be established to enable employees with professional skills to focus on current work during module implementation.

5 Future Development Trends of LSP and Library Services

The case demonstrates that LSP will bring profound impacts to library services. However, will FOLIO necessarily become the market representative of LSP? Many cases from other industries tell us that the first industry platform to attempt microservices architecture is not necessarily the final market choice, because a microservices architecture with a highly stable user group is determined by various objective factors including time, market, users, and environment. But at least currently, FOLIO aligns with the development path of library smart services: supported by advanced technical architecture, it emphasizes flexible organizational structures, cross-border personnel collaboration, recognition of organizational culture, smooth communication channels, and sharing of knowledge resources, with all stakeholders working toward common goals.

The cross-border collaboration model represented by FOLIO will certainly become a universal model in LSP construction. Here, we might as well envision the upcoming library service platform application scenarios: rich community resources, modularly developable applications, seamless linking of businesses··· Through application development based on infrastructure, freely creating new

services, new library services will gradually mature. Libraries will achieve resource self-management, business self-organization, and model self-selection based on resource ownership, ultimately bringing users superior service experiences.

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