Embedding Research Information Management in University Institutional Repository Services: A Case Study of Shanghai University Institutional Repository (Postprint)

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Date: 2023-04-01T16:15:52+00:00

Abstract

[Purpose/Significance] Embedding university institutional repositories into research information management represents a new direction for their sustainable development and value enhancement. This paper introduces the service practice process of Shanghai University's institutional repository embedded in research information management, aiming to provide reference for the construction of university institutional repositories.

[Method/Process] Based on literature review and case analysis, this study investigates related research on embedding institutional repositories into research information management both domestically and internationally. Addressing the needs of Shanghai University's institutional repository to meet research information management requirements, it defines a service mechanism of user-participated collaborative construction and sharing. Through inter-departmental collaboration and inter-system sharing, it promotes the services of institutional repository data. During the practice process, feedback was collected, and improvements were made in data maintenance, attribution management methods, and hierarchical management models, with reflections proposed on deepening the collaborative construction and sharing mechanism of institutional repositories.

[Results/Conclusion] Practice demonstrates that in the process of embedding university institutional repositories into research information management, a user-participated collaborative construction and sharing service mechanism is an effective approach to achieving sustainable development.

Full Text

ChinaXiv Partner Journal, Vol. 64, No. 8, April 2020

Embedding Institutional Repository Services in Research Information Management: A Case Study of Shanghai University Institutional Repository

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Abstract:
[Purpose/Significance] Integrating institutional repositories (IRs) into research information management represents a new direction for their sustainable development and value enhancement. This paper introduces the service practices of Shanghai University Institutional Repository embedded in research information management, aiming to provide reference for university IR construction. [Method/Process] Based on literature review and case analysis, we examined relevant research on IR integration with research information management both domestically and internationally. Addressing Shanghai University Institutional Repository's need to support research information management, we established a user-participatory co-construction and sharing service mechanism. Through inter-departmental collaboration and inter-system data sharing, we promoted IR data services. Feedback collected during implementation informed improvements in data maintenance, attribution management, and hierarchical management models, leading to further reflections on deepening the co-construction and sharing mechanism. [Result/Conclusion] Practice demonstrates that a user-participatory co-construction and sharing service mechanism is an effective pathway for sustainable development of university IRs embedded in research information management.

Keywords: Institutional Repository; Research Information Management; Service Mechanism; Co-construction and Sharing; University

Classification: G250.74
DOI: 10.13266/j.issn.0252-3116.2020.08.007

Introduction

As early as 2010, T. Cramer from Stanford University Libraries proposed that traditional institutional repositories (IRs) limited to functions of displaying, collecting, and storing institutional outputs were approaching obsolescence [1]. W. Horstmann suggested making IRs "disappear" into the research workflow [2]. Zhang Xiaolin argued that linking IRs with research management information systems could effectively support the management and evaluation of research outputs for research projects [3]. Hu Jing et al. proposed exploring the integration of IRs with research management systems to promote complementary development [4]. Under this theoretical guidance, research institutions at home and abroad have successively explored the relationship between IRs and research information management systems in recent years. Cornell University, University of St Andrews, National Science Library of Chinese Academy of Sciences, University of Hong Kong, ShanghaiTech University, Peking University,

Northwestern Polytechnical University, and other institutions have conducted varying degrees of practice in expanding IR support for research information management. Both theoretical research and practical exploration indicate that embedding IRs in research information management processes has become one of the current development directions for IRs.

Research information encompasses a comprehensive range of research activity information including research projects, funding, institutions, scientific and technological personnel, innovation teams, research achievements, awards, academic activities, and academic publications. Research information management refers to the series of organized activities involving collection, organization, statistics, analysis, refinement, and dissemination of research information to form usable information resources [5]. In this paper, research information management primarily refers to activities related to collecting, organizing, and analyzing research output information and evaluation data.

Currently, most mainland Chinese universities still operate under a fragmented and inefficient research information management model. Researchers must log into different platforms to repeatedly fill in and submit research information. Because information is scattered across databases with different structures, management departments face numerous inconveniences when synthesizing multi-source data for management and decision-making support. Libraries providing output statistics services for research management departments must verify data entry by entry, creating substantial duplicated labor in establishing relationships among outputs, personnel, and affiliated departments, with service efficiency urgently needing improvement.

2. Integration Approaches of University IRs in Research Information Management

Many universities are exploring ways to integrate institutional repositories with research information management. On one hand, this facilitates centralized collection of output data for institutional members and research management departments, enabling application in various scenarios and research management processes. On the other hand, it meets the continuous need for statistical analysis of institutional research outputs in research information management by integrating and displaying data scattered across different systems for macro-level applications. For example, some have explored extended IR platform functionalities to provide output data services for research information management, while others have linked data from research management systems (including projects and personnel) with IR research outputs [6].

Integrating IRs with research information management has been practiced from different angles both domestically and internationally, focusing primarily on three aspects:

(1) Research Output Statistics. The University of Sydney's eScholarship Repository enables statistical display of outputs by college, author, discipline,

document type, and time period [7]. The Chinese Academy of Sciences Institutional Repository provides output statistics by research institute, laboratory, and team, plus browsing and download statistics [8], as well as deposit and utilization trend statistics across different periods [9]. Peking University Institutional Repository has established cooperative relationships with the Social Sciences Department, Science and Technology Department, Academic Affairs Department, and Medical Department to provide data support for annual academic output statistics of various colleges and laboratories [10]. Xi'an Jiaotong University constructed a service-extended IR that integrates into the research management system through a scholar database, enabling output statistics for individuals and colleges [11].

(2) Information Analysis and Visualization. Cornell University Library built the Scholars@Cornell platform to collect university-wide research outputs, grouping literature by discipline and keyword themes to display departmental and international collaborations among experts on specific research topics [12]. Monash University's Research Units aggregates university-wide research outputs, enabling visual demonstration of collaboration maps and personal profile pages, displaying outputs from perspectives of research projects, publications, awards, academic activities (conferences, peer review, editing, presentations), and media publications, combined with discipline and departmental levels [13]. The University of Hong Kong Scholars Hub displays journal-, author-, and article-level metric evaluation information on paper and patent output pages, plus visual analysis of collaborators and geographic distribution [14, 15]. Xi'an Jiaotong University Institutional Repository reveals output data not only through database inclusion status but also via output trend charts, keyword clouds, and international collaboration maps, supplemented by Altmetric statistics and Web of Science citation data [16].

(3) Multi-source Data Association. Many institutions have conducted varying degrees of development and integration with unified identity authentication systems, funding management systems, academic affairs systems, and personnel systems, enabling IR-stored research outputs to be shared with other systems. The University of California's eScholarship aggregates published institutional outputs and releases journal and monograph publications from its press, building a school-owned academic creation and dissemination platform [17]. The University of St Andrews uses Elsevier's PURE platform to store publications and collect academic activities and impact metrics, integrating multiple important research management systems and importing metadata into the IR to save tedious work in crawling and verification [18, 19]. Virginia Tech's institutional repository integrates with an electronic faculty activity reporting system to automatically import faculty research outputs, improving service efficiency [20]. The National Science Library of Chinese Academy of Sciences attempted to integrate research management information platform data into IR [21]. Peking University launched a comprehensive research management information system (VI) in 2019, achieving seamless embedding of IR construction key nodes into research management workflows. Northwestern Polytechnical University integrated its

IR with the graduate management system [22]. Beijing University of Posts and Telecommunications considered integration with research management systems, E-Learning, and unified identity authentication in its IR construction [23]. Central China Normal University's IR stores faculty research outputs and connects with the academic affairs course system and personnel title evaluation system through a faculty smart cloud platform [24]. The University of Hong Kong Scholars Hub provides individual scholar pages displaying academic and social service achievements, achieving integration with research funding management systems. Some institutions in Taiwan have included dissertations and other special collections in IR platforms, linking open access platform resources and university press publications using other internal and external resources [25].

In summary, IR support for research information management focuses primarily on output statistics. While some foreign universities have achieved data connectivity between research information systems and IRs, most Chinese universities remain in the theoretical exploration stage, with IR service extensions for embedded research information management still in the initial practice phase. By sharing Shanghai University Institutional Repository's co-construction and sharing service experiences in embedding research information management, this paper provides reference for more universities to carry out related work.

3. Requirement Analysis for Shanghai University IR Embedded in Research Information Management

Shanghai University Institutional Repository's practice of integrating into research information management originated from the library's long-term responsibility for commissioned research output statistics and intelligence analysis tasks for the university's research management department. In recent years, both service demand volume and difficulty have increased, with data analysis indicators becoming increasingly refined. Data application problems have become more prominent, as fragmented batch data makes it inconvenient for research management departments to dynamically monitor changes and trends from global perspectives such as timelines, document types, and collaboration relationships for comprehensive management. Drawing on domestic and international functional implementations and combining Shanghai University Institutional Repository's requirements for embedding in research information management processes, the library sought broad user participation from the initial functional design stage, collaborating with institutional members, research management departments, personnel management departments, and technical support to establish a co-construction and sharing service mechanism. This mechanism ensures sustainable IR operation and lays the foundation for future expansion of research output data association with multiple research information management systems, thereby guaranteeing continuous development and value enhancement.

Unlike traditional open-access IRs, the platform's construction purpose focused on output collection, research evaluation, and decision support. Through interviews with participating members, including Shanghai University institutional

members, college-level research management personnel (research secretaries), Development Planning Office, Innovation Management Department (including Humanities and Social Sciences Office and Science and Technology Office, hereinafter referred to as research management departments), and personnel management departments, we conducted in-depth needs research. The main functional requirements for the institutional repository in research information management are summarized in Figure 1 [Figure 1: see original paper].

Figure 1. Main functional requirements of different users for the institutional repository in research information management

Addressing research information management needs, the IR focuses not only on data collection and preservation of outputs themselves but also on comprehensive information collection for research outputs, 主要体现在以下几个方面: Research output data collection and preservation. Institutional members comprehensively preserve various types of outputs on the platform. The library and information office provide technical support for output type attribute fields, evaluation indicators, organizational trees, and personnel information. Research output evaluation. Research management departments need to verify data accuracy, comprehensively understand and master the university's research outputs over the years, clearly view various attributes of outputs, and attach evaluation indicators such as papers, journals, and disciplines to achieve output statistics at individual, team, discipline, and university assessment levels. Research decision support. The Personnel Department, research management departments, and Development Planning Office promote IR data accumulation and integration through data collection notifications and supervision processes, obtaining research information data and monitoring temporal development trends to track changes in institutional members' and departments' outputs, providing references for talent recruitment, cultivation, and discipline construction.

The IR serves as both a platform for institutional members to store and display personal outputs and a data foundation for research information management departments to conduct output statistics and management. It not only helps institutional members conveniently register research outputs but also effectively improves research output management efficiency.

4. Collaborative Practice of Shanghai University IR in Research Information Management

Shanghai University's IR service embedded in research information management involves the library, users (research management departments, personnel management departments, Development Planning Office, colleges, institutional members, etc.), and university IT service departments (Information Office). The three aspects of output collection, research evaluation, and decision support form a closed loop, with the service mechanism illustrated in Figure 2 [Figure 2: see original paper].

Figure 2. Co-construction and sharing service mechanism of Shang-

hai University Institutional Repository embedded in research information management

The functional layer clarifies the IR service workflow according to research information management processes. Starting with output crawling from Web of Science, Ei, CNKI, Wanfang, and other databases plus manual submission, the system configures various evaluation indicators including core journal lists, database inclusion and citation status, journal impact factors and quartiles, awards, and other evaluation types. Further association with external data sources such as personnel systems and research management systems achieves data integration. The support layer consists of participating parties contributing their technology, data, and policy support, with demand serving as the driving force for platform sustainable development.

4.1 User Participation as the Foundation of IR Services

In IRs embedded in research information management, users with different identities have different needs, which constitute both the starting point for platform service function design and the ultimate service goal. Therefore, broad participation of relevant personnel was invited from the initial construction stage, laying a solid foundation for service development.

Shanghai University Institutional Repository, based on a commercial platform, underwent secondary development to meet personalized user needs: (1) Institutional members participate in output registration. The IR crawls research paper outputs from multiple databases. In addition to confirming and claiming automatically crawled and matched outputs as personal achievements, members also submit monographs, research reports, literary works, artistic works, and other output types to the IR, achieving complete and accurate information accumulation and display of personal outputs. (2) Research output management departments clarify output evaluation requirements in research information management. To evaluate outputs from multiple dimensions including quantity, quality, and impact, management departments specify evaluation information from perspectives of inclusion, citation, journal impact factors and quartiles, awards, and academic recognition. Various evaluation indicators configured in the IR adopt both domestic general standards and Shanghai University's internal academic evaluation regulations formulated by research output management departments, such as "Shanghai University Internal Core Journal List" and "First-level Discipline Journals," enabling output evaluation standards at different levels to be statistically implemented on the platform. Addressing the evaluation needs of Shanghai University's literature and arts disciplines, multiple visits to relevant research management personnel and institutional members were conducted to set unique fields and types for literary and artistic works. After members submit basic work information, the system automatically generates output ID numbers, through which recognition and evaluation information such as competition participation, awards, exhibitions, and collections can be supplemented. (3) Research management and personnel management depart-

ments propose multi-angle research management decision support requirements. Through interfaces between different systems, output information, personnel information, and research project information are integrated, associating outputs with people, departments, research projects, and funding data to provide auxiliary information for research investment and resource allocation. The Personnel Department needs to accurately collect personal output information and extract output data according to different time periods, supporting output statistics for various purposes such as appointment period assessments and talent evaluations. It can also set screening conditions by inclusion type and discipline field to provide references for talent recruitment and discipline construction. Research management departments can extract statistical data for different groups including individuals, teams, and colleges, setting filters for time periods, inclusion types, and journal levels.

User participation in IR construction forms the foundation of Shanghai University Institutional Repository's embedded research information management services, while the operational mechanism during service processes constitutes the system's core.

4.2 Co-construction and Sharing Mechanism as the Driving Force for Sustainable IR Development

The co-construction and sharing service mechanism serves as the driving force for Shanghai University Institutional Repository's embedding in research information management. Centering on needs for output collection, research evaluation, and decision support, librarians coordinate participation from all user sectors to accomplish inter-departmental information co-construction and achieve inter-system data sharing.

4.2.1 Inter-departmental Co-construction Mechanism Librarians first select the IR platform and prepare foundational work, including contacting the university Information Office for technical support and communicating with platform developers regarding secondary development requirements. Multiple visits to relevant university departments were made to promote the IR project, investigate departmental needs for research output information management, organize required fields for different output type statistics and displays, and clarify evaluation indicator systems. During implementation, service advancement requires promotion from research and personnel management departments, which send notifications for output confirmation and supplementary submission before data statistics are needed and supervise completion status. After members claim and submit data, librarians follow up promptly to perform data verification and cleaning maintenance. Accurate data reviewed and confirmed by leaders are timely synchronized to the research management system, and project information from research management departments is associated with project funding fields in the IR, facilitating project funding management and effectiveness evaluation.

4.2.2 Inter-system Sharing Mechanism Through promotion during requirement investigation and data construction stages, university-level relevant departments recognize IR research output information data. Via database interfaces, data interaction with various research management-related systems is completed, achieving one-time registration and repeated utilization, which reduces time costs while improving data acquisition efficiency for all departments.

To achieve association of research outputs and research management data from different sources, inter-system data interaction includes: Establishing multi-dimensional views within the IR to associate output attributes. Through author claiming, outputs are accurately attributed to members and departments; output source publication information is matched with journal evaluation indicators; and output IDs establish associations with awards and recognition information. Importing personnel system data into the IR. The personnel system provides institutional members' names, employee numbers, and affiliated departments, with each member's employee number serving as their ID in the IR to aggregate members, departments, colleges, and institutes under organizational trees, forming datasets at different scopes. Synchronizing IR data to relevant systems of research and personnel management departments. In the personnel system, IR research outputs are called for modules such as appointment period outputs, title evaluation, and performance assessment for data reuse according to conditions. By synchronizing verified data from the IR to the research management system, the IR recognition mechanism facilitates research information management across various segments.

4.3 Data Sharing as the Goal of IR Service Enhancement

Shanghai University Institutional Repository embedded in research information management aims not only for research output collection and preservation but more importantly to promote extensive data sharing and application based on the IR as a foundational data platform. To this end, the library collaborated with relevant departments to clarify recognition systems for IR research output data, technical departments developed interfaces between different systems to complete data sharing, and gradually promoted IR data's wide application in all segments of research information management processes.

Currently, the IR supports research output management-related work for multiple departments, specifically: Applied in annual departmental KPI assessments, high-level research output promotion plans, ESI discipline contributions, and discipline development trend analysis led by the Development Planning Office; Applied in Ministry of Education output statistics and college-level output tracking required by the Innovation Management Department; Applied in regular annual assessments, appointment period assessments, and intermediate title recognition in personnel management, as well as high-level talent evaluation, replacing information registration and aggregation work in multiple application scenarios for research output information.

The IR provides output data for multiple university platforms, specifically: Synchronization of "journal paper works" list information in institutional members' personal profiles on the information management portal; Synchronization of "papers and works" output page information in teachers' personal profiles in the personnel system; Data for papers, works, and patents in Shanghai University Data Intelligent Decision System, all sourced from the IR, generating research performance information at individual, departmental, and talent team levels; Loading of the institutional repository system in the teaching and research module of Shanghai University's one-stop service system (see Figure 3 [Figure 3: see original paper]), achieving synchronization of personal and departmental research output data in departmental archives.

Figure 3. Integration of IR and research management system in Shanghai University's one-stop service platform

5. Practice Improvements for Shanghai University IR Embedded in Research Information Management

Although Shanghai University Institutional Repository gained broad user participation during its design phase, the embedding process in research information management—involving assessment and evaluation related to institutional members' vital interests—demanded higher data accuracy and efficiency. Users provided timely feedback during practical participation. To further deepen the co-construction and sharing mechanism, the library made active adjustments in data maintenance and management systems.

5.1 Improving System Data Maintenance Efficiency

Driven by the co-construction and sharing service mechanism, institutional members and data administrators jointly maintain platform data to ensure accuracy of research information management and decision-making basis.

Data administrators continuously perform long-term, regular data verification, specifically: When crawling institutional outputs from databases, comprehensively organize multiple spelling forms of institutional names; simultaneously publicize standardized institutional name spelling to members to improve automatic crawling coverage. Information from multiple data sources causes automatic deduplication failures for the same output due to language and data rule differences [26]. Data administrators summarize problem patterns, repeatedly communicate with system developers to adjust algorithms for improved automatic deduplication rates; establish journal title dictionaries for merging processing of the same publication information; and use ISSN numbers plus publication year/volume/issue/page information to batch merge and deduplicate data described in different languages from the same output source.

5.2 Refining Output Attribution Management Methods

To meet research management departments' needs for team performance assessment and improve attribution accuracy, most data crawled by the IR system can be automatically identified to establish relationships between outputs and authors based on authors' affiliated departments. However, a considerable portion of data cannot be automatically matched due to author name or affiliation spelling issues. To improve data accuracy, on one hand, the IR recognition mechanism from research management departments incentivizes college-level research management personnel to participate in collecting and claiming departmental outputs, improving attribution accuracy. On the other hand, it promotes data sharing with more relevant departments, expanding IR data application scenarios so that all segments of research information management can directly obtain college-level output data from the platform, thereby increasing institutional members' initiative in submitting research outputs.

5.3 Implementing Hierarchical Data Management Model

During initial practice, library data administrators undertook the organization and verification of university-wide output data. In practice, we discovered that data administrators faced heavy workloads, needing not only to review and modify information submitted by institutional members but also to continuously clean and organize data automatically crawled from various databases for verification and deduplication. When research management departments required data statistics at fixed time points, the pressure of reviewing and modifying data surged due to concentrated member submissions. Meanwhile, due to university organizational adjustments, colleges frequently proposed changes and adjustments to their secondary departments, requiring data administrators to track complex organizational trees and monitor dynamic changes promptly.

Therefore, the library collaborated with research management departments to organize and train research secretaries from each college to divide responsibilities for their respective departmental data, taking charge of output collection promotion, submission data review, data correction, and other maintenance work, plus partial attribution identification for unaffiliated outputs. The original data administrators in the service mechanism thus formed a hierarchical management model with different authority levels, as shown in Figure 4 [Figure 4: see original paper]. Library data administrators manage university-wide data, focusing on discovering and improving global issues and performing strategic data cleaning and correction. College administrators manage their own departmental data, submitting unresolved issues to library data administrators. This hierarchical management model improves work efficiency and distributes pressure on data administrators.

Figure 4. Hierarchical data management model of Shanghai University Institutional Repository

The adjusted model's advantages include: college administrators understand

internal departmental changes, are more familiar with members and their outputs, know departmental output evaluation standards, and manage data more meticulously and accurately. Shared outputs also satisfy their need to use IR statistical functions to monitor departmental output dynamics in real time, utilize platform historical data to grasp development trends, and provide timely references for departmental leadership decision-making and management.

6. Reflections and Conclusion

Shanghai University Institutional Repository has achieved good results in exploring service mechanisms for integrating into research information management processes. However, problems remain to be explored and resolved in deepening the co-construction and sharing mechanism: The output attribution confirmation path needs adjustment. Promoting institutional members to register ORCID iDs and identify information through these numbers will greatly improve automatic matching accuracy for attribution information. Further improving data completeness and accuracy through more content deposit policy incentives and teacher training promotion methods. Enhancing personal profile display functions on the IR platform to encourage teachers to use IR-based personal profiles for various academic exchange activities and influence promotion, advancing personalized personal reputation management, and timely updating information on highly-cited scholars, awards, and honors to enhance members' dependence on and enthusiasm for participating in IR co-construction. Paying attention to relevant technologies, standards, and protocols released by the Confederation of Open Access Repositories (COAR), emphasizing standardization in persistent identifiers and metric indicators to prepare metadata for open academic environments.

University IR construction should not be limited to output collection and storage functions. Linking with research information management systems represents an important current development direction. Shanghai University Institutional Repository's service practice embedded in research information management starts with broadly soliciting user participation in co-construction, combining research information management needs for collection, organization, statistics, and analysis of research information. With platform technical support, librarian data support, and research management department policy support as the supporting layer for co-construction functions, and meeting different user data needs as the sharing purpose, the IR continues to operate well under this co-construction and sharing mechanism. In IR service practice for research information management, building an assistant management layer and improving data attribution methods effectively enhance IR services embedded in research information management. As part of institutional information infrastructure, the IR integrates with various university research information management subsystems to consistently serve university research information management.

Constructing IRs embedded in research information management is an important initiative for libraries to proactively serve the entire university, providing

support for research information data integration and promoting sustainable IR development in good condition through university-wide co-construction and sharing service mechanisms. Simultaneously, IR services can further enhance the library's status and reputation. Through communication with institutional members and research management departments, librarians' professional data management capabilities and rigorous, responsible work attitudes can highlight the importance of library work and enhance the value and visibility of library services.

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Author Contributions

Jie Feng: Topic selection, literature and web investigation, work material collection, paper writing and revision.
Zhan Huaqing: Practical experience summary, paper content revision.
Fang Xiangming: Literature and web investigation, paper content revision.
Lu Zhiguo: Practical experience summary, paper content revision.

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