The evolution of Japan's knowledge infrastructure in the era of open access

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Abstract: In 2021, CiNii—Japan's largest academic information retrieval platform—launched CiNii Research as a unified search engine, gradually integrating and upgrading its modules for articles, books, doctoral dissertations, and research projects. This paper outlines the evolution of CiNii: (1) the infrastructure phase of the NACSIS system (1983–2004), (2) the startup and expansion phase of the CiNii platform (2005–2020), and (3) the integration and upgrade phase of the CiNii Research engine (2021–). It summarizes the key features of CiNii Research, including the expansion of its search scope, optimization of search logic, and advanced English-language search capabilities. Furthermore, by examining the government-led, public-interest platform's commitment to content integration and open access, this paper discusses the implications of these upgrades for academic information services in China's higher education sector.

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Keywords: knowledge infrastructure, Academic information services, CiNii, CiNii research

1. Introduction

As the open science movement gains momentum, academic information retrieval platforms are evolving from simple indexing services into integrated knowledge discovery platforms that bring together a variety of resources, including academic literature, research data, research projects, and institutional repositories content. Since its launch in 2005, CiNii has grown into Japan's largest academic information retrieval platform. As of the end of March 2026, its holdings have reached substantial scale, including 57.71 million articles, 13.48 million books, 2.85 million research data records, and 1.09 million research projects (NII, 2026). In April 2021, CiNii Research was upgraded to an integrated search engine (NII, 2021a), undergoing gradual module consolidation and intelligent optimization. This transformation is closely aligned with Japan’s evolving open access policy. Starting in FY2025 (April 2025–March 2026), Japan will implement a new open access policy requiring that publicly funded research results be made immediately open access upon publication (Government of Japan, 2024). Enabled by its unified metadata standards and harvesting mechanism, CiNii Research integrates various types of academic information, thereby directly supporting this policy mandate and serving as the discovery layer for Japan’s decentralized open access ecosystem.

Zhang et al. (2023) noted that the National Institute of Informatics (NII) and the Japan Science and Technology Agency (JST), which had previously belonged to different ministries, underwent an operational reorganization in 2014 after Ministry of

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Education, Culture, Sports, Science and Technology (MEXT) consolidated administrative functions, as their roles had significant overlap: NII focused on front-end search engines, while JST focused on back-end database development. The division of labor between NII and JST is limited to internal operational management within MEXT, and the overall architecture of the CiNii platform has not been affected. Based on a comprehensive review of CiNii's evolutionary history, this paper will summarize the key features of the latest update to the CiNii Research integrated search engine and explore the implications of this upgrade for academic information services in China's higher education sector.

2. The Evolution of CiNii

This paper employs a historical-institutional analysis combined with platform function analysis to trace the evolution of CiNii. Primary sources include official publications and web-based materials from NII and its affiliated research centers, such as Center for Open Science and Data Platform (RCOS) and Research Center for Knowledge Media and Content Scien (KMCS). Policy context is drawn from the government of Japan open-access directives. Platform-specific data—covering database scope, harvesting mechanisms, and search functionalities—were verified through direct interface analysis of CiNii Research conducted between January and June 2026.

2.1. The Infrastructure Phase of the NACSIS System (1983–2004)

The name CiNii is an abbreviation of Citation Information by NII, reflecting its focus on academic information. NII stands for the National Institute of Informatics, which serves as both a national joint-use university research organization and an information systems research institute. It is affiliated with MEXT and is headquartered in Tokyo. Established in 2000, NII was renamed from the National Center for Science

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Information System (NACSIS).

Thus, the organizational roots of CiNii can be traced back to NACSIS in 1985 and its predecessor, the University of Tokyo's Center for Information Science, established in 1983. The launch of NACSIS-CAT in 1985 marked the establishment of a joint cataloging system for Japanese university libraries. This was followed by the NACSIS-IR database retrieval system in 1987, and the NACSIS-ILL interlibrary loan system in 1992, laying the initial groundwork for a shared academic information infrastructure. The NACSIS-ELS electronic library system was the core platform for accessing electronic resources during the pre-CiNii era. It began free operations in 1997, focusing on the digitization of Japanese academic society journals, and in 1999, it introduced a detailed billing system to pay copyright fees to the respective academic societies. It recorded bibliographic information—including titles, authors, abstracts, keywords, and source journals—while simultaneously saving each page of the document as an image, effectively combining an abstract database with an image database (Adachi, 1999). At the user level, it provided academic literature services featuring document information search, page viewing, and document copying and delivery functions. While digitizing academic society journals that had already been published in print, NACSIS-ELS also promoted the electronic publication of such journals by providing each society with its proprietary editing system free of charge (Negishi, 1999). For academic documents such as research reports published by universities, NII funded their digitization and public release, first by establishing a database of academic journal catalogs and second by expanding it into a research bulletin portal that includes full-text images (Uemura, 2019).

2.2. The Initial Expansion Phase of the CiNii Platform (2005–2020)

The early 2000s witnessed a paradigm shift from standalone electronic library

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systems to interoperable web-scale discovery platforms. NACSIS-ELS's siloed, image-centric architecture became insufficient for networked full-text retrieval, thus setting the stage for the launch of CiNii Articles. The CiNii platform was established in 2005 with the launch of CiNii Articles, with its core database being NII-ELS, which was developed from NACSIS-ELS. Starting in 2014, NII ceased to be responsible for the operation of the backend database, and NII-ELS was subsequently split: data on natural science research was transferred to the Japan Science and Technology Information Aggregator (J-STAGE), operated by JST, while data on humanities research was transferred to the National Diet Library's Digital Collections (NDL Digital Collections) (NII, 2021b). CiNii Articles subsequently became an independent front-end search engine. Statistics from the end of March 2020 showed that it provided access to over 22 million full-text links, including journal articles from academic societies, conference papers, and university journals (NII, 2020). The specific source databases for CiNii Articles are shown in Fig. 1.

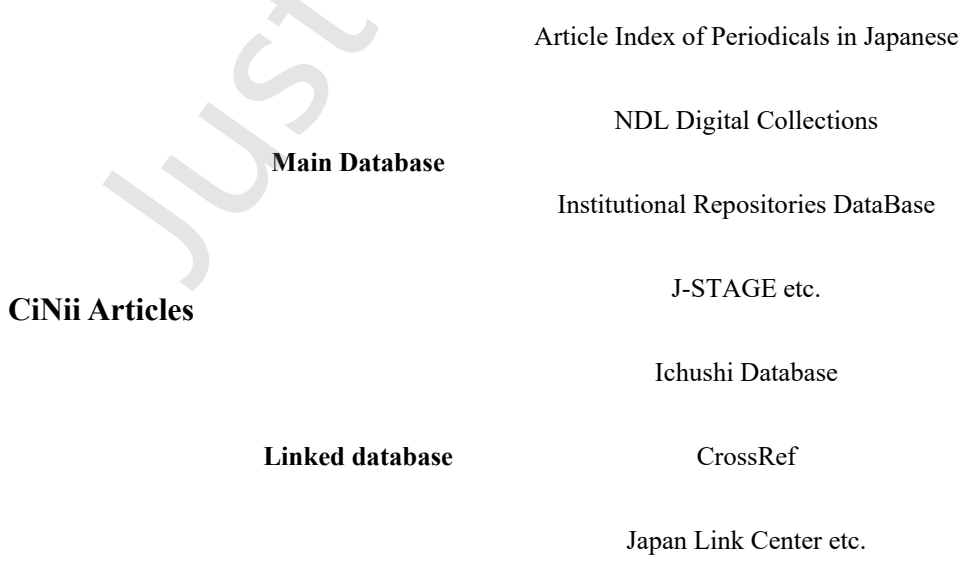


Fig. 1 Databases for CiNii Articles (as of March 2020)

In 2011, CiNii Books launched its services based on the NACSIS-CAT/ILL data

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platform. NACSIS-CAT, which currently includes 1,348 participating universities, enables users to search for book collection information across Japanese university libraries through a single platform (NII, 2026). NII also maintains an additional NACSIS-ILL system to facilitate document delivery and interlibrary loan services between participating university libraries through CiNii Books.

CiNii Dissertations was launched in 2012 as a new subsystem, providing cross-database search capabilities for Japanese doctoral dissertations available in the National Diet Library's collections, digital collections, and institutional repositories at universities and other organizations. At the time of its integration into CiNii Research, the total number of doctoral dissertations in the collection was approximately 710,000 entries (NII, 2024b).

The research module is linked to Grants-in-Aid for Scientific Research Database (KAKEN), operated by NII, which is a database covering all research projects publicly funded by MEXT, including those supported by JST. Since August 2017, KAKEN has been linked with the Open Researcher and Contributor ID (ORCID), allowing researchers to connect their researcher identifiers to ORCID iDs through the KAKEN database (NII, 2017). This feature enhances the reliability of author information within CiNii Research. Drawing on data from CiNii Research and KAKEN, Ikeuchi (2026) shows that multidisciplinary research data—particularly in the natural sciences—is deposited in both Japanese institutional repositories and international general-purpose repositories, confirming its cross-infrastructural dissemination.

2.3. The Integration and Upgrade Phase of the CiNii Research Engine (2021–)

CiNii faced a significant data silo problem. Articles, books, and research projects were managed by separate subsystems, requiring users to switch between different

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interfaces. In April 2021, CiNii Research was officially launched as the next-generation search engine for the academic information retrieval platform, marking the gradual beginning of module integration. The merger with CiNii Articles was completed in April 2022; CiNii Dissertations was successfully integrated in December 2024; and the migration of CiNii Books concluded in March 2026. Following a transition period of approximately six months to one year, the access points for each module were permanently phased out, and search services were unified under CiNii Research. CiNii Research has become a comprehensive search service integrating various types of academic information, including articles, books, doctoral dissertations, research data, research projects, and institutional repository content.

In April 2024, the operation of CiNii Research was transferred from RCOS to KMCS (KMCS, n.d.). At the heart of RCOS's work is NII Research Data Cloud (NII RDC), which consists of three core platforms aligned with the research data lifecycle: GakuNin RDM (management), JAIRO Cloud (publication), and CiNii Research (discovery). The NII RDC was selected for the Open Access Acceleration Project with the goal of establishing an infrastructure to accelerating open access and support its implementation at universities and research institutions nationwide (RCOS, n.d.). More broadly, the government of Japan views the NII RDC as knowledge infrastructure that supports open science, research integrity, and data-driven research. The infrastructure was targeted for full operation by FY2020 (April 2020–March 2021) (Government of Japan, 2021). The launch of CiNii Research on April 1, 2021 represents a tangible deliverable of this policy framework. Furthermore, with the discontinuation of WebcatPlus—the Japanese University Library Union Catalog system, which NII helped build and co-managed—on March 31, 2024, the unique role of CiNii Books and CiNii Research has been further emphasized.

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3. Key Features of the CiNii Research Upgrade

3.1. Expansion of Search Scope

CiNii Research integrates various internal resources, including search modules for articles, books, doctoral dissertations, and research projects. Print resources are continuously maintained through the mature union catalog system NACSIS-CAT, while electronic resources are supported by a partnership with the Japan Link Center (JaLC) to assign Digital Object Identifiers (DOIs) to academic information, ensuring persistent accessibility and effectively preventing duplicate harvesting. Supporting institutional repository activities in university libraries has long been a priority for NII (Yamaji, K. et al., 2016). The Institutional Repositories Database (IRDB), also developed by NII, aggregates metadata using the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) with the Junii2 metadata format. Junii2, which was developed in 2006 based on the Dublin Core Metadata Element Set and revised to version 3.1 as of 2017, has been the standard for metadata exchange among Japanese institutional repositories (IRDB, n.d.). However, to address changes in the international scholarly communication environment and to improve global interoperability, the Japan Consortium for Open Access Repository (JPCOAR) published JPCOAR Schema Version 1.0 in 2017 as the successor to Junii2 (Itsumura, 2018). Crucially, IRDB participates in the JPCOAR and contributes to the JPCOAR Schema, reinforcing CiNii Research as Japan's national open access infrastructure. The success of CiNii Research relies heavily on the IRDB's harvesting mechanism (Tanabe, 2022). It regularly harvests metadata from the institutional repositories of 833 universities in Japan, accumulating over 4.66 million items, with more than 70% containing external full-text URLs while the full-text files themselves are hosted by institutional repositories such (NII, 2026). CiNii Research enables users to perform

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unified searches across distributed databases containing diverse media formats, such as print and electronic resources, demonstrating the digital transformation of academic information retrieval platforms amid the trend toward print-digital convergence.

To strengthen external collaboration, CiNii Research features links on its results pages to calil.jp and WorldCat, the global online union catalog database operated by the Online Computer Library Center (OCLC). In particular, the two-way cross-search with the National Diet Library Search (NDL Search) displays search results directly on each other's interfaces. Users can jump to relevant results for the same search term with a single click, and this one-stop search significantly enhances the efficiency of information resource discovery.

3.2. Optimization of Search Logic

CiNii Research has developed specialized search logic tailored to different resource types. For example, the research module centers on searches by research projects and researchers. Reflecting the balanced distribution of research funding across disciplines in Japan, the project search function enables users to track the latest research trends across all scientific disciplines. The researcher search function effectively links information resources via ORCID. When searching for a researcher, the system not only displays a list of research outputs but also presents a comprehensive knowledge graph, including team members of their research projects, primary publication journals, and academic networks based on citation relationships.

Beyond these domain-specific functions, CiNii Research also integrates natural language processing technology to enable semantic association search. As a key implementation of this capability, NII launched a trial version of the CiNii Research Knowledge Graph Search feature on CiNii Labs in June 2025 (CiNii Labs, 2025).

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This graph database treats entities such as authors, papers, institutions, and data as nodes, and constructing a knowledge graph through relational edges to support complex relationship discovery and path retrieval. In particular, its deep integration with the research management platform has established a full-cycle information chain spanning from research project initiation and execution to the dissemination of results, significantly enhancing the visibility of Japanese academic information resources. CiNii Research's advanced search functions are highly refined: in addition to allowing users to set precise searches by entering specific information such as keywords, titles, individual or group names, and years, users can customize results to prioritize specific source databases or items with available full-text links, tailoring the display to their needs. Furthermore, through IP authentication or remote access via institutional authentication, CiNii Research prioritizes displaying collection information from the user's university library and provides direct links to the OPAC system to check circulation status. For open-access literature, users can click to access the source, quickly completing the integrated process of search, location, and retrieval. The optimization of CiNii Research's search logic facilitates the online discovery and in-depth exploration of academic information, thereby strengthening and clarifying NII's role in supporting Japanese academic research and higher education.

3.3. Advanced English Search

CiNii Research offers a bilingual interface in Japanese and English. In October 2024, NII launched a trial version of the automatic translation feature on CiNii Labs, with the official version planned for integration into CiNii Research during FY2025 (NII, 2024a). Users can utilize this feature to search for Japanese articles using English keywords, and the titles and related index information of the retrieved Japanese articles are translated and displayed in English. Since the Japanese-to-English

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translations are pre-processed and cached in batches, there is no delay in search results caused by real-time translation, ensuring a smooth user experience. An evaluation confirmed that English discoverability of Japanese articles improved significantly, with search results increasing approximately 1.5 times (Yamada et al., 2024). As a result, the international usage of CiNii Research has increased, and NII has achieved significant progress in its efforts to promote the internationalization of Japanese academia.

4. Impact on the Operational Practices of Japanese University Libraries

4.1 Shifts in Library Workflows

CiNii Research appears to have a direct impact on the traditional workflows of academic information resource acquisition, cataloging, and circulation. First, CiNii Research is influencing resource acquisition strategies, with preliminary evidence suggesting a rebalancing toward electronic materials. Second, the focus of cataloging work is shifting from books to digital resources, such as electronic journals, datasets, and research software. Due to CiNii Research's automatic harvesting mechanism, university librarians must ensure the quality of metadata in their institutional repositories; this additional workload, which relies heavily on manual cataloging by library staff, may create a burden. Third, the relative decline in the display priority of the book module within CiNii Research is linked to current circulation trends. Requests for interlibrary loans of print materials are decreasing, while user requests for document delivery and digital delivery are on the rise. Regarding articles in institutional repositories, users prefer to access the electronic full text directly.

4.2 Expansion of Research Support Services

University librarians are leveraging CiNii Research to provide more personalized

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academic information services to faculty and students. They are shifting the focus of student guidance toward topics such as "how to construct precise search queries in CiNii Research" and "how to distinguish between open access and commercial versions," thereby translating information literacy education into concrete practice. For university faculty and researchers, librarians use CiNii Research to identify research topics within the same field, track cutting-edge research frontiers, and find potential collaborators, thereby expanding their research support functions.

5. Implications for China's Higher Education Academic Information Service

5.1. Metadata Standards and Harvesting Mechanism as the Foundation of Unified Discovery

The collaboration and sharing of bibliographic information resources among university libraries in Japan are more advanced than those in public libraries (Gao, 2002). Participating libraries in China Academic Library & Information System (CALIS) Union Catalog's Japanese bibliographic database subproject are also partner libraries of NACSIS-CAT. They rapidly compile bibliographic data for Japanese collections by importing data from Japanese sources. Given the close relationship between CALIS and NACSIS-CAT, comparative studies of the two are relatively comprehensive (Li and Han, 2009; Sun and Wang, 2020). Although CALIS receives government support, it is managed by a consortium and lacks in-depth integration of research project data (equivalent to KAKEN) as well as a national-level metadata harvesting mechanism (equivalent to IRDB). As a result, while CALIS provides a meta-search across multiple databases, it has not achieved the single-interface unified search experience that CiNii Research offers for articles, books, and research projects simultaneously. Table 1 presents a structured comparative analysis of CiNii and

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CALIS across nine operational dimensions.

Table 1 Comparative Analysis: CiNii (Japan) vs. CALIS (China)

DIMENSION	CINII (JAPAN)	CALIS (CHINA)
OPERATING ENTITY	NII (government-led, non-profit)	Peking University / Ministry of Education (consortium)
FUNDING MODEL	MEXT fiscal appropriations	Government + membership fees
RESOURCE COVERAGE	Articles, books, dissertations, projects, data	Articles, books, dissertations, IR metadata
INTEGRATION STATUS	Unified search (single interface)	Federated search (three-tier cloud, OAI-PMH)
OA POLICY ALIGNMENT	Discovery-layer OA	Hybrid (OA + licensed)
METADATA STANDARD	JPCOAR (interoperable with COAR)	CALIS standard (MARC, OAI-PMH based)
RESEARCHER-PROJECT-OUTPUT LINKAGE	KAKEN + ORCID integration	Limited project linkage
INTERNATIONAL VISIBILITY	Bilingual (JA/EN); auto-translation	Limited English interface
KNOWLEDGE GRAPH	Entity-based (authors, papers, institutions, data)	Under development

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Specifically, China could adapt the JPCOAR model to develop a Chinese Institutional Repository Metadata Interoperability Standard that harmonizes the heterogeneous metadata schemas currently used by CALIS, CNKI, and university repositories. Drawing on CiNii Research's harvesting mechanism, a national

harvesting mechanism could implement automated OAI-PMH harvesting from institutional repositories, coupled with graph-database mapping to establish entity links among researchers (via ORCID or domestic author IDs), funded projects (via NSFC/NSSF databases), and research outputs. This would create a full-cycle knowledge chain—from project initiation to output dissemination—analogous to CiNii Research's integration with KAKEN. By positioning itself as a research support hub, an academic information service platform for higher education holds a strategic advantage and is gradually assuming additional responsibilities, such as the long-term management of research outputs.

5.2. Public-Interest Academic Information Platform Driven by Government Leadership and Open Access

Beyond its technical architecture, the key insight from CiNii Research for China pertains to its governance model and institutional sustainability. NII's status as a government organization and its reliance on fiscal appropriations for operational funding establish the CiNii platform as a government-led, public-interest platform dedicated to promoting the collaborative creation and sharing of academic information, representing a fundamental difference from the operational mechanisms of other for-profit knowledge bases (Zhang, 2023). The Open Access Acceleration Project demonstrates Japan's substantial financial commitment to preparing universities and research institutions for national immediate open access, with NII RDC serving as the core platform. As one of the knowledge infrastructures compliant with these policy requirements, the CiNii platform, together with J-STAGE and various institutional repositories, forms Japan's public service network for open access academic information. CiNii Research directs users to full-text links rather than directly hosting the full text. This "discovery rather than provision" model is more

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prudent in terms of copyright management, while simultaneously increasing the visibility of institutional repositories across Japan and showcasing academic outputs on a national and even global scale. The open access dimension of CiNii Research extends beyond content availability to structural design. Unlike commercial discovery platforms that prioritize subscribed content, CiNii Research's ranking algorithm prioritizes open-access and institutional-repository materials, actively redistributing traffic toward publicly accessible outputs. This architectural commitment to open access represents a form of "platform-level open access policy" where infrastructure design itself enforces openness.

For China, this suggests a tiered infrastructure governance model: a national discovery platform and institutional repositories, avoiding the copyright and storage burdens of centralized hosting. Furthermore, facing the dual challenges of language barriers and limited channels in academic dissemination—common to non-English-speaking countries—China's higher education academic information services can both draw on CiNii Research's recent experience in leveraging machine translation to attract overseas users and learn from NII's long-term strategy of supporting academic publishing to enhance international academic influence, propelling Chinese academia onto the global stage.

6. Conclusion

The evolution of CiNii Research illustrates the emergence of smart knowledge infrastructure in the era of open access. Transcending "knowledge passivity"—where users retrieve isolated documents—toward "cognitive activeness," it leverages knowledge graphs and semantic search to reveal relational insights and latent patterns across the research lifecycle. This paradigm shift positions CiNii Research as an intelligent intermediary that augments scholarly cognition beyond conventional

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indexing, reshaping operational practices in Japanese university libraries while offering valuableinsights for China's higher education sector, specifically through unified metadata standards, a national harvesting mechanism, and platform-level open access design. Beyond technological innovation, NII's government-led, public-interest approach underscores that sustainable knowledge infrastructure requires not only advanced technology but also institutional commitment to openness and interoperability.

Author contributions

The sole author Yin Qiqi contributed to all aspects of this manuscript, including conceptualization, methodology, investigation, writing – original draft, writing – review & editing, visualization, and project administration.

Availability of data and materials

Not applicable.

AI usage statement

During the preparation of this work, the author used Deepseek in order to translate. After using this tool, the author reviewed and edited the content as needed and take full responsibility for the content of the publication.

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

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Author biography



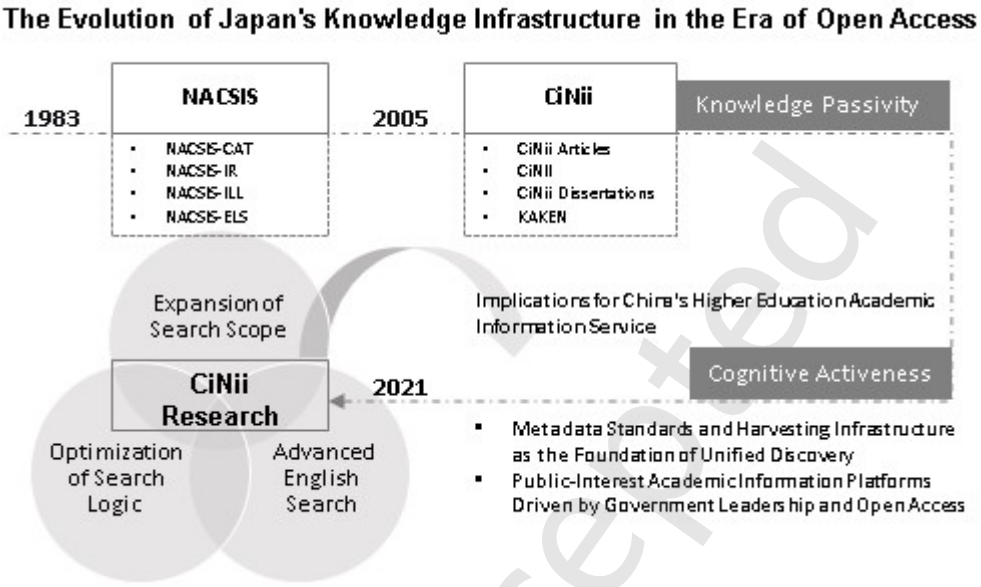
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447 include development of documentary resources and sinology abroad.

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449 **Graphical abstract**



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