

## Bridging the Digital Divide: Discovery Services and Federated Search for E-Resource Accessibility

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### ABSTRACT

*The digital divide continues to pose challenges for equitable access to information, particularly in academic and research settings. With the exponential growth of digital content, academic and research libraries are increasingly relying on electronic resources (e-resources) such as e-journals, e-books, and databases. Federated search and discovery services have emerged as essential tools to streamline access to these diverse and dispersed e-resources. This paper explores how federated search and discovery services can mitigate this gap by providing unified, efficient, and user-friendly access to electronic resources (e-resources). By analysing current technologies, user experiences, and accessibility outcomes, in addition to that the study highlighted how these tools enhance digital inclusivity and support information equity of stakeholders.*

**KEYWORDS:** Federated Search, Discovery Services, E-resources, Digital Divide.

### INTRODUCTION

Access to digital information has become necessary for education, research, and scholarly communication. With the immense growth of electronic resources, the traditional methods for determining resources are no longer sufficient. Users are now expecting instant access to appropriate information, irrespective of the source or format. The exponential growth of electronic resources in academic libraries has posed significant challenges in ensuring seamless and efficient access to scholarly content. Federated search and discovery services have materialised as vibrant tools to channel this gap by accumulating different information sources into a single, searchable interface (Joint, 2009). A discovery tool is often referred to as a stand-alone OPAC, a detection layer, a discovery layer interface, an OPAC replacement, or the next generation catalogue (NGC) (Yang & Wagner, 2010). The digital divide, generally known as the gap between those who have and those who do not have access to digital information and the ICT arena. Students, researchers, and library users in regions with inadequate resources commonly face barriers in retrieving academic resources. The above-mentioned problems may be addressed by the use of Federated search and discovery services, which will offer possible solutions by bridging the connection to a comprehensive array of digital content through a single platform from various databases.

## **OBJECTIVES**

1. To discover the role of federated search and discovery services in reducing digital access gaps.
2. To evaluate how these tools support users with limited technical skills.
3. To recommend best practices for using discovery interfaces to bridge the digital divide.

## **REVIEW OF LITERATURE**

**Trujillo (2025)** opined that Library discovery facilities aim to provide the best of both worlds by making it simple to locate materials on a subject as well as well-known titles. However, users' demands are not always met by the experience of obtaining known goods. The mutual rank of 102 popular book labels examined in Primo, EBSCO Discovery Service, and WorldCat Discovery at various institutions was measured in order to investigate problems with recognised materials.

**Sachin et al (2020)**, Opined that it has already had a greater impact on all aspects of the information industry, and the impact of information technology is simply ruled out. The question today is how much the libraries have adopted emerging technologies to support research, teaching, and learning activities. The use of these technologies in research and academic libraries has been highlighted through live case studies. The authors concluded with a suggestion to create the finest possible learning resource centre and utilize ICT resources to the fullest extent possible while staying within the constraints of the current library system to keep up with the latest advancements. The Federated Search Tool, as represented in this work by **Lingam (2020)**, aggregates the resources to which a library promises and enables cross-searching of these resources. They function by facilitating computer-to-computer communication using the Z39.50 protocol, which database providers utilize. Search providers are also covered.

**Chatterjee and Das (2015)** explored the extent to which the Web Scale Discovery Service and its tools have progressed in becoming the next-generation catalogue. The development of the Discovery tool and service is summed up in the paper. The service offered by the IIT Kharagpur Central Library, known as "E-Search Software," is also covered in the study. While many next-generation catalogue capabilities are present in discovery tools, only a small number of them are truly next-generation catalogues. Both open-source and proprietary discovery technologies lack two key features: federated searching and relevance established based on circulation statistics. Information on the Central Library of IIT Kharagpur's discovery service is provided in this document. It will give details on the precise position of discovery tools about the much-anticipated next-generation catalogue.

**Hussain (2015)** examined the Federated search's benefits and drawbacks. The author gives a summary of the federated model of information search and retrieval and investigates the different federated search products used by various libraries. Using search phrases like "federated search," "cross-search," "metasearch," interoperability, and digital libraries, a limited literature search was conducted. Federated search in numerous reputable databases, both domestically and abroad, as well as a compilation of federated model and search product literature, were located and obtained.

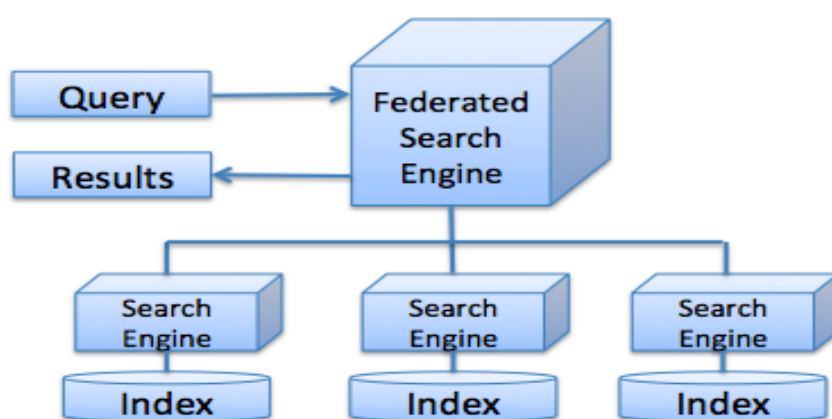
**Sharon and Wagner (2010)** aim to assess and contrast proprietary and open source discovery tools to determine the extent to which discovery tools have advanced toward becoming the next generation catalogue. Both open source

and branded discovery technologies lack two features: federated searching and relevancy based on circulation statistics. When it comes to adopting the more sophisticated aspects of the next generation catalogue, open source discovery tools appear to be more daring and creative than proprietary ones. It could be necessary for discovery tool vendors to accelerate their efforts to catch up. It is the first extensive assessment and comparison of proprietary and open-source discovery tools. It will give details on the precise position of discovery tools about the much-anticipated next-generation catalogue.

## **CONCEPT OF FEDERATED SEARCH**

### **Introduction**

Federated search is defined as a system that supports users in searching several databases and repositories simultaneously through a single request interface. It permits users to search various databases simultaneously through a single query interface, retrieving real-time outcomes from different sources. This search refers to the practice of retrieving information from multiple distributed search engines and databases of all forms from a single user interface and considers it to be a one-stop shop for data search. It is a searching system that uses a unique request to access information simultaneously across numerous indices, which include databases, cloud storage solutions, and Application Programming Interfaces (API's). Desperate searching on one index, which will yield the most exact results for that information, while it collects information from all the available sources and shows the most appropriate output from the combined datasets. (Mukhopadhyay, n.d.) Observed that Federated Searches operate in real time and depend on the resources they are interacting with for data storage and retrieval; they do not store data anywhere. (Lingam, n.d.) Opined that a federated examination tool, which brings together the resources of a library subscription and permits cross-searching of these resources. They work using the Z39.50 protocol, used by database providers to facilitate communication between computers. It allows fetching information from several data sources with a single search query, which triggers an engine that seamlessly aggregates the information and outputs the key results. Federated search is a system that allows users to search multiple databases and the library catalogue through a single interface and query, compiling and organizing the results for review.



### **Key Characteristics include**

- **Instantaneous access to information from various databases:** Information can be retrieved spontaneously from different databases

- **Unified interface with scattered query processing:** Provides a single, consistent interface through which users can search queries and process the queries independently and get results.
- **Content storage requirements are not needed:** The user does not require storing information locally because the system can access queries from multiple external sources and acts as a direct content provider to the users
- **Integrated results: Federated search provides consolidated and systematized results that** are retrieved from multiple data sources, deduplicated, classified, arranged, and presented in an integrated and comprehensible format to the user.
- **Customizable Search:** It helps to get the results according to the user's particular preferences, requests, or contexts. It improves user control, precision, and relevance in resource discovery.
- **Reduce Time and Effort:** Federated search can save the time and effort of the user to get information because it can be able to access data from different data sources and display it in a unique interface.
- **Data security and Integrity:** It ensures user privacy from unauthorised access and guarantees that the accessed and displayed data is correct, reliable, and unchanged during transmission and processing.
- **Metadata and Search Index:** It enriches searchability, faceted navigation, resource discovery, and networking. High-grade metadata improves search relevance, user experience, and access, while vigorous indexing certifies performance and scalability through different content sources.
- **Relevance and Ranking:** It helps the users to provide the most appropriate, latest, relevant, and top-scoring information based on users' queries from multiple databases.

### **Advantages of federated search**

(Kumar et al., n.d.) The advantages of federated search include the following

- Reduce the time required for basic information search.
- Simultaneous searching from different sources at the same time.
- Provide direct links to navigate the source for advanced browsing.
- Capability to filter, sort, save, print, and export.

### **Disadvantages of federated search**

According to Mukhopadhyay (n.d.) discussed the disadvantages of Federated Search include the following:

- Whole dependence on single platforms' live API/RSS feeds (won't work if any one goes down)
- Not a worthy solution for a large amount of resources, too many requests/answers, delays
- Data sources may deliver diverse formats, and determining the relevancy of each platform live is a task
- Result list populates based on the time taken to get the results, not necessarily relevance

### **Challenges**

- **Passing of Credentials:** The users have to provide their authentication information to log in to access the information may be that information can be transmitted to external content providers or databases. It facilitates continuous access to authorized or licensed resources without necessitating the user to log in repeatedly.

- **Mapping results list navigators into a common form:** It is critical to provide a smooth, innate user experience in federated search environments. It safeguards that, despite backend diversity, users interrelate with cohesive and identical search results.
- **Sorting and scoring results:** These are important utilities in search systems that determine how outcomes are evaluated and presented. Inaccurate scoring systems and improper sorting options decrease the effectiveness of discovery and federated search platforms.
- **Robust query:** It highlights the complications in analysing and implementing various user queries across different systems. Overcoming it needs smart normalization, query translation, and semantic understanding, particularly in environments where source variability is high.
- **Availability:** The availability of content from different sources arises from reliance on peripheral content sources with adaptable uptime and contact conditions. To avoid this challenge, hands-on system design, caching, nursing, and redundancy are required to guarantee users have trustworthy access to resources.
- **Development and testing:** It is a tough task to provide a systematic design, application, and assessment to ensure that users can meet the presentation, retrieval, and accuracy of information standards before distribution.

### **Discovery services**

Discovery services are the platforms that produce metadata from a wide range of sources, or databases, repositories, and digital archives, and associate them into a single searchable index. Discovery services build upon federated search by pre-indexing vast amounts of metadata from a wide array of content providers. They function similarly to web search engines, offering faster response times, relevance-ranked results, and a more cohesive user experience. These go a step further by using a pre-harvested central index of metadata from various content providers, offering faster search and better relevancy ranking. (Trujillo, 2025) discussed that Index-based sighting services, which amalgamate content indexes from numerous providers, permit libraries to constitute a single search for physical and online library collections. Pavao, Gabriel Junior, & Vanz (2024) explored that discovery services are particularly treasured for an academic library audience, where users regularly require articles as well as books to conduct research. These are also known as web-scale discovery systems. According to Library Technology Guides, by 2026, discovery services are expected to see major innovations, and library discovery platforms will offer access across all formats and subject areas with a level of complexity and functionality similar to leading web search engines like Google.

### **Features**

According to Breeding (2024), the following features expressly reduce users' perceptual load and enable more efficient navigation through vast digital ecosystems.

- **Unified Search Interface**
- **Relevance Ranking**
- **Faceted navigation**
- **Linked Data Integration**

**Chatterjee and Das (2015)** discussed some of the features of the discovery services that help in the effective and efficient use of these sources by users

- A cohesive platform to explore all the resources, with authorised, open, and local collections.
- Pre-harvested principal index of metadata.
- Google likes a single search box.
- Unique results list for all collections.
- Full-featured user interface.
- Facets and tools for narrowing results.
- Holdings and status information for library catalogue items.
- Connections to full text.
- Infrastructure, processing, and indexing are provided and maintained remotely by the vendor.
- Centralised, local indexing of metadata.
- Advanced filtering and faceted navigation.
- Personalised recommendations and relevance ranking.
- Seamless integration with library holdings and access controls.

Moreover, discovery services uphold the indexing of institutional repositories and open access platforms, thereby increasing visibility of otherwise diminished content.

### **Advantages of Discovery services**

According to **Mukhopadhyay (n.d.)**, some of the advantages that help users use Discovery services for accessing E-resources are as follows:

- A solo interface to search numerous platforms
- Data searched across a central index, no dependency on individual platforms, real-time, fast, and reliable
- Having a central index enables the ability to get relevant results when searching
- A good solution if a large number of platforms/resources are to be searched.

### **Disadvantages of Discovery services**

According to **Mukhopadhyay (n.d.)**, Some of the disadvantages that make it difficult to use Discovery services for accessing E-resources are as follows:

- Producing a central index is generally a massive task; a good discovery service usually incurs a specific cost.
- A central index may be challenging to sustain and update all resources.
- Some platforms update slowly, causing delayed information in search through the central index.
- Information Overload
- Challenges in Filtering Results
- Dealing with Heterogeneous Resources
- Limited to Static Content
- Security and Privacy Concerns

### **Conceptual Framework**

**The Digital Divide:** from the report of OECD (2021) *“The digital divide incorporates differences in physical access (devices, internet), digital skills, and content usability.”* It varies from corner-to-corner territories and may be determined by numerous factors, including: territorial features such as density, demography, and expanse to cities; socio-economic aspects such as gender, age, skill level; and firm appearances such as firm size. Some elements of digital divides are generally attributed to provincial characteristics, and others are regularly highlighted by them, such as those in revenue and ability inequalities.

**Discovery Services:** Discovery services unify access to e-resources by integrating library catalogues, subscription databases, and open-access content under a single search interface (Gross & Sheridan, 2011).

**Federated search:** Federated search varies from discovery services in its real-time approach. Instead of querying a pre-indexed repository, it simultaneously directs user enquiries to various databases and aggregates the results on the server. This dynamic model is particularly useful for institutions that lack the infrastructure or authorisations to gather metadata locally.

**Mukhopadhyay (n.d.)** identified that the leading difference between a federated search and discovery service is that a discovery service would have its information base consist of pre-harvested results from all the different resources.

### **Understanding the Digital Divide in E-Resource Access**

According to OECD (2023), *“the digital divide, often designated in terms of infrastructural or technical gaps, also includes more nuanced barriers associated with digital literacy, content discoverability, and resource accessibility.”*

The digital Divide is multidimensional, encompassing issues of connectivity, digital literacy, and system usability. The digital divide ranges beyond internet access, encompassing inequities in users' ability to locate, assess, and utilise digital content. Libraries in low-income areas often lack adequate infrastructure or access to premium databases, perpetuating information inequality. Moreover, traditional search tools often prioritise commercial databases over open-access repositories, marginalising essential scholarly and community-generated content. Federated search is particularly valuable in bridging access to open educational resources (OER), preprint archives, and government publications. However, it often faces performance challenges, such as slower response times and inconsistent ranking of results (GEM Report UNESCO, 2023). Discovery services support the insertion of institutional repositories, surfacing grey literature, and local research that commercial directories may manage.

**Suryawanshi, Jamade, and Jamade (2020)** identified that a federated discovery service facilitates real-time searches across various information resources simultaneously, helping users to get closer to their theme from different sources, such as library catalogues, e-journals, e-books, databases, institutional databases, and publisher databases.

### **Role in Libraries and Institutions**

**Suryawanshi, Jamade, and Jamade (2020)** noticed that Quality and excellence are interconnected, and hence, to attain excellence in the quality of libraries, it is necessary to adopt up-to-date technological devices towards the enhancement of the efficiency of libraries. Libraries must actively participate in standardisation initiatives and push for metadata quality during vendor negotiations and consortium agreements.

Academic libraries use federated search and discovery services to minimise retrieval to an emerging range of resources. Federated search systems are regularly combined with link resolvers and library portals, allowing users to find full-text articles or request materials via interlibrary loan.

Discovery services and federated search systems are key innovations that simplify the user's journey to finding relevant scholarly content. These tools aggregate metadata and provide a unified search interface for disparate databases and digital repositories. Their role becomes vital in digital-first institutions and for users with limited technical expertise.

### **Interoperability and Metadata Challenges**

According to **NISO (2024)**, a critical limitation of both discovery and federated systems lies in metadata inconsistencies. Libraries trust on standards like Dublin Core, MARC21, MODS, and schema.org to structure metadata. However, observance varies broadly among content providers, leading to issues in record reduplication, field plotting, and semantic retrieval.

Likewise, patented indexing algorithms can present a preference in how content is ranked or displayed. There is an emergent call for transparency and user assistance in algorithm design, especially within educational contexts.

To address these challenges, libraries must:

- Involved in vendor consultations, stressing loyalty to metadata standards.
- Work together in consortia to promote metadata openness and cross-platform interoperability.
- Trained staff in metadata standardisation practices.

### **Recommendations and Future Directions**

To efficiently use discovery and federated search systems in addressing the digital divide, libraries should consider the following strategic actions:

- Implement hybrid discovery models that manage and maintain the strengths of both pre-indexed and federated approaches.
- Rank the assimilation of open-access content to ensure affordability and inclusivity.
- Establish metadata standardisation protocols across library consortia.
- Propose user training sessions concentrated on search literacy, discovery tools, and retrieval of digital content.
- Participate in collaborative aid models for resource-sharing, mostly in low-income areas.
- Form collaborative purchasing groups to make resource access more affordable.

### **CONCLUSION**

Libraries can help bridge the digital divide by implementing interoperable systems, open-access policies, and user-friendly designs in their discovery services and federated search systems. These tools play a crucial role in democratizing access to digital knowledge, but their full potential depends on continuous user education, localized content, and infrastructure improvements. To be effective, libraries must focus on inclusive design, multilingual interfaces, and mobile responsiveness. Collaboration with vendors is also essential to ensure inclusive metadata standards, affordable access models, and training for users and staff. Bridging the digital divide requires a commitment to equitable information access beyond just technical solutions.

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