



UniShare-LMS: A Governance and Credit-Aware Framework for Federated Library Management Systems

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Abstract: Traditional Library Management Systems (LMS) have evolved from fundamental and elementary cataloguing instruments to platforms supporting digital entry and user engagement. However, they continue insufficient for tackling modern obstacles like budget restrictions, resource replication, and equitable admittance across organizational boundaries. This paper introduces UniShare-LMS, a federated framework that merges behavioral management processes with academic prioritization algorithms to permit intelligent resource sharing across library consortia. The system employs a dynamic Student Library Credit Score (SLCS) to incentivize responsible borrowing and a multi-tiered reservation algorithm that allocates resources established on academic relevance alternatively than request chronology. Built on a Koha/ILS core with MySQL backend and React.js frontend, UniShare-LMS applies automated financial management for cost recovery in inter-library loans. Our implementation shows that the integration of credit-aware management with necessity-based queuing significantly improves resource utilization fairness, reduces redundancy, and enhances the sustainability of collaborative library networks.

Keywords: Library Management System (LMS), Federated Model, Resource Sharing, Student Library Credit Score (SLCS), Prioritization Algorithm, Inter-Library Loan (ILL), Koha, Consortium, Open-Source

I. INTRODUCTION

1.1 Background and Context

Academic libraries in the digital era are not constrained to actual sites or distinct systems. College resource management, access enabling, and learning support have all been transformed by Library Management Systems (LMS). Automated essential functions including cataloging, circulation, acquisition, and user administration by LMS platforms enables libraries to operate efficiently and expand their services to meet growing requirements. Though the volume of academic content increases and budgets stay limited, individual universities frequently struggle to provide full digital resource access. From distinct LMS implementations to collaborative, inter- institutional resource sharing models, this complexity has driven a paradigm shift. Cutting duplication, maximizing costs, and ensuring equitable access to academic resources across many institutions are the goals of these models.

1.2 The Rise of Collaborative resource Sharing

Consortium-based approaches have become a key solution in academic institutions aiming to distribute resources. Traditional consortia offer shared subscriptions to electronic publications, databases, and digital archives, hence enabling member institutions access to content at lower costs. More sophisticated systems include Federated Identity Management, Unified Patron Registries, and Need-Based Request Queuing, hence ensuring resource allocation based on scholarly relevance instead of only availability. Recent breakthroughs like the Federated Patron Model and Academic Prioritization Algorithms enable LMS systems to traverse institutional borders. Course enrollment, research relevance, and behavioral indicators including compliance history help these systems to rank requests. These systems further justice in addition to boosting operational efficiency and accountability.

1.3 LMS Evolution: From Automation to Governance

From Control to Automation Financial sustainability and behavioral governance elements are being more and more incorporated into modern LMS designs. The Student Library Credit Score (SLCS), for instance, employs a dynamic scoring technique to adjust borrowing permissions depending on user activity. Automated monitoring of interinstitutional transactions and cost recovery strategies ensure lending institutions are compensated for resource sharing, hence rendering the model scalable and economically sustainable. Modular designs made possible by open-source platforms like Koha and NewGenLib as well as commercial systems help to support these ideas. Recommender systems using popularity-based techniques and cooperative filtering are also integrated into LMS interfaces to personalize user experiences and improve resource discoverability.

2. Literature survey

Academic libraries in India have evolved a lot, mostly from open-source Library Management Systems (LMS) and increased collaboration via resource-sharing consortia. This section delves into important research and practical examples to illustrate how these trends have helped to create more scalable, just, and good governance-centered library systems.

2.1 Open-Source LMS Platforms in India

Indian academic libraries have seen great growth on sites like Koha, NewGenLib, and Evergreen. Their affordability, flexibility, and construction by engaged communities help them to win over people. Originally from New Zealand, Koha now heads India [1]. Its modular design encompasses everything from acquisitions and OPAC services to cataloging and circulation. Libraries can easily link into worldwide bibliographic systems since it is compatible with MARC21 and Z39.50. Universities such Chitkara and Hyderabad have shared their own effective Koha implementations, citing reduced licensing costs and more fluid operations [2]. NewGenLib, created by Verus Solutions in Hyderabad, offers libraries still another strong option geared for India. For libraries with collections in several languages, this is very important because it enables multilingual interfaces via Unicode. NewGenLib is straightforward to use, excels in reporting, and is ideal for small and medium-sized organizations, according to researchers. Indian libraries open-source LMS not just for the cheaper cost; it's also the flexibility. Libraries may link up with national digital repositories, modify workflows [14], and even engage in collaborative development projects—all of which is very important in a nation where library infrastructure and budgets are all over the place.

2.2 Library Consortia: Teamwork in Action

The go-to strategy for solving the growing cost of digital assets and ensuring fair access for all is consortia. Among the well-known figures in India are the UGC-INFONET Digital Library Consortium, established by the University Grants Commission and INFLIBNET to make scholarly journals available to colleges across India. Managed from IIT Delhi, the INDEST-AICTE Consortium helps technical colleges by enabling top engineering and science databases. N-LIST guarantees that undergraduate institutions can purchase journals and e-books at reduced prices, and DELNET enables member libraries to distribute catalogues and books amongst themselves. These entities operate on shared governance; member libraries provide little levies and jointly license digital materials [6]. By this method, academic resources become accessible to more people and duplicate subscriptions are reduced. Recent studies explore the increasing urge to combine open-source LMS with consortia services. Many universities, for instance, utilize N-LIST [15] to access e-resources but manage their own collections via Koha. This “best of both worlds” configuration enables libraries to maintain authority over their own materials while also enjoying the advantages of centralized digital content.

2.3 Governance and Scaling Up: Making it all work

Scientists are now examining the requirements for controlling these combined LMS-consortium arrangements. Among the major concepts is federated identity management [11], which enables teachers and students to access resources and borrow much more readily by using a single login over several libraries. Behavioral credit systems [10]—where pilot projects are exploring points-based systems like the Student Library Credit Score (SLCS) to reward responsible borrowing and aid in determining who first gets resources—is another innovation. Automated financial governance [9] is also being investigated; it tracks transactions and immediately retrieves payments within the LMS, so enabling lending libraries to keep the system running without monetary issues. These concepts reveal a change from just exchanging of resources to smart, policy-driven collaboration. They also fit national goals such Digital India, which aims to open knowledge for everyone utilizing technology.

2.4 The Roadblocks and Possibilities

Open-source LMS and consortia have their challenges in India despite all of the developments. The lack of qualified personnel at several colleges to manage these systems underlines the technical knowledge gap [13]. Adoption is also hampered by infrastructure concerns including erratic internet and obsolete equipment, especially in rural areas. Another difficulty is policy alignment [6], since patience and trust are needed to bring everyone on the same page with respect to regulations and governance. Still, the drive is there. The gaps are gradually closing as more libraries trade experiences and grow local knowledge. Academic libraries that are open, linked, and ready to evolve seem bright going forward.

3. Framework and Design Approach

This chapter describes the framework used to develop and execute a library management system (LMS) governed by a governance structure, conscious of credit, and capable of interacting with other systems. Drawing from both open-source and commercial best practices as sources of concepts and ideas [1][2][12], the approach integrates aspects of system architectural modularity, the behavioral accountability principle, and the scalable inter-institutional cooperation strategy.

Three interoperable layers comprise the LMS. Employing standardized MARC21 or Dublin Core metadata schemes [1][14], the core library management system layer supports conventional library activities like cataloging, circulation, acquisitions, and serials control. Ensuring appropriate data sharing among institutions is the joint data layer, which consists of a union catalog, federated patron registry, and digital resource index [6][8]. Behavioral scoring is overseen by the management layer via the Student Library

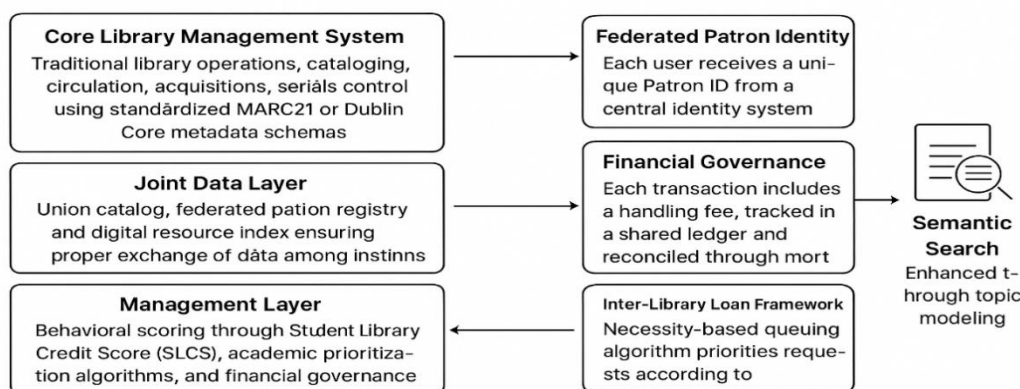
Credit Score (SLCS), academic prioritization algorithms, and financial governance procedures [10][13]. This multi-tiered design guarantees the library's ability to develop while retaining sophisticated features next to fundamental services without disturbance. The technology stack combines several elements. With JavaScript, HTML5/CSS3, Python (Tkinter for desktop, Flask/Django for web), the frontend is created. For structured data, the backend employs MySQL or PostgreSQL; optional NoSQL databases such as MongoDB are used for topic modeling [2][12]. For ERP integration, federated identity systems, and external LMS systems, middleware depends on RESTful APIs [11]. Security is guaranteed via role-based access control, encryption of consumer data, audit trails, and GDPR [11][13] data protection compliance.

At the heart of the system is the inter-library loan (ILL) framework. A central identity system gives each user a distinctive Patron ID that follows them around all transactions [11]. For correct discovery, a single union catalog compiles real-time-updated bibliographic records and availability data from all participating libraries [6][8]. Using SLCS [10][13], requests are prioritized via a need-based queuing algorithm taking into account academic relevance, course credit weight, and behavioral tie-breakers. This guarantees that academic need comes first over simple timing, hence providing everyone equal access. Financial governance is automated with each transaction containing a handling fee, monitored in a shared ledger and reconciled through monthly reports to guarantee transparency and sustainability [9][13].

Limitations in conventional transactional systems give rise to the need of contemporary ILL. Regardless of urgency, ancient systems handled requests in the order they arrived, therefore frequently delaying important educational resources [6][7]. Modern frameworks like UniShare-LMS give academic relevance top priority for requests, therefore guaranteeing that a dissertation-related query is not postponed by ordinary borrowing [10]. Federated patron identity links borrowers' academic profile and borrowing patterns to a single persistent ID, guaranteeing recognition of users across institutions [11]. Financial control generates reconciliation reports [9] and automatically records charges, so enabling sustainable sharing. Audit trails that record every request, transfer, and return keep transparency, thereby fostering confidence and accountability throughout the alliance [9][13].

The behavioral credit system (SLCS) inspires responsible borrowing [10][13] by means of a points-based model in place of penal penalties. Scores are modified according to user actions: prompt returns add points; early pickups give bonuses; late returns, missed bookings, or uncompensated payments decrease points. The number of items permitted, reservation priority, and loan periods [10] all depend on this score, which follows the user around universities. Low scores provide mild restrictions; high grades enable benefits including greater borrowing privileges. Dashboard, reminders, and incentives like badges and leaderboards ensure transparency; these link with student ERP systems to combine academic and library behaviors [13].

Finally, topic modeling improves semantic search by using latent Dirichlet Allocation (LDA) to find underlying themes from e-book content and enabling users to search by topic instead of by keywords [12]. The workflow comprises converting content into bag-of-words format, using LDA to find topics, tagging documents with topic vectors, and allowing theme-based search and filtering. This enables consumers to choose the most pertinent books with assurance [12], lowers time lost on pointless content, and raises awareness of forgotten resources.



4. System Evaluation and Implementation Framework

4.1.1 User Experience and Usability

The fundamental needs for all user groups are the intuition and accessibility of the Learning Management System [1][2]. Real-world scenarios, including requesting an inter-library loan, checking credit scores, and booking or buying trip tickets, should be part of usability testing [7]. Task completion rates, time taken to complete tasks, frequency of user mistakes, and user pleasure ratings gathered via surveys form the assessment criteria [1][2].

4.1.2 Impact on Behaviour (SLCS)

Promoting borrowing in a responsible manner, the Student Library Credit Score (SLCS) [10][13] seeks to encourage such activity. One of the means to gauge its success is by studying data on user behaviour before and after the system's launch. Reduction in late returns, increase in early pickups, and changes in average SLCS ratings across user groups [10] represent the most significant points.

4.1.3 Equity in resource distribution

Based on academic relevance and user behaviour [6][8], the aim of the prioritization algorithm should be to drive resource allocation. Evaluation should centre on the proportion of prioritized requests fulfilled, distribution of high-demand resources among universities and levels, and user perceptions on justice derived from their feedback [11].

4.1.4 System Performance

From a technical standpoint, the LMS should be fast and stable [1][12]. The performance indicators include average response time for catalogue searches, processing time for ILL requests, and system uptime and stability [2].

4.1.5 Financial sustainability

Because the financial governance is automated, it ought to be open and effective simultaneously [9][13]. The assessment might cover timeliness and clarity of reconciliation reports, precision of inter-institutional fee tracking, and overall cost recovery rate for lending organizations [9].

4.2 Implementation Requirements

4.2.1 Technical Infrastructure

Scalable architecture (either cloud-based or on-premise) [1][2] It is advised to utilize secure relational databases like MySQL or PostgreSQL [12]. With role-based access control and encrypted data processing [11], a web-based user interface must be responsive. Integrating it with institutional ERPs and federated identity systems is vital [6][11].

4.2.2 Organizational Readiness

Consortium agreements should officially define shared governance, SLCS policies, and ILL procedures [3][4]. Along with onboarding materials and support for students and faculty, programs for librarians, IT employees, and administrators are required [5][6].

4.2.3 Regulation Framework

SLCS scoring guidelines [10][13], limits, and appeal processes have to be exactly established. One should set established standardized ILL request prioritization and service-level agreements [6]. Handling fees should be set up beforehand; reconciliation processes automated for financial governance [9].

4.3 Implementation across Organizations

4.3.1 Pilot Implementation

Testing core characteristics requires a little group of organizations (3–5) chosen [3][4]. Confirmation of federated identity integration, SLCS scoring and access modulation testing, piloting ILL routing and fulfilling processes, and feedback gathering for improvement are the primary concerns of this stage [6].

4.3.2 Regional Development

Following the pilot's success, the mechanism should be rolled out to a regional group of organizations [5][6]. This phase entails scaling up infrastructure, harmonizing institutional policies, catalog integration, engaging consumers via staff events and training, and creating governance structures with cost-sharing models [6].

4.3.3 National or Cross- Border Integration

Once developed, the LMS can be integrated into national or international academic networks [3][5]. This stage includes conformance with national digital libraries and repositories for smooth data interchange, multilingual support and localization, cross-border ILL agreements with legal compliance, and national-level reporting and analytics [6].

4.4 Workflow Overview

4.4.1 User Interaction Process

A student accesses the LMS through federated identification [11]. The system gathers the SLCS score [10] as well as the academic profile. Should the local resource be unavailable, the system automatically begins an ILL request [6]. The prioritization algorithm grades academic relevance and SLCS score [10][13]. The resource is dispatched from a lending company once approved; the user gets a message with pickup information [9].

4.4.2 SLCS Monitoring and Correction

Every user interaction—borrowing, returning, and booking—is noted [10]. Proper actions such returning on time enhance the SLCS score; wrong behaviors such late returns reduce it [13]. Real-time indicator, the SLCS score helps to define borrowing rights including the maximum of items allowed or reservation priority [10]. A unique interface that promotes candor and accountability lets users see their results and history [13].

4.4.3 Work process for interlibrary loan

Participating institutions keep records of all the items they have in the union catalog [6][8]. The system looks the network [6] if a user purchases something not available in the neighborhood library. Based on academic urgency and SLCS score [10], requests are graded. The lending company handles the application and dispatches the product [9]. The system records the transaction and changes the financial ledger once done [9][13].

4.4.4 Financial Governance Process

For every ILL transaction, a predetermined handling fee is charged [9]. The system records the charge automatically and produces monthly reconciliation reports [9][13]. Institutions can monitor their borrowing and lending balances to guarantee openness and sustainability [9].

4.5 Implementation Architecture

4.5.1 Core Components

Acquisition and inventory manages procurement and stock tracking [2]. Digital resource access balances e-books, periodicals, and multimedia material [12]. Cataloging and metadata use MARC21, Dublin Core, and user-defined schemas [14].

4.5.2 Governing Layer

The SLCS engine translates and keeps track of changes in user ratings [10]. Ranked ILL requests [13] by the prioritization algorithm utilizing academic and behavioral data. User rights are modified in response to SLCS levels [10].

4.5.3 Common Data Services

Across institutions, the federated identity system verifies user identity [11]. Combining holdings of all member libraries [6][8], the union catalogue searches. The patron registry maintains consolidated user profiles and borrowing history [6].

4.5.4 Integrative Interface

RESTful APIs enable interaction between digital repositories, external LMS platforms, and ERP systems [11]. Secure access is provided by authentication techniques including LDAP, OAuth2, and SSO [11]. Reporting tools produce analytics for financial tracking, compliance, and usage [9].

4.5.5 Compliance and Security

Role-based access control provides suitable rights for employees and users [11]. AES-256 encryption protects sensitive data [12]. GDPR-compliant data handling and audit logging keeps accountability high [11].

5. Critical Insights and Discussion

Looking at the current studies and summarizing the key ideas, several elements of the UniShare-LMS model for consortium-based academic libraries come out. Begin with the federated architecture. For linking several universities, this three-tiered approach—Core LMS, Shared Data, and Governance—makes logical sense. Placing the Union Catalogue and Federated Patron Registry in the Shared Data level solves two important problems right away: facilitating resource discovery and handling user identities across libraries. Earlier studies on federated models back this strategy. This architecture gives consortium libraries the tools they need to share resources effectively.

The Student Library Credit Score (SLCS) follows next. This idea stresses rewarding good deeds rather than dwelling on punishments. Research shows that rewards are more successful than penalties in changing how library visitors behave. The scoring system—earning points for timely returns, losing points for overdue items or missed reservations—directly impacts how consumers engage with the system. The goal is simple: encourage sensible borrowing and keep materials flowing. Should it be properly put in use, this should let the system run more seamlessly. Another crucial factor is justice. Traditional first-come-first-served booking systems often favor certain users above others. The Dynamic Reservation Prioritization Algorithm (O3) solves this by assessing who needs them most, considering criteria including Major Relevance, Course Credit Weight, and SLCS, not just assigning resources to the first request. This approach matches resources with educational requirements, which is in line with what studies indicate is needed for genuine fairness. Finally, sustainability is vital. Inter-Library Loan programs frequently have expenses and trust issues. The structure offers financial clarity by assigning a clear handling fee to each cross-institutional transaction and using automated ledgers and reporting. This solves a major obstacle and builds trust among member libraries, therefore making the consortium model more financially viable. Generally, the UniShare-LMS framework directly addresses major challenges—collaboration, user behavior, fairness, and sustainability—offering practical solutions based in both research and real-world needs.

6. Conclusion

The development of Library Management Systems from discrete institutional instruments to wise, governance-oriented platforms for inter-institutional cooperation has been thoroughly investigated in this review. The study of current open-source solutions and consortium models in India points toward a clear path toward more integrated and equal resource sharing. The suggested UniShare-LMS approach captures this development. Through the Student Library Credit Score (SLCS) and algorithmic fairness via the Dynamic Reservation Prioritization Algorithm, it successfully shows how a modular architectural design may be efficiently combined with behavioral incentives. Furthermore, its integrated financial governance model for Inter-Library Loans offers a crucial basis for long-term sustainability. In conclusion, frameworks like UniShare-LMS will help transform libraries into proactive, cooperative centers that directly and effectively support the academic mission by using technology to promote fairness, encourage responsibility, and guarantee operational transparency.

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