

ANNOTATION
to the dissertation for the degree of Doctor of Philosophy (PhD)
in 8D03206- Library Information System

Kolbayev Nurbolat Shagymanuly
«Methodology for modeling e-libraries in higher education institutions (based
on the example of Al- Farabi Library)»

Relevance of the research topic. This study is devoted to the issues of designing and developing electronic libraries in higher education institutions. An electronic library is a complex information and communication system that plays a vital role in preserving and disseminating knowledge, science, and cultural heritage in the context of the modern information society. The functions of a university library are no longer limited to collecting and storing information—they now include knowledge transfer, scientific communication, and the provision of user-oriented intellectual services.

Within the framework of the dissertation, a new-generation model of an electronic library is proposed—a multi-level architectural and functional model. This model is considered an integrated system that meets modern technological standards and user requirements. The model structure includes functional-service, ontological, user, and integration levels. The proposed model was tested and implemented in the infrastructure of the Al-Farabi Kazakh National University Library.

The analysis of theoretical models (5S, DLRM, CIDOC CRM, DOLCE, DELOS) made it possible to develop new methodological foundations tailored to the academic environment, with an emphasis on cognitive and ontological support. In addition, a combination of international and national evaluation tools (e-SQMSU, SUS, UEQ) was applied to assess the system's quality. Thus, this study conceptualizes the electronic library not only in technical terms but also in pedagogical, cultural, and scientific dimensions.

Relevance of the Research Topic

In the context of the information society, the higher education system is undergoing fundamental transformations. For next-generation universities, it is crucial not only to provide high-quality education and conduct scientific research but also to develop a modern digital infrastructure. In this process, electronic libraries play a key role as an essential component of the digital educational environment.

Electronic libraries offer academic and research institutions new opportunities for searching, processing, storing, and disseminating information. However, in most Kazakhstan universities, the existing electronic library systems are based on ready-made platforms (such as IRBIS, KOHA) and are primarily limited to the digitization of book collections. These systems generally do not provide a fully integrated architectural model, ontological modeling, user-oriented services, or cognitive support.

Moreover, the relevance of the topic is reinforced by the insufficient scientific and methodological development of electronic library design, the mismatch between regulatory frameworks and modern theoretical models, as well as the inadequate implementation of international standards (RDF, OAI-PMH, DSpace, CIDOC CRM, DOLCE).

The State program "Digital Kazakhstan", the new edition of the Law "On Education" (2023), and the Concept for the Development of Artificial Intelligence for 2024–2029 provide for the modernization of educational infrastructure. In this context, the creation of an intelligent, multi-level electronic library fully aligns with the strategic directions for the development of the national higher education system.

These factors underscore the necessity of developing a modern model of an electronic library tailored for universities. The proposed model is aimed at seamless integration into the digital educational environment, ensuring cognitive support for students and faculty, ontological organization of educational resources, and the application of measurable effectiveness criteria.

Scientific Novelty of the Research:

A multi-level architectural and functional model of an electronic library has been developed, designed for integration into the digital infrastructure of higher education institutions and external educational platforms.

Theoretical methods for building a university electronic library have been substantiated based on the evolutionary concepts of digital libraries (DL 1.0–DL 4.0), as well as the 5S and DLRM models.

Mechanisms for classifying information flows and integrating them with academic digital resources have been proposed.

The model's effectiveness was tested on the basis of the library of Al-Farabi Kazakh National University.

Object of the Research:

Electronic libraries of higher education institutions as an integral component of the digital educational and research infrastructure.

Subject of the Research:

Methodology of design, architecture, ontological modeling, and performance evaluation of electronic libraries in the academic environment.

Research Sources:

The theoretical and practical foundation of the dissertation is based on domestic and international scientific publications, official regulatory documents, electronic resources, and empirical data. The main sources are classified as follows:

Scientific and Theoretical Literature:

1) Foundational works on the theory of digital libraries, their evolution, and conceptual models (5S, DLRM, CIDOC CRM, DOLCE, Delos):

- William Y. Arms – Digital Libraries
- Edward A. Fox – 5S Framework for Digital Libraries
- Christine L. Borgman – Scholarship in the Digital Age
- Clifford Lynch, Michael Lesk, Ian H. Witten, Michael Buckland, Marcia J. Bates, Sarah Shreeves, Carl Lagoze, and others.
- Works on ontological modeling of digital libraries:

– Official documents and academic papers describing the CIDOC CRM and DOLCE models.

- Studies on the architecture of digital libraries and software infrastructure:

- Works by developers of the DELOS Network and DSpace (Candela L., Smith M., Walker J., Ioannidis Y., et al.)

2) *Domestic Scientific Research:*

- Publications by Kazakhstan researchers in the fields of digital education, informatization, and electronic resource modeling:

- G.I. Nurzhanova, K.T. Tuyenbayeva, A.E. Sagimbayeva, S.A. Adilzhanova, A.M. Akhmetova, M.V. Grishko, D.K. Darkenbayev, A.Zh. Kartbayev, A.S. Karibayeva, and others.

3) *Regulatory Documents and State Programs:*

- Law of the Republic of Kazakhstan “On Education” (2023 edition)

- Government Decree No. 827 – Digital Kazakhstan State Program

- Order of the Ministry of Science and Higher Education of the Republic of Kazakhstan No. 44

- Concept for the Development of Higher Education and Science for 2023–2029

- Concept for the Development of Artificial Intelligence for 2024–2029

4) *Practical Basis and Empirical Data:*

- Main experimental platform: the library of Al-Farabi Kazakh National University

- Library architecture, functional systems, the IRBIS 64+ automated library and information system, repositories, and integration with educational platforms (LMS, Univer system, external databases)

- User surveys and model effectiveness evaluation based on e-SQMSU, SUS, and UEQ

- Implementation act of the electronic library and internal operational reports

5) *Scientific Publications and Conference Materials:*

- Author's research papers on the dissertation topic:

- 3 articles in journals recommended by the Committee for Quality Assurance in the Sphere of Science and Higher Education of the Republic of Kazakhstan

- 1 article in a journal indexed in the Scopus database

- 2 articles in proceedings of international scientific conferences

- Participation in scientific events:

- International conference Farabi Aleml

- Scientific and practical conference BiblioPiter–2022

- International conference Central Asia – 2024 (Jizzakh, Uzbekistan)

- Discussion of research outcomes during a scientific internship at Istanbul University (Turkey)

Research Base:

The primary practical base for this research is the Scientific Library of Al-Farabi Kazakh National University.

Research Methods and Methodological Foundation:

The study employs methods of modeling, ontological classification (CIDOC CRM, DOLCE), user experience evaluation (e-SQMSU, SUS, UEQ), architectural analysis, and cognitive design.

Research Aim:

To develop a multi-level architectural and functional model of an electronic library, integrated into the digital infrastructure of a higher education institution and adapted to the intelligent ecosystem.

Research Objectives:

- Analyze the evolution of digital libraries (DL 1.0–DL 4.0), their functions, and typical models (DLRM, 5S Framework, CIDOC CRM, DOLCE, Delos);
- Define key design principles: modularity, semantic completeness, cognitive support, interoperability;
- Develop a multi-level model of an electronic library with an ontological core;
- Implement the proposed model in the library of Al-Farabi Kazakh National University and formalize the implementation through an official act;
- Evaluate the model's effectiveness using the e-SQMSU criteria (PPB, FB, EU, UMV), as well as SUS and UEQ methodologies;
- Disseminate the research findings within the academic community.

Research Hypothesis:

It is assumed that integrating ontological knowledge models with functional search and personalization services within a unified architecture of the electronic library will enhance information accessibility, improve user experience, and ensure effective integration of the library into the university's educational and research ecosystem.

Theoretical and Practical Significance:

This research contributes to the development of digital library theory, ontological modeling of information in academic environments, and cognitively-oriented information systems. The work provides a scientific and methodological foundation for designing next-generation academic digital libraries.

The architectural model of the Al-Farabi electronic library and the methodology developed on its basis can be effectively used in the creation and modernization of electronic libraries in higher education institutions, as well as in the development of digital educational platforms, academic repositories, and integration services.

Key Provisions to Be Defended:

- Based on the theoretical analysis of the evolutionary stages of digital libraries (DL 1.0–DL 4.0) and their conceptual models (DLRM, 5S, CIDOC CRM, DOLCE), theoretical and methodological foundations were developed for designing next-generation digital libraries adapted to higher education institutions.
- A multi-level architectural and functional model was developed, integrable into the digital infrastructure of universities and external educational platforms (LMS, academic repositories, databases). The model includes user, service, ontological, repository, and integration layers.

- An ontological core was formed based on CIDOC CRM and DOLCE, ensuring semantic organization of knowledge. This core enables intelligent search, thematic navigation, and personalized learning trajectories.

- A comprehensive methodology for evaluating model effectiveness was developed using e-SQMSU, SUS, and UEQ tools, and was tested with real users. The results demonstrated a high level of user satisfaction and functional alignment.

- The proposed model was implemented in the library of Al-Farabi Kazakh National University and officially validated. Its integration capabilities, level of cognitive support, and architectural robustness demonstrated successful adaptation into the university's digital educational and research processes.

Publications and Research Validation:

As a result of the research, 6 articles were published. Among them, 3 articles were published in journals recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan. Two articles were presented at international scientific and practical conferences held in Kazakhstan. In addition, one article was published in an international journal indexed in the Scopus database and having a non-zero impact factor. The dissertation was reviewed and discussed by the Chair of World History, Historiography and Source Studies at Al-Farabi Kazakh National University and was recommended for defense.

Structure of the Dissertation:

The dissertation consists of an introduction, three chapters, and a conclusion. The total length is 170 pages, including 9 figures, 12 tables, 19 diagrams, 2 charts, and a reference list of 153 sources.