FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 10 No. 5, March, 2026, pp 161 – 164
DOI: https://doi.org/10.33003/fjs-2026-1005-4809

COMPARATIVE ANALYSIS OF CASE-TOOLS FOR LABORATORY INFORMATION SYSTEMS IN THE MINING INDUSTRY

[1]Rozikulov Aziz Nosirovich, [2]Carsten Drebenstedt, [2]Rozikulov Abrorkhon Nosirovich, [3]Toshov Javokhir Burievich, and [4]Rodica Cujba Stepanek

[1]The Higher School of Business and Entrepreneurship under the Cabinet of Ministers of the Republic of Uzbekistan, Tashkent, Uzbekistan.
[2]Department of Mining and Special Civil Engineering, TU Bergakademie Freiberg, Germany.
[3]Tashkent State Technical University, Uzbekistan.
[4]Department of Mines, Oil and Gas, University of Petrosani, Petroșani, Romania.

ABSTRACT

LIMS (Laboratory Information Management System) in the mining industry must support the entire cycle of laboratory processes, from sample collection, registration and tracking to analytical testing, calculation of ore quality indicators and generation of regulated reports. The system must ensure integration with the enterprise's corporate information circuits (ERP, MES, SCADA), support the requirements of ISO 9001 and ISO/IEC 17025 standards, and guarantee the reliability, integrity and traceability of data. In these conditions, the use of CASE tools becomes particularly important, as they enable initial process modelling, formalisation of laboratory business processes, documentation of system architecture, requirements and change management, and automatic generation of project documentation. CASE tools should provide visual process description (BPMN/UML/IDEF), bottleneck analysis, simulation modelling of laboratory workload, performance evaluation, as well as support for versioning and change control.This study aims to provide a comparative analysis of modern CASE tools in terms of their applicability for the design and implementation of LIMS in the mining industry. The functional capabilities, ease of modelling, integration mechanisms, support for standards, scalability, and cost-effectiveness of the solutions are evaluated. The results of the analysis allow us to justify the choice of the optimal tool for developing a reliable, manageable laboratory information system that meets industry requirements.

Keywords: LIMS, CASE tools, process modelling, laboratory business processes, mining industry.

INTRODUCTION

The selection of a CASE tool for developing a laboratory information management system (LIMS) is carried out in stages and is based on a sequential procedure of analysing requirements, evaluating available tools, and making an informed decision.

The first stage, clarification of criteria, involves determining the needs of laboratory users, project objectives, existing limitations, and a list of requirements for the tool. The CASE tool must provide comprehensive modelling of laboratory activities, support the description of processes, data, and organisational structure, and comply with corporate and industry quality standards (Pillai, 2025).

Furthermore, an assessment of available CASE tools is performed, taking into account the solutions available on the market and the technical capabilities of the enterprise (Rush, 2007; Romero, 2022). At this stage, their functional characteristics are analysed, including support for modern modelling notations (IDEF, BPMN, DFD, etc.), the ability to build mixed models that combine functions, data, management and resources, the availability of automated documentation and project documentation generation tools, process analysis and optimisation tools (including functional cost analysis and simulation modelling), integration with data models (ERD) and external information systems, compliance with ISO 9000/9001 quality standards, as well as user-friendly interface, ease of staff training and implementation in the organisational and technological processes of the enterprise (Lending, 1998; Limayem, 2004).

The results of the assessment form the Result of assessment, which may require additional information gathering and re-clarification of requirements.

At the final stage, Selection of CASE tools, alternatives are compared and the tool that most fully meets the established criteria is determined. The result of the process is a Recommended solution that ensures effective LIMS design and consistency with the enterprise's existing IT infrastructure (Tagger, 2011). Therefore, applying a structured approach to selecting a CASE tool allows you to systematise requirements, objectively evaluate tools, and make an informed decision, minimising risks and improving the quality of design solutions.

MATERIALS AND METHODS

The materials of this study include scientific and methodological publications on laboratory information management systems (LIMS), enterprise modelling, and CASE technologies, as well as analytical data on the functionality of selected CASE tools. Four solutions were chosen for comparison: ARIS, AllFusion Process Modeler (BPwin), ERwin Data Modeler, and Rational Rose. These tools were selected because they represent different approaches to modelling business processes, data structures, and system architecture, and are widely cited in the literature on information system design. The industrial context of the study is the mining sector, where LIMS must support laboratory workflows, ensure traceability of samples and results, and integrate with enterprise systems such as ERP, MES, and SCADA in accordance with ISO 9001 and ISO/IEC 17025 requirements.

The study applies a comparative analytical approach combined with a multicriteria evaluation of CASE tools for LIMS design (Figure 1). The assessment procedure was carried out in three stages. At the first stage, the requirements for the CASE tool were identified on the basis of laboratory process needs, project objectives, integration constraints, and quality management requirements. At the second stage, the selected tools were analysed according to their functional

capabilities, including support for process modelling notations, data modelling, enterprise architecture description, documentation generation, collaboration features, usability, visualisation quality, and relevance of vendor support. At the third stage, the alternatives were compared using a qualitative scoring scale from 1 to 3, where 3 indicates high support, 2 medium support, and 1 low or absent support. The total score for each CASE tool was calculated by summing the values across all criteria, and the highest-ranked solution was interpreted as the most suitable basis for LIMS design in the mining industry.

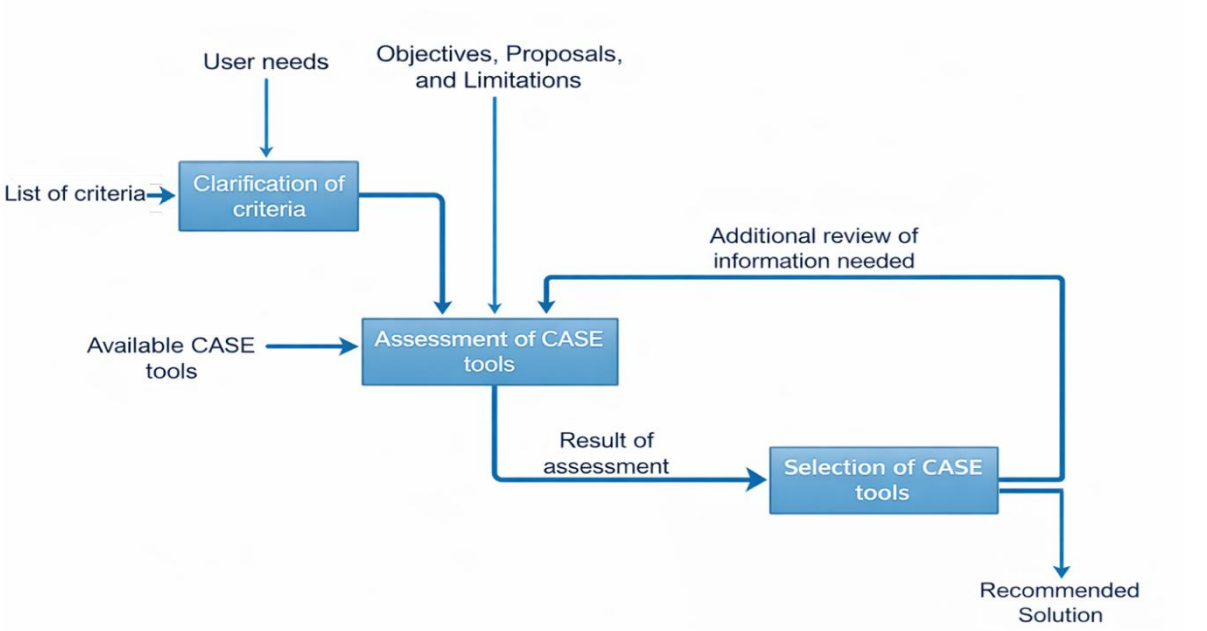

Figure 1: Model of the Assessment and Selection Process

The comparison included the following evaluation criteria: business process modelling, data modelling, enterprise architecture support, collaboration, ease of use, visualisation quality, and modernity/support. These criteria reflect the specific needs of industrial laboratories, where the design of a LIMS requires not only database formalisation but also modelling of operational workflows, roles, quality control points, and integration interfaces.

To interpret the results in a practical way, the capabilities of the selected CASE tools were additionally considered in relation to a target LIMS implementation scenario. This scenario includes modelling the end-to-end laboratory process chain: sample selection, acceptance, preparation, analysis, validation, reporting, and integration with enterprise systems. Particular attention was paid to support for process documentation, development of conceptual and logical data models, traceability attributes, and continuous improvement mechanisms such as PDCA and Activity-Based Costing analysis.

Comparison of ARIS, BPwin, Erwin, and Rational Rose

ARIS

is a methodology and tool covering organisational, functional, data and management aspects; strengths: powerful graphics, reports, standard analysis algorithms, documentation, simulation modelling and ISO 9000 compliance testing. Disadvantages: high implementation cost, lengthy training, no code/SQL script generation (Davis, 2012).

AllFusion Process Modeler (BPwin)

supports IDEF0/IDEF3/DFD, mixed models, ABC analysis; easy to learn and inexpensive, but poorly developed representativeness and limited economic analysis (Kukartsev, 2020; Matino, 2018).

ERwin Data Modeler (ERwin)

strong in conceptual and logical data modelling (IDEF1X/IE), convenient diagrams and database artefact generation; does not cover business process optimisation and standard representation of key processes (Burbank, 2011; Ribeiro, 2025).

Rational Rose

object-oriented approach, code generation and cross-platform compatibility; disadvantages: price, complexity, no simulation, weak representativeness of models for process reengineering (Jolak, 2020).

To make an informed choice of LIMS design tool, a comparative evaluation of CASE tools ARIS, AllFusion Process Modeler (BPwin), ERwin Data Modeler (ERwin) and IBM Rational Rose was carried out in table 1.

The evaluation was performed on a scale: 3 — high support, 2 — medium, 1 — low or absent.

Business process modelling

ARIS and BPwin received the highest scores 3 points, because they are focused on functional and process modelling, support IDEF/BPMN/EPC, and allow for the creation of comprehensive enterprise activity diagrams.

Rational Rose provides only a partial description of processes using UML 2 points. ERwin specialises in data, so its process analysis capabilities are limited 1 point.

Data Modelling

The leader is ERwin (3 points), which provides full conceptual and logical database design, IDEF1X/IE notation, and database artefact generation. The other tools support data processing at an average level 2 points, mainly in the form of integration with process models.

Enterprise Architecture
ARIS received the maximum score 3 because it covers organisational structures, functions, data, and management within a single enterprise architecture. BPwin and Rational Rose have partial support 2 points, while ERwin is limited to the data model only 1 point.

Collaboration
ARIS provides advanced collaborative development tools and a repository 3 points. BPwin and ERwin support collaboration at a basic level 2 points. Rational Rose is less convenient for distributed teams 1 point.

Table 1: Comparative Evaluation of CASE Tools ARIS, AllFusion Process Modeler (BPwin), ERwin Data Modeler (ERwin) and IBM Rational Rose

Criteria	ARIS	BPwin	Erwin Data Modeler	IBM Rational Rose
Business process modelling	3	3	1	2
Data modelling	2	2	3	2
Enterprise Architecture	3	2	1	2
Collaboration	3	2	2	1
Ease of use	2	3	2	1
Visualisation quality	3	2	2	2
Modernity/support	3	2	2	2
TOTAL (total points)	22	18	15	14

Based on the table, it was calculated that Aris has more strengths than BPwin, Erwin, and Rational Rose, and is best suited as a case tool.

Practical Implementation Plan
The process model in ARIS is a chain of sample selection, acceptance, preparation, analysis, validation, reporting and integration, roles, resources, control points, ISO 9001/17025 requirements Figure 2.

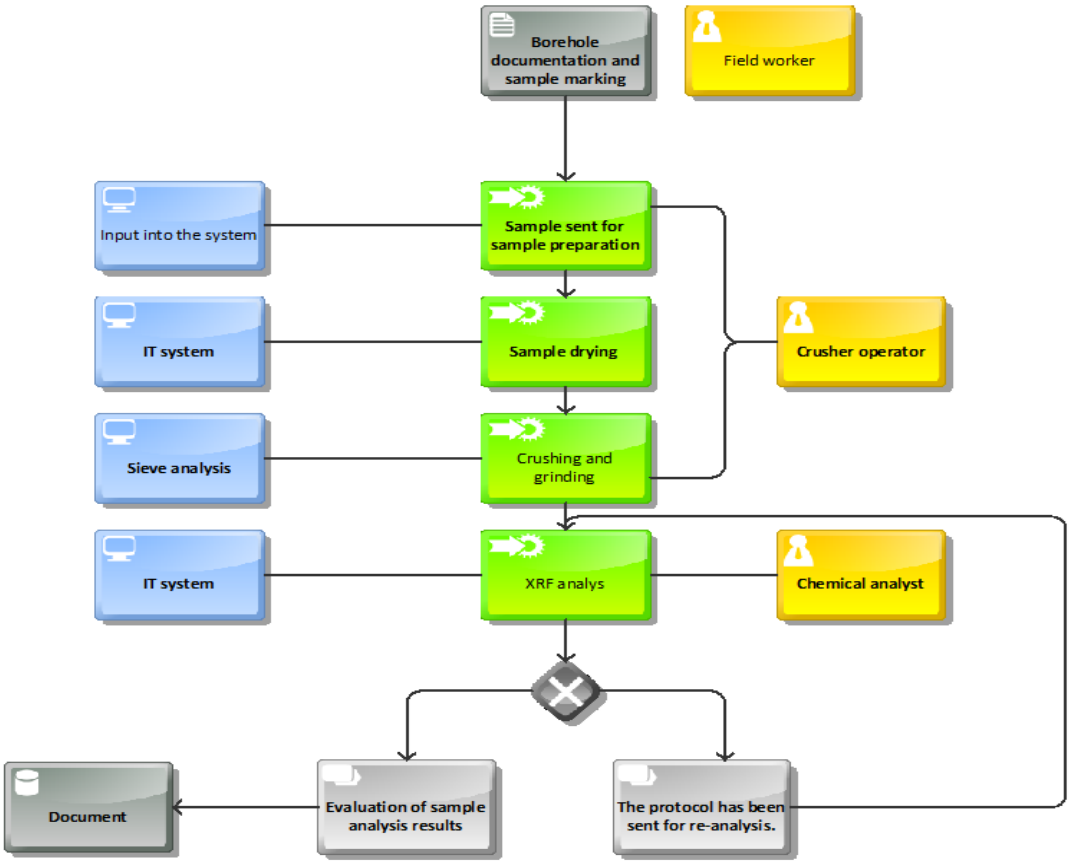

Figure 2: ARIS Process Model

In the design and implementation of a Laboratory Information Management System (LIMS), the use of CASE tools is of particular importance, since they provide an integrated description of business processes, data structures, and enterprise integration mechanisms. One of the key areas is the development of regulations, operating instructions, and reporting documentation directly from ARIS process models. This approach improves quality management, ensures consistency in personnel training procedures, and creates a reliable basis for internal and external audits in accordance with quality management standards, including the ISO 9000 series.

Another important task is the development of conceptual and logical data models. For this purpose, ER-modeling tools such as ERwin can be applied to formalize the main entities of laboratory activity, including sample, batch, method, instrument, result, and status, as well as traceability keys and reference dictionaries. On the basis of such models, database schemas can be generated for the selected LIMS platform, while data exchange mechanisms can be designed for integration through an enterprise service bus or similar middleware infrastructure.

CONCLUSION

The present study examined the applicability of selected CASE tools to the design and implementation of laboratory information management systems in the mining industry. Based on a comparative multicriteria evaluation of ARIS, BPwin, ERwin Data Modeler, and IBM Rational Rose, ARIS was identified as the most suitable tool due to its broad support for business process modelling, enterprise architecture representation, collaboration, documentation, and analytical capabilities.

The results suggest that, for mining-sector LIMS projects, priority should be given to tools that enable comprehensive modelling of laboratory workflows, traceability mechanisms, organisational responsibilities, and quality control procedures, while also supporting integration with ERP, MES, and SCADA systems. In this context, ARIS provides the most balanced methodological and practical foundation for process-centred LIMS design. At the same time, its limitations in database artefact generation may be compensated for through complementary use of specialised data modelling tools such as ERwin.

Thus, the study demonstrates that an effective CASE tool for LIMS should be evaluated not only in terms of isolated modelling functions, but also in relation to the broader requirements of industrial digitalisation, regulatory compliance, and continuous process improvement. The proposed assessment framework can serve as a useful methodological reference for enterprises planning the development or modernisation of laboratory information systems.

REFERENCES

Burbank, D. &. (2011). *Data modeling made simple with CA ERwin Data Modeler R8.* New Jersey: Technics Publications .

Davis, R. (2012). *Business process modelling with ARIS: a practical guide.* London: Springer.

Jolak, R. (2020). Understanding and Supporting Software Design in Model-Based Software Engineering. Gothenburg: Chalmers University of Technology and University of Gothenburg.

Kazaal, A. R. (2005). Improving enterprise business processes with systems analysis and design methodologies and tools.

Kukartsev, A. V. (2020). Modeling as a tool for reengineering the enterprise production processes. *Journal of Physics: Conference Series Vol. 1661, No. 1*, p. 012176. doi:10.1088/1742-6596/1661/1/012176

Lending, D. &. (1998). The use of CASE tools. *In Proceedings of the 1998 ACM SIGCPR conference on Computer personnel research*, pp. 49-58.

Limayem, M. K. (2004). CASE tools usage and impact on system development performance. *Journal of Organizational Computing and Electronic Commerce, 14(3)*, pp. 153-174. doi: https://doi.org/10.1207/s15327744joce1403_01

Matino, I. (2018). Modelling and simulation of industrial operations for prognostic monitoring and control, process integration and optimization.

Pillai, S. P. (2025). Laboratory quality management system fundamentals. *Frontiers in Bioengineering and Biotechnology, 13*, pp. 1-13. doi: https://doi.org/10.3389/fbioe.2025.1578654

Ribeiro, A. O. (2025). Business Process Modeling Techniques for Data Integration Conceptual Modeling. *ICEIS (1)*, pp. 158-169.

Romero, M. G. (2022). A framework for assessing capability in organisations using enterprise models. *Journal of Industrial Information Integration, 27*, p. 100297. doi: https://doi.org/10.1016/j.jii.2021.100297

Rush, H. B. (2007). Assessing the technological capabilities of firms: developing a policy tool. *R&d Management, 37(3)*, pp. 221-236. doi: https://doi.org/10.1111/j.1467-9310.2007.00471.x

Scheer, A. W. (2000). *ARIS—business process modeling.* Science & Business Media.

Tagger, B. (2011). An introduction and guide to successfully implementing a LIMS (laboratory information management system). *Computer Science Departement, University of Wales, Aberystwyth, Ceredigion, Wales*, p. 9.