High-Risk Equipment Risk Assessment System

Case Providing Department: Laboratory and Technical Management Office

Supported by LM

1. Background

This project is built on a no-code platform to fully digitalize the previously offline LEC risk assessment process for high-risk laboratory equipment. An online assessment system integrated with the Fixed Asset Management System was established. Through automatic synchronization of equipment data, online approval workflows with electronic signatures, and QR-code-based access for students, the system enables a standardized, paperless, and highly efficient assessment process. As a result, management efficiency and data accuracy have been significantly improved, driving laboratory safety management toward digitalization and green transformation.

I. Implementation Background

With the continuous increase in both the quantity and diversity of laboratory equipment in universities—particularly the widespread use of high-risk equipment such as autoclaves, centrifuges, and laser devices

—equipment safety management has become a critical component of laboratory operations. To standardize equipment usage procedures and mitigate potential risks, the university has long adopted an offline LEC (Likelihood × Exposure × Consequence) semi-quantitative risk assessment approach using the Equipment Risk Assessment Form.

This form covers equipment information, hazard identification, risk level determination, and control measures, and requires completion by the equipment administrator, departmental review, approval by the safety officer, and subsequent archiving.

While this process improved standardization to some extent, the traditional paper-based assessment approach has increasingly revealed limitations as equipment volumes and usage frequency grew, making it difficult to meet the needs of modern laboratory management. Therefore, a no-code platform was introduced to comprehensively optimize and reconstruct the original process, promoting the digital transformation of equipment risk assessment.

II. Issues with the Original Offline Assessment Process

1. Inconvenient equipment information entry and high risk of data inconsistency

In paper-based assessment forms, basic information such as equipment name, model, identification number, and location had to be manually queried and filled in, which was time-consuming and labor-intensive. Due to the lack of integration with the Fixed Asset Management System, inconsistencies and errors frequently occurred, undermining the accuracy of the assessment basis and affecting the effectiveness of subsequent risk evaluations.

2. Cumbersome approval procedures and low efficiency

Paper-based assessment forms required multi-level, sequential approvals, resulting in long processing cycles and frequent delays caused by staff absence or document loss. The approval process lacked traceability and clear accountability, significantly impacting timeliness and closed-loop management.

3. Difficulty in revision and version control

When equipment information or usage environments changed, assessment forms had to be reprinted, refilled, and reapproved. Version control became chaotic, and historical records were difficult to trace, hindering continuous improvement and compliance audits.

4. Inconvenient access and low information transmission efficiency

Students and operators could not quickly access equipment risk assessment results and had to request paper copies from administrators, which was not conducive to daily safety awareness cultivation or effective implementation of risk control measures.

5. Cumbersome archiving and misalignment with green office practices

The printing, binding, and storage of large volumes of paper documents consumed physical space and contradicted the university's initiatives for paperless administration and green campus development, resulting in high management costs and limited environmental benefits.

2. Solutions

The core of this system lies in leveraging a no-code platform to integrate previously fragmented and isolated offline processes into a unified, online, data-driven, and intelligent closed-loop management system. The key functional designs are as follows:

1. Automatic Synchronization and Population of Equipment Information

Function Description:

The high-risk equipment risk assessment system is integrated with the

data forms of the Laboratory Fixed Asset Management System previously developed on the department's no-code platform. When creating a risk assessment for a specific piece of equipment, users only need to enter or scan the asset number, and the system automatically retrieves and populates basic information, including equipment name, manufacturer/model, serial number, purchase date, custodial unit, equipment administrator, and installation location.

Pain Points Addressed:

This function fundamentally resolves the core issues of "manual lookup required" and "information inconsistency" in offline processes, ensuring the accuracy and authority of equipment data used for risk assessment.

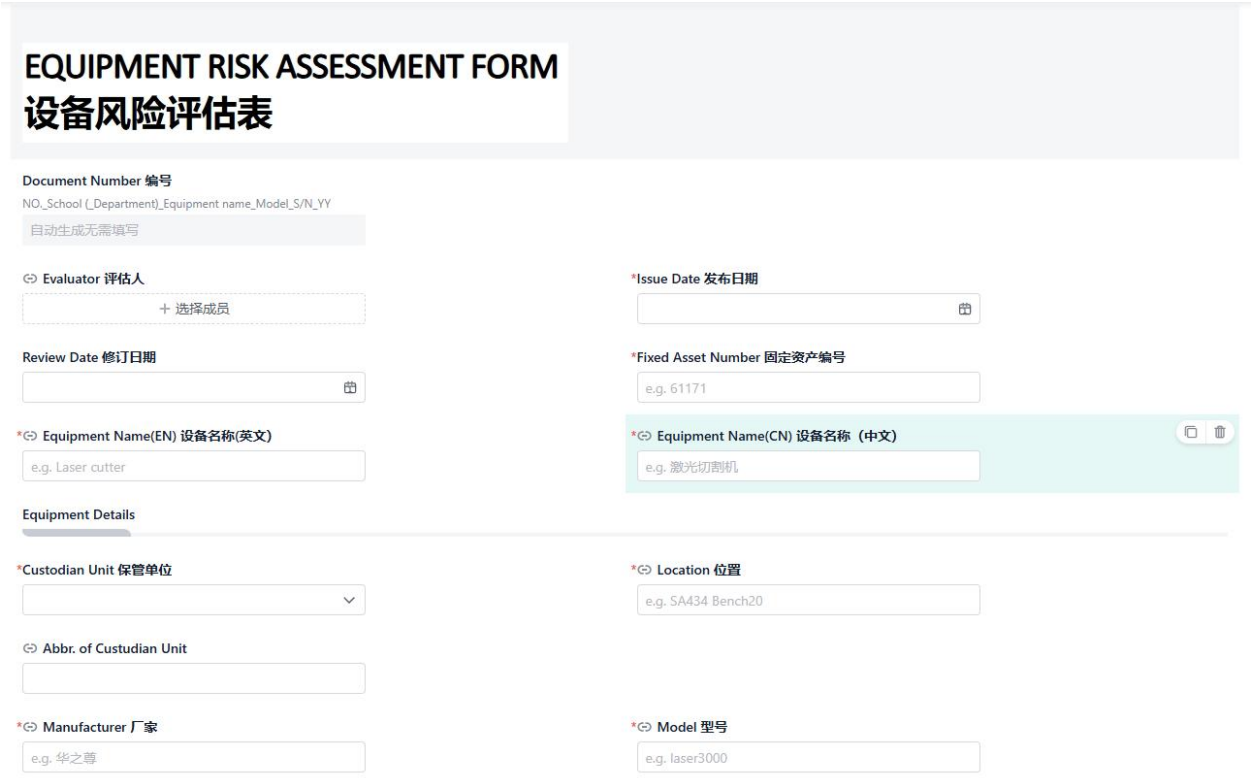

Figure 36 Equipment Risk Assessment Form

2. Structured and Intelligent Risk Assessment Forms

Function Description:

The original offline Excel-based assessment form was fully replicated and optimized as an online form.

- Hazard selection and highlighting:

The “hazards” section is presented using checkboxes and color-coded highlights. Once applicable hazards are selected, identified risks are automatically emphasized.

- Dropdown selection for LEC parameters:

In the “Risk Level (Before/After Control)” section, the three dimensions—Accident Likelihood (L), Exposure Frequency (E), and Consequence Severity (C)—are designed as dropdown menus. All options strictly correspond to predefined dictionaries or the Reference of Standard Value worksheet, preventing input errors or arbitrary entries.

- Automatic risk calculation and classification:

Based on the selected L, E, and C values, the system automatically calculates the risk score (D = L × E × C) and displays the corresponding risk level (e.g., Level I – IV) along with required control measures. This functionality encapsulates the complex formulas previously embedded in Excel, significantly lowering the usage threshold and error rate.

Pain Points Addressed:

The assessment process is standardized and automated, eliminating manual calculation errors and ensuring scientific consistency and reliability in risk evaluations.

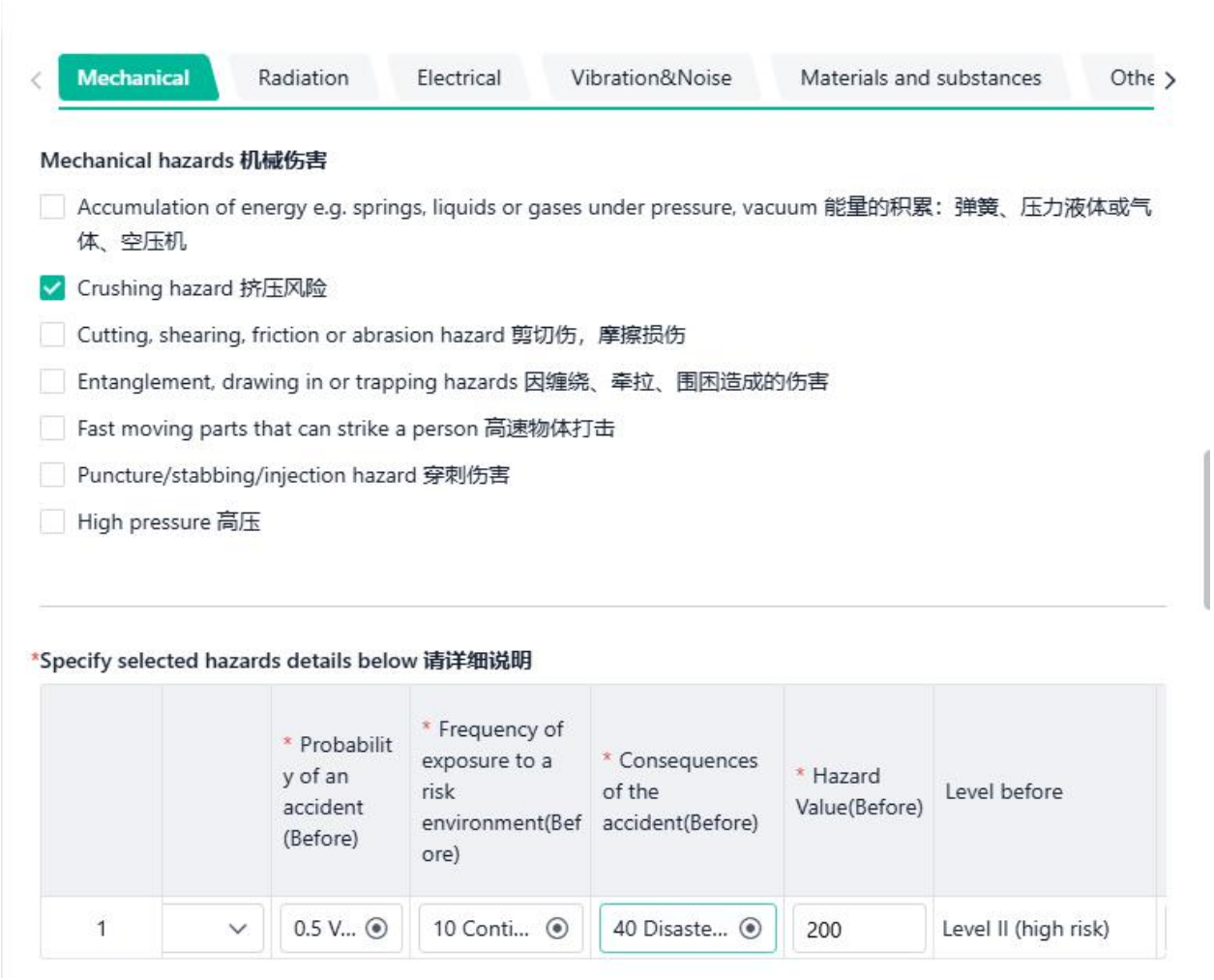

Figure 37 Structured and Intelligent Risk Assessment Form

3. Online Approval Workflow and Electronic Signatures

Function Description:

A configurable approval workflow is established.

- Workflow-driven processing:

After the assessor completes and submits the form, the system

automatically routes the task to the next approver according to predefined workflows (e.g., Equipment Administrator → Laboratory Manager → Department Head).

- Multi-channel notifications:

Approvers receive notifications via the platform and email.

- Electronic signatures and traceability:

Approvers can perform actions such as “Approve” or “Reject” online and provide comments. The system generates a formal assessment report containing electronic signatures (or records) and timestamps of the assessor, reviewer, and approver. All approval records are tamper-proof and fully traceable.

Pain Points Addressed:

This resolves the inefficiencies, lack of transparency, and document loss risks of offline approvals, reducing approval cycles from days or weeks to just a few hours.

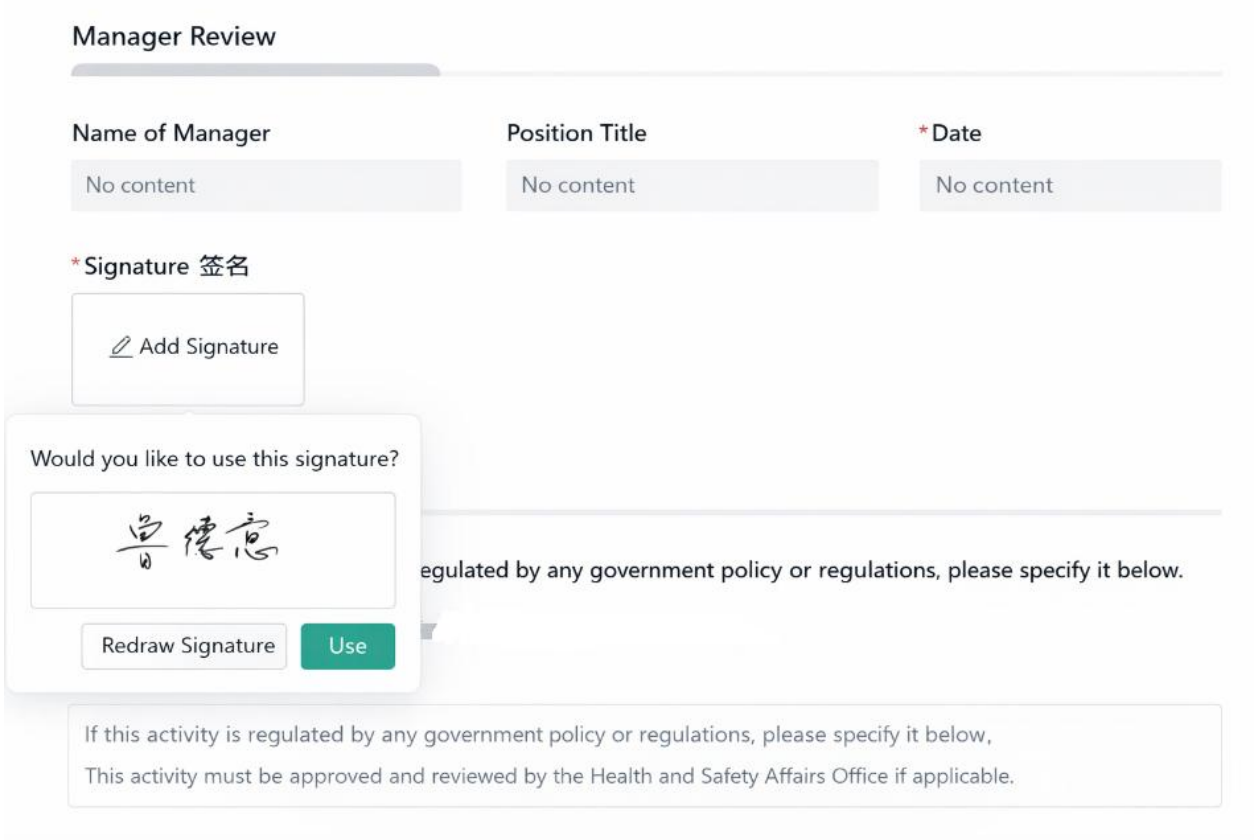

Figure 38 Online Approval Workflow and Electronic Signatures

4. QR Code Generation for Assessment Reports and Convenient Access

Function Description:

For each approved risk assessment report, the system automatically generates a unique QR code. The QR code can be printed and affixed to the corresponding equipment in a visible location, allowing users to scan and view the report on their mobile devices. Reports can also be printed using predefined templates for reference.

Pain Points Addressed:

Students and operators can instantly access complete risk assessment reports, safe operating instructions, and emergency measures via mobile scanning, significantly improving information accessibility and safety awareness.

5. Version Management and Electronic Archiving

- Version control:

When equipment information, usage environments, or assessment standards change, users can initiate a “revision” based on the original record. All historical versions are retained for traceability and audits.

- Cloud-based archiving:

All assessment reports and related records are stored as structured data on cloud servers, enabling rapid retrieval, filtering, and statistical analysis by equipment name, asset number, department, risk level, or time.

Pain Points Addressed:

This resolves the challenges of revising and archiving paper documents, enables full lifecycle digital management, and lays the foundation for laboratory safety data analytics.

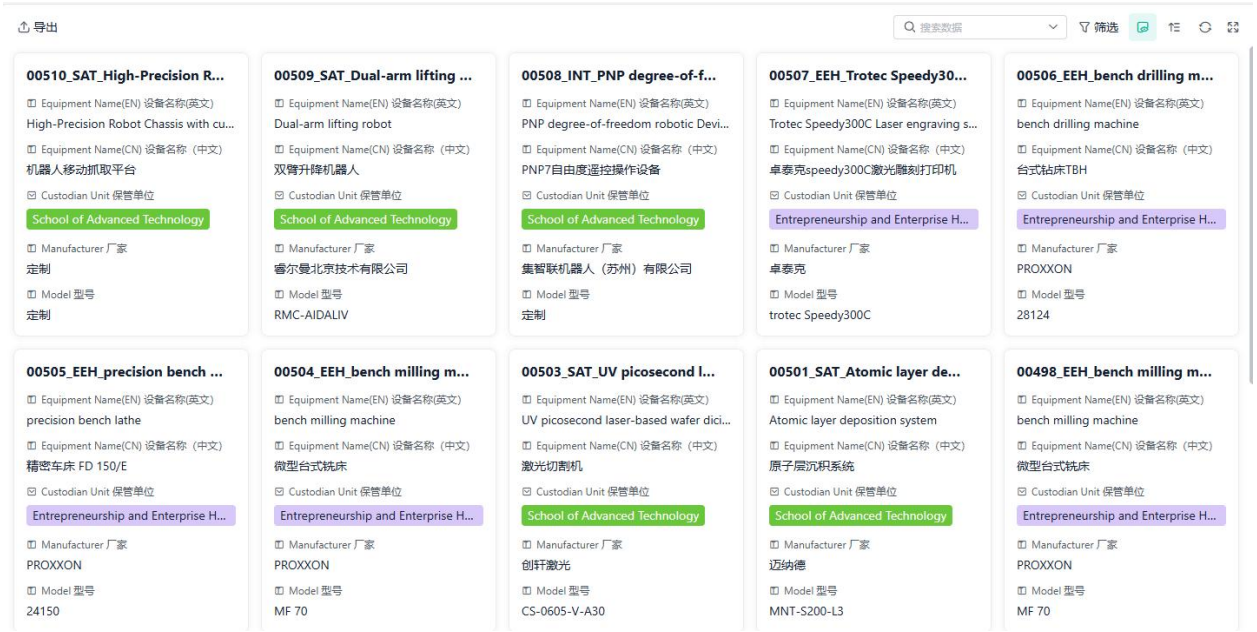

Figure 39 Version Management and Electronic Archiving

6. Knowledge Base for Personal Protective Equipment (PPE) and Control Measures

Function Description:

Content such as “hierarchy of risk control” and “required personal protective equipment” from the Equipment Risk Assessment Template is embedded into the system as standardized option libraries. Users can directly select appropriate measures when defining controls, ensuring standardization while improving efficiency.

Summary:

Through data integration, process reengineering, intelligent calculation, and mobile access, the system transforms a previously fragmented,

paper-based, and labor-intensive risk assessment process into an efficient, accurate, transparent, and sustainable digital management framework.

3. Outcomes and Benefits

The successful implementation of this project has delivered significant and multidimensional benefits to laboratory safety management. Key outcomes include:

I. Efficiency Improvement: Achieving Cost Reduction, Efficiency Gains, and Faster Processing

- Time savings:

Automatic population of equipment information reduces tasks that previously took hours to just minutes, significantly alleviating administrative workload.

- Reduced labor costs:

Rework and communication costs caused by information errors or non-standard formats are eliminated.

- Accelerated approval cycles:

Online workflows compress approval timelines from days or weeks to a matter of hours, with real-time tracking of approval nodes.

- Rapid information retrieval:

Electronic storage enables second-level retrieval of historical assessment reports, greatly facilitating audits, inspections, and continuous improvement.

II. Management Value: Advancing Standardization, Precision, and Intelligence

- Data-driven and scientific decision-making:

The system accumulates a structured database of equipment risks and can generate multi-dimensional analytical reports (e.g., risk distribution by category, high-frequency hazard equipment rankings), providing data-driven support for safety investment, inspection planning, and risk early warning.

- Standardized and closed-loop risk control:

By embedding the LEC method, the system ensures consistent assessment standards and eliminates subjective interpretation differences. A complete digital control loop — from assessment and control definition to approval and execution (via QR code access) —

ensures effective implementation of safety measures.

- Clear and traceable safety accountability:

Online workflows record who assessed, reviewed, and approved each case. Combined with electronic signatures, responsibilities are clearly defined and fully traceable, reinforcing organization-wide safety accountability.

- Institutionalization of safety culture:

The “one device, one QR code” model transforms safety information from locked cabinets into on-site, readily accessible “personal safety advisors,” encouraging proactive learning and fostering a normalized laboratory safety culture.

III. Comprehensive and Implicit Benefits

- Enhanced compliance:

Full coverage and standardized processes for high-risk equipment assessments enable efficient responses to inspections and audits, improving overall compliance levels.

- Promotion of green, paperless operations:

Complete elimination of paper forms significantly reduces paper and consumable usage, directly supporting the university’s green campus

initiatives and demonstrating environmental responsibility.

- A replicable digital transformation model:

Built rapidly on a no-code platform with low cost and short implementation cycles, this project serves as a highly replicable reference model for digital transformation in other domains such as chemical management and emergency response management.

4. Replicability and Promotion Value

This solution provides a highly valuable and replicable reference for the digital transformation of other business areas, including chemical management and emergency response management.

5. Next Steps

- Expansion Plan I:

Deep integration with the laboratory access control system to enable precise, scenario-based safety training focused on personnel management. Through targeted training and authorization, unsafe behaviors can be reduced at the source.

- Expansion Plan II:

Establish comprehensive lifecycle safety profiles for equipment to enable dynamic risk management and predictive maintenance. By continuously monitoring equipment status, risk changes can be proactively identified, shifting safety management toward preventive control.