Optimization of Reagent Inventory and Storage in a Chemistry Laboratory

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Abstract

This research addresses reagent inventory management in a chemistry laboratory relying on manual tracking systems and basic spreadsheets. The laboratory managed ~148 reagents with up to 3 expired-reagent incidents per year. A digital system using Microsoft Excel integrated with the VIVA platform — with a four-stage automated expiration alert — was implemented aligned with Lean Laboratory and ISO 17025 standards. Expired reagent use dropped from 3/year to zero (100% improvement) and full traceability was achieved across all 148 reagents.
Keywords: Digital Inventory Management, ISO 17025 Compliance, Lean Laboratory, Reagent Expiration Monitoring.

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Introduction

Chemistry laboratories require precise control over reagents to ensure safety, quality, and regulatory compliance. Many facilities rely on manual systems prone to human error, incomplete records, and delayed updates [1].
This research develops and evaluates a digital reagent inventory system at Baxter Chemistry Laboratory, demonstrating that accessible, low-cost tools can achieve measurable improvements in laboratory performance and ISO 17025 compliance.

Background

- Alrabghi & Tiwari [1]: Manual systems are slow and error-prone, relying entirely on human intervention for data entry.
- Bird et al. [3]: Electronic records significantly enhance data management and ensure greater precision.
- ISO 17025:2017 [2]: All reagents must be properly identified, tracked, and managed throughout their lifecycle.
- ASQ [5]: Lean Laboratory principles eliminate waste through standardized processes.
- NRC [6] & Sharma [8]: Prudent practices and forecasting tools support proactive inventory optimization.

Problem

~148 reagents managed with physical cards and basic Excel — no automated monitoring. Up to 3 incidents/year where expired reagents were used undetected — a direct ISO 17025 violation and a patient safety risk.

Objective: Design and implement a low-cost digital inventory system to eliminate expired-reagent use, achieve full traceability, and ensure ISO 17025 compliance.

Methodology

Research Design Applied descriptive quantitative | Pre- vs. post-implementation comparison Implementation — 4 Phases
Phase 1 — Audit: Physical inventory of all 148 reagents (name, lot #, expiration date, location, quantity)
Phase 2 — Model: Excel inventory with conditional formatting highlighting reagents approaching expiration
Phase 3 — Alerts: VIVA platform configured with 4-stage email alerts (30d / 7d / 1d / expiration day) + designated responsible individual assigned
Phase 4 — Training: Personnel trained on system use and alert response procedures

Data Collection
- Baseline: Historical records — 3 expired reagent incidents/year
- Direct observation of pre implementation workflow
- Post-implementation: VIVA alert logs + analyst surveys on usability Research Schedule: March 2 – May 23, 2026 Report Submission: May 13, 2026 | Poster Presentation: May 20, 2026

Results and Discussion

148	3→0	100%
Reagents Digitized	Expired / Year	Risk Reduction

Key Outcomes

❖ 148 reagents fully digitized — complete traceability achieved for the first time
❖ **Expired reagent use: 3 per year → 0 (100% reduction)**
❖ 4-stage VIVA alerts enabled proactive expiration management
❖ Designated administrator improved data accuracy and accountability

Quantitative Results

Indicator	Before	After	Result
Expired reagents	3 / year	0	100% reduction
Reagents tracked	148 (manual)	148 (digital)	Full traceability
Expiration alerts	None	4-stage auto.	Early detection
Inventory accuracy	Incomplete	Systematic	Standardized

Discussion

Results confirm the digital system eliminated all primary problems. The 100% reduction in expired reagent use directly reduces compliance risk under ISO 17025 [2] and eliminates a potential source of analytical error affecting product quality decisions.

The four-stage alert system provided multiple corrective-action opportunities before expiration [3]. Shifting to preventive management aligns with Lean Laboratory principles [5] and represents a sustainable operational improvement.

Limitation: System depends on manual data entry — consistent updates by designated personnel are essential for long-term accuracy.

Conclusions

This study demonstrates that a structured digital reagent inventory system delivers measurable improvements using accessible, low-cost tools:

- 148 reagents digitized with complete traceability
- **Expired reagent use: 3/year → 0 (100% improvement)**
- ISO 17025 compliance enhanced through automated monitoring
- Replicable model for small and medium-sized laboratories

Key insight: The problem was organizational — not technological. Defining accountability, digitalizing data, and automating alerts eliminated the risk entirely.

Future Work

1. Integrate with LIMS to eliminate manual data entry dependency
2. Implement barcode / RFID for real-time automatic reagent tracking
3. Long-term cost-benefit analysis of reagent waste reduction
4. Extend model to Microbiology and Production departments

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References

[1] A. Alrabghi & A. Tiwari, Simulation Modelling Practice and Theory, vol. 66, pp. 81–99, 2016.
[2] ISO 17025:2017 – General Requirements for the Competence of Testing and Calibration Laboratories, ISO, 2017.
[3] C. L. Bird, C. Willoughby & J. G. Frey, Chemical Society Reviews, vol. 42, no. 20, pp. 8157–8175, 2013.
[4] U.S. FDA, Part 11, Electronic Records; Electronic Signatures, 2022.
[5] American Society for Quality, Six Sigma: What It Is and How It Works, 2023.
[6] National Research Council, Prudent Practices in the Laboratory, Updated ed., 2011.
[7] C. B. Thanawalla, Complying with TSCA Inventory Requirements, Wiley, 2002.
[8] S. Sharma, Inventory Planning with Forecasting Expenditure, CRC Press, 2022.