

# Data Modernization in Practice: Streamlining Large-Scale Environmental Testing for Statewide Childcare Drinking Water Through Integration of REDCap and LIMS



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## Introduction

**Background:** New Jersey Department of Children and Families’ (NJDCF) Childcare Drinking Water Project provides free lead and copper testing for 4,000+ childcare centers in NJ, a requirement for annual licensure renewal and crucial for protecting children from the harmful effects of exposure through drinking water<sup>1,2</sup>. NJ Department of Health’s Environmental & Chemical Laboratory Services (ECLS) is providing the water testing. The size and complexity of the project required an innovative method to improve manual outreach, coordination, and sample handling efforts between the Metals and Sample Receiving (SR) Labs and Data Management & Analysis (DMA) Program.

**Objective:** Create a semi-automated workflow integrating REDCap surveys (web application for secure and flexible data collection) and R-based middleware (open-source statistical computing and graphics programming language) to optimize the sampling and log-in process, thus reducing error and improving reproducibility.

- Challenges:**
- Limitations of current ECLS Laboratory Information Management System (LIMS)
    - Client/Project hierarchical structure limits # of projects per client → increases manual entry
    - No method to electronically capture sampling information directly from daycare centers → increases manual entry
  - Other considerations
    - Collaborative efforts between NJDCF, childcare centers, and within NJDOH-ECLS: SR, DMA, & Metals Laboratory
    - NJ Department of Environmental Protection (DEP) has requested the submission of lead results into the electronic environmental (E2) reporting system for beta testing using a specific XML upload format.

## Methodology

Table 1. Challenges and Solutions in Development of a Semi-Automated Workflow

Challenge	Solution	Tools
Contact childcare centers	Send project details & Pre-Registration survey	
Verify center interest	Opt-in via survey, option to waive participation	
Set up Client/Project in ELEMENT database prior to log-in	Upload each center as a Client, manually enter Project info	→  →
Collect sample information	Pre-Sampling survey gathers number of samples & location names before shipping	→
Transcribe handwritten sample information from paper forms	Post-Sampling survey collects sampling date/time, verifies correct sampling methods, electronic login generated	→  →
Quality Assurance COC/submittal form	Generate Word document from survey data using Quarto	+
Complex billing (separate billing to NJDCF/NJDOH)	Billing data feed generated and applied	→  →
Data feed for NJDCF	Electronic data feed generation	→
E2 template for upload to NJ State database	E2 submission data feed generation	→

Key Process	
<b>Semi-Automated</b> Semi-automated is defined for this purpose as requiring a human intermediary (NJDCF coordinator) to execute scripts and manage project workflow	
<b>Mixed</b> Limitation of LIMS requires manual entry for project information	
<b>Manual</b> Standard reference	
Tools	
	REDCap
	RStudio integrated development environment for R
	ELEMENT LIMS
	Email
	Telcor Billing
	Quarto open-source scientific publishing system

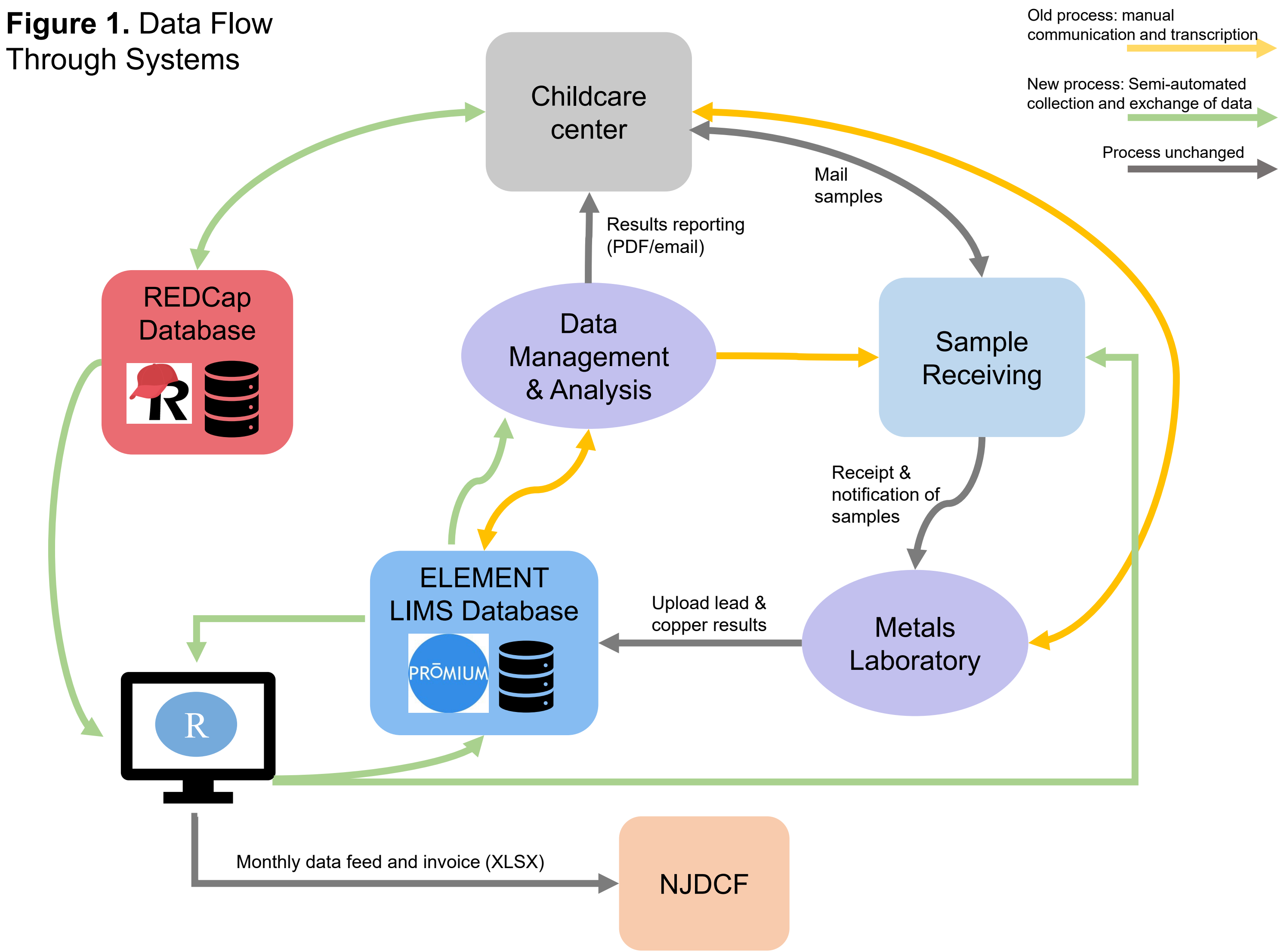
## Conclusions

- Project Impact:**
- Application of data modernization for the laboratory
    - Project information readily available in database
  - **4-fold reduction in time spent per client** by ECLS staff

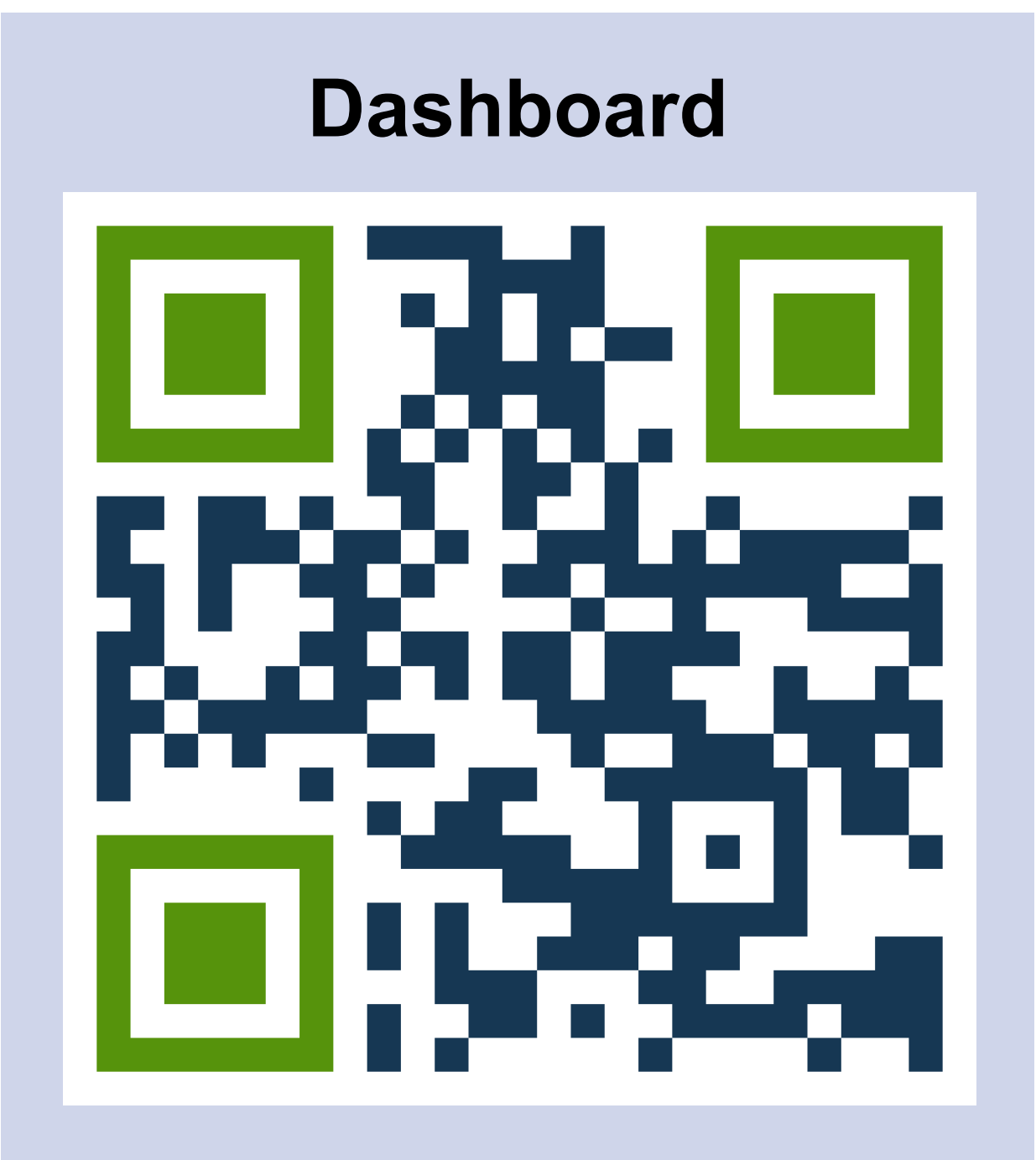
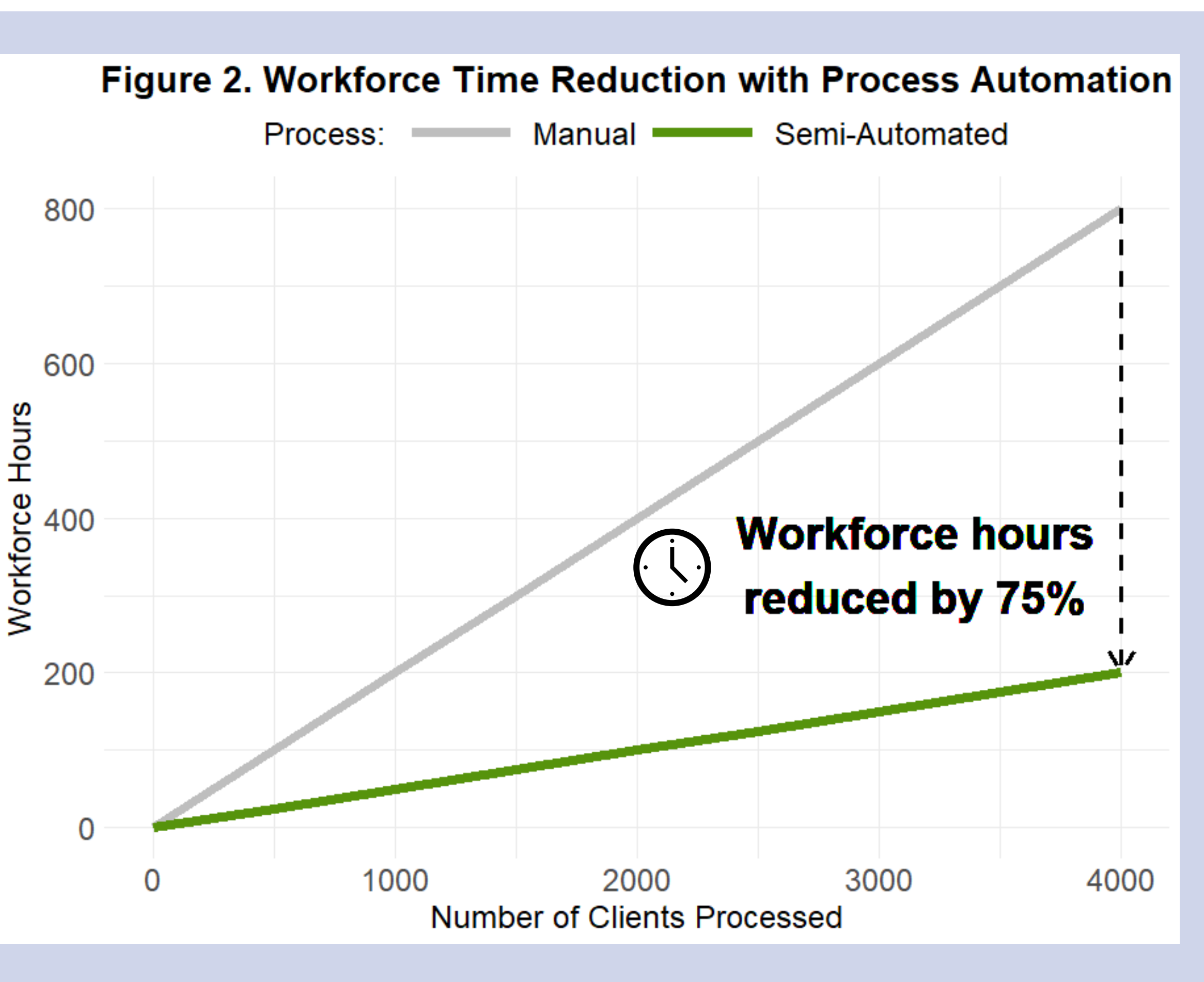
Improvements in Data:	
+	Efficiency
+	Automation
+	Productivity
+	Visualization
+	Quality

- Ongoing Limitations**
- Requires human intervention and maintenance of workflow
  - Technical limitations of survey users
    - Accessing REDCap survey, etc.
  - Need for reliable follow-up method
    - e.g., consistent reminder emails, childcare center nonresponse

## Design Considerations



## Results



## References

1. Al osman, M., Yang, F., & Massey, I. Y. (2019). Exposure routes and health effects of heavy metals on children. In *BioMetals* (Vol. 32, Issue 4, pp. 563–573). Springer Netherlands. <https://doi.org/10.1007/s10534-019-00193-5>
2. U.S. Environmental Protection Agency. (2005). *Lead and Copper Rule: A quick reference guide for schools and child care facilities that are regulated under the Safe Drinking Water Act*. Office of Water. <https://dep.nj.gov/wp-content/uploads/watersupply/epa-lcr-quick-ref.pdf>

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