



To invest wisely, health department heads, budget and procurement officials, public health laboratory administrators, and others considering the purchase of public health laboratory information systems (LIMS) must be fully informed about the costs of a system throughout its useful life.

Commercial off-the-shelf (COTS) products represent one LIMS alternative, but there are numerous costs associated with acquisition, implementation, and, especially, maintenance of these products that are not obvious.

Research conducted by the Public Health Informatics Institute shows that maintenance costs represent 84% of the total cost, while the combined acquisition and implementation costs of COTS LIMS represent 16% of the total cost of this type of a LIMS over a useful life of 8 years.

Research Brief



Batteries Not Included

Understanding the total cost of ownership for a commercial off-the-shelf public health laboratory information management system

Public health laboratories (PHLs) operate as a first line of defense to protect the American people against diseases and other health hazards. Working in collaboration with other arms of the nation's public health system, PHLs provide diagnostic testing, disease surveillance, applied research, laboratory training, and other essential services to the communities they serve. Clinicians, hospitals, emergency responders, and public health officials at local, state, and federal agencies increasingly rely on the rapid, accurate, and complete communication of health-related information from local and state PHLs to diagnose, treat, prevent, and control diseases and other public health threats.

Laboratory information management systems (LIMS) provide the infrastructure for PHLs to effectively log and accession specimens; unambiguously associate specimen data with epidemiological, clinical, and test result data; and electronically report findings to public health partners. In addition, a complete LIMS incorporates other business processes essential to internal functioning, such as billing, test quality control and assurance, reagent and kit/forms inventory control, etc. Consequently, sophisticated, efficient, electronic LIMS are critical for PHLs to fulfill their public health mission.

Many PHL officials are seeking to invest wisely in LIMS that will improve the quality, capacity, productivity, and efficiency of their laboratories, and thus their ability to serve the public. In 2003, a collaboration of 16 PHLs, the Association of Public Health Laboratories (APHL), and the Public Health Informatics Institute produced a LIMS requirements document to guide them in their purchasing, and the Centers for Disease Control and Prevention (CDC) defined interoperable LIMS standards through its Public Health Information Network (PHIN) initiative.

Some commercial, off-the-shelf (COTS) LIMS meet these requirements and are ready for immediate implementation. These products eliminate the need for each laboratory to create a new system from the ground up. The long-term success of these products, however, requires PHL directors to thoroughly plan and appropriately budget for the acquisition, implementation, and maintenance phases. At the request of the APHL, the Public Health Informatics Institute researched costs (see Methodology) associated with each of these categories to create a research brief that will inform local, state, and national efforts to plan and budget for successful implementation of LIMS.

The long-term success of commercial, off-the-shelf LIMS products requires PHL directors to thoroughly plan and appropriately budget for the acquisition, implementation, and maintenance phases of LIMS products.

Acquisition

The major factors contributing to acquisition costs of a LIMS are licensing costs, infrastructure costs, and the complexity of the tests performed by the PHL (see Table 1).

Acquisition costs include the price of user licenses¹, but also costs for related network infrastructure—desktop PCs, servers, and networking equipment—that may be required for optimal performance of a LIMS.

Purchasing a LIMS is more complex than purchasing retail software. An organization rolling out the latest version of Microsoft Office® simply multiplies the number of users by the purchase price to determine the total price. LIMS vendors use two basic approaches to licensing agreement structures; one is based on the number of users of a system, and the other is based on the number of processes. Since there is no direct correlation between the number of employees and the number of processes, comparing costs of licenses for different products can be very difficult. A close examination of a PHL's operational procedures

and processes is required in order to compare types of licenses and select the most cost-efficient license structure.

User-based licensing agreements offer the choice of a named user license, which charges a fee for each user who will access the system, or a concurrent license, which charges for each person who uses the system at the same time. A license based on processes charges for the number of test processes running concurrently. The license may cover only the basic system, with additional licensing required for each instrument interface connected to the system and for each system module. This approach has the advantage of allowing a laboratory to grow into a system by purchasing licenses, interfaces, and modules as it can afford them.

Most modern, sophisticated LIMS require a robust network infrastructure, and many PHLs are using older technology that may not support a new LIMS. New database and application servers will need to be installed. The network hardware or network operating system may need to be purchased for the first time or

Cost Component	Laboratory Size		
	Small Laboratory (in thousands)	Model Laboratory (in thousands)	Large Laboratory (in thousands)
User licenses	\$ 130	\$ 245	\$ 400
Database license	\$ 11	\$ 16	\$ 33
Other software	\$ 6	\$ 14	\$ 22
Billing software	\$ 16	\$ 16	\$ 16
Instrument interfaces	\$ 16	\$ 28	\$ 40
New hardware	\$ 40	\$ 80	\$ 120
New LAN (if none exists)	\$ 15	\$ 25	\$ 40

Table 1: Acquisition costs by cost component and PHL size (a)

(a) Acquisition costs are one-time costs. On-going support is a separate cost under Maintenance.

Cost Component	Laboratory Size		
	Small Laboratory (in thousands)	Model Laboratory (in thousands)	Large Laboratory (in thousands)
Implementation and customization (a)	\$50	\$100	\$150
Interface customization	\$ 7	\$ 17	\$ 30
Training (testing personnel)	\$ 4	\$ 5	\$ 10
Overtime for training	\$ 4	\$ 11	\$ 22

Table 2: *Implementation costs by component and PHL size*

(a) Implementation includes vendor fees for installation, customization, and testing. Most implementation fees are charged on a per diem basis, which ranges from \$750–\$2000. The actual amount of time required for a customization can vary greatly.

upgraded. Most PCs more than 3 years old will need to be upgraded or replaced. Although most commercial LIMS vendors will include the cost for a database license in their proposal, they will not include the costs for server or PC upgrades, or fees that instrument vendors may charge for instrument interfaces and maintenance. These costs can be considerable.

Finally, the types, volume, and complexity of tests performed by PHLs vary widely. Most PHLs perform microbiology testing, (i.e., bacteriology, mycobacteriology, serology, virology, and parasitology), but many also perform newborn screening, environmental testing, food safety testing, and molecular diagnostic testing. In addition, some testing requires sophisticated technologies and instrumentation. Together, these factors contribute to the complexity, and thus, the cost of the LIMS solution.

Implementation

Implementation costs have the widest range of the LIMS cost categories and are the most difficult to project because of the number of variables (see Table 2).

The easiest costs to project are those for implementation fees paid to the vendor, including costs to install, configure, and test the system. Costs for user training of laboratory and technical staff (and if requested, train-the-trainer) are based on a time and material fee schedule and are usually included in the implementation fee schedule. Training is inclusive of both the laboratory staff and technical staff.

Hidden costs associated with training include backfilling the staff while they are in training classes. The learning curve associated with the new processes will have an impact on the amount of time needed to maintain normal operations and must also be factored into staffing costs.

PHLs should budget for customization costs for any LIMS product. The cost of customization for a product's implementation will depend on the LIMS product selected, the PHL's requirements, the complexity of current legacy systems, and the number of interfaces supported by the vendor. Because many commercial vendors have relatively few PHL customers, many of the interfaces for PHL LIMS will need to be written and

About APHL

The Association of Public Health Laboratories (APHL) works to safeguard the public's health by strengthening public health laboratories in the United States and across the world. In collaboration with members, APHL advances laboratory systems and practices, and promotes policies that support healthy communities. The association's founding members are directors of state public health laboratories. Others include state laboratory staff, city and county laboratory directors, and international representatives. APHL is a non-profit, 501(c)(3) organization.

APHL works with an array of public and private sector partners to advance public health policy, develop the next generation of laboratory leaders, and improve public health laboratory practice. In collaboration with the Centers for Disease Control and Prevention, APHL sponsors the National Laboratory Training Network (NLTN), which offers high quality, low cost continuing education to professionals from medical, public health and environmental laboratories.

For more information, www.aphl.org, call (202) 822.5227, or direct e-mail inquiries to pzarcone@aphl.org.

Vendor Support for LIMS

LIMS vendors are not required to support a specific version of their software unless contracted to do so. For example, a PHL could buy/license a system one year and the vendor could issue a new version two years later. If the vendor then drops support for the old system, the PHL would be required to either provide its own support or purchase the new version of the LIMS software.

these costs may be very high. The cost of customization could range from 40–60% of the license fee. Some PHLs may have the technical staff with the experience to complete some of the customizations, while other PHLs will have to outsource this work. In addition, when considering customizations, PHLs must review vendor system performance guarantees and vendor post-conversion support agreements to understand the extent to which, if any, customizations will be certified for vendor support. If the vendor does not support customizations, the need for in-house support and technical expertise increases, as does the associated risk.

Implementation of a new information system presents an opportunity to engage in business process re-engineering discussions in order to improve processes, make gains in efficiency, and take advantage of new system functionality offered by the commercial LIMS product. Although not included in implementation costs here, there is a cost involved to analyze current processes, determine future processes, assess the gap between the current state and the future (or desired) state, write and implement new policies and procedures to support the new processes, and provide change management to the PHL staff in support of the new processes. Many PHLs do not have the skill set in-house to lead the business process re-engineering and change management activities. Outsourcing these activities is an option, but assessing and understanding the associated costs is key.

Maintenance

Maintenance costs represent the largest single category of costs because they are recurring annual costs, not one-time costs (see Table 3). In estimating actual maintenance costs,

PHLs should plan for annual software maintenance fees paid to the vendor, but also annual costs for database support, in-house IT support, hardware support, and additional technical support. Costs may also be incurred for data entry staff and additional training. Costs for upgrades must be included in maintenance, as well as testing of upgrades. (See sidebar)

The annual cost for vendor software maintenance ranges from 15%–20% of the license fees². This generally includes phone support, patches, and minor upgrades for the core LIMS. A maintenance fee may also need to be paid to the database vendor and the instrument vendors for support of these systems. A PHL may also want to obtain a hardware support contract on its computer hardware, such as the servers, PCs, printers, and network equipment.

Annual vendor software maintenance contracts do not cover in-house IT help desk support. In-house staff will be needed to provide software support for all non-LIMS software, such as the operating systems and other applications used by the PHL. Even with maintenance contracts to cover the hardware, an IT staff will be needed to provide the first level of support on the hardware, and also work with the software vendors during phone support and patch installation. None of the maintenance contracts covered here provide on-site troubleshooting. More sophisticated computer systems will need more technical support. This may mean adding to the laboratory's technical support staff or outsourcing to a third party for support.

As mentioned in the re-engineering discussion in the Implementation section, even if the PHL is currently partially automated, many laboratories will be migrating from a paper system to a computer-based system for at least part of their LIMS solutions. Most of

Cost Component	Laboratory Size		
	Small Laboratory (in thousands)	Model Laboratory (in thousands)	Large Laboratory (in thousands)
Vendor (software) support	\$38	\$ 69	\$115
Data entry clerks (a)	\$40 (1)	\$140 (3)	\$240 (6)
In-house IT support staff (a)	\$50 (1)	\$150 (3)	\$250 (5)
User conference	\$ 5.5	\$ 5.5	\$ 11
Hardware support	\$ 6	\$ 12	\$ 18

Table 3: Annual maintenance costs by cost component and PHL size

(a) These staffing costs are for new positions (number of FTEs shown in parentheses) that may be required to support the LIMS. These could be new hires or redeployment of existing staff. Staffing costs are based on the loaded cost (salary and benefits) of an employee. Staffing costs may vary based on geographical location.³

the test orders they receive from a physician or other healthcare entities, however, may still arrive on a paper form. Data entry clerks may need to be hired or converted from another PHL task to enter this information into the system. In addition to the salary costs, costs for continued training also may be incurred as new employees are hired or new functionality is added.

If a major upgrade is needed, these upgrades must be tested in-house to ensure they will work with all of a PHL's customization. Rigorous testing, a mandatory element of managing a modern LIMS, requires significant laboratory commitment, testing resources, and time. Most vendors will no longer support products after 8–10 years; PHLs must plan for a LIMS upgrade.

LIMS maintenance costs should factor in costs associated with continued learning about the product. Active participation of PHL staff in a vendor's user group is recommended; this is usually included in the LIMS maintenance fees. Many vendors also host annual user conferences that provide customers

opportunities to improve their skills on a product, have a voice in future enhancements, and preview new system features. In addition, customers have direct, face-to-face interaction with the vendor community during user conferences. This time can be used for voicing concerns and raising questions. PHLs should budget for these conference fees and associated travel costs.

How much does it cost to own and operate a LIMS?

Acquisition, implementation, and maintenance are the three major cost components that need to be considered when purchasing a LIMS. Both first year and ongoing costs must be considered. Although a total cost cannot be calculated for all PHLs because of PHLs' wide variation in needs, the Public Health Informatics Institute has estimated costs based on laboratory size (see Methodology).

The total cost of ownership for a LIMS for the first year ranges from approximately \$300,000–\$1.5 million

Bundling Maintenance Fees

Some states may allow the purchase of multiple years of maintenance fees within a single purchase. This allows a PHL the security of knowing maintenance fees are paid in full for a period of time. If a state has a severable service requirement, then the purchase of future maintenance would be treated separately from the acquisition of the LIMS and implementation services. In these circumstances, PHLs would not be able to bundle the payment of the annual maintenance fees with LIMS acquisition and implementation costs.

Cost Component	Laboratory Size		
	Small Laboratory (in thousands)	Model Laboratory (in thousands)	Large Laboratory (in thousands)
Acquisition (a)	\$ 140–250	\$ 300–430	\$ 530–700
Implementation (a)	\$ 35–70	\$ 55–125	\$ 70–175
Annual maintenance (b)	\$ 100–135	\$ 250–360	\$ 450–650
Total cost (first year)	\$ 275–400	\$ 600–935	\$ 1,000–1,500

Table 4: Total LIMS cost for the first year

(a) Acquisition and Implementation costs are one-time costs.
 (b) Maintenance costs are recurring annual costs.

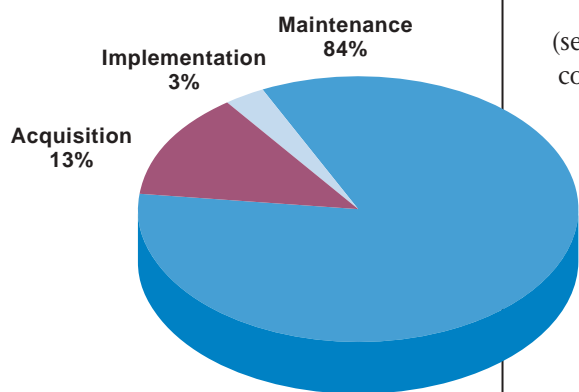


Figure 1: Model Lab
 Cost breakdown for product acquisition, implementation, and annual maintenance over the useful life (8 years) of a LIMS.

(see Table 4). Recurring maintenance costs range from \$100,000–\$650,000 per year for each additional year of the system’s life. The average system will need to be replaced in 8–10 years, which is the industry standard for the useful life of most large software systems. Figure 1 shows the average cost by percentage for each of these three main areas calculated over an 8-year span. Note that acquisition cost is just a fraction of the total cost of the system over its useful life.

Methodology

The Institute used data obtained in the development of the APHL/Institute LIMS requirements specifications document to derive the hardware, software, and support skills that are necessary to acquire, implement, and support a commercial LIMS that meets the requirements set forth in that document. The Institute obtained pricing information for a variety of commercial LIMS products from federal General Services Administration (GSA) schedules⁴,

Measure	Laboratory Size		
	Model Laboratory (a) (number of FTEs)	Small Laboratory (number of FTEs)	Large Laboratory (number of FTEs)
Testing personnel	75	50	200
IT personnel	4	2	10
Other employees (b)	37	10	50
Total staff	116	62	260
Analytical areas	13	8	20

Table 5: Representative laboratory sizes

(a) Data for the “model” laboratory represent an average of data gathered from the 10 PHL project partners participating in the 2002-2003 APHL/Institute collaborative to develop requirements specifications for public health LIMS.
 (b) Includes all non-testing, non-IT personnel, such as data entry and shipping and receiving staff.

Internet searches, and telephone interviews with four vendor representatives⁵. Pricing information was tabulated and averaged for each vendor by category of cost for each laboratory size. The Institute obtained information about current systems and technical support from APHL members to verify that the research findings were consistent with the PHLs' real world experiences.

The methodology for determining costs is based on the recognition that although PHLs have commonality in terms of mission, business processes, reporting requirements, and analytical areas, each also has several unique aspects, including the size of the laboratory, number of analytical areas, number of testing personnel and other lab employees, and volume of tests processed annually. Data on staffing and types of analytical areas obtained from the 10 PHLs that participated in the requirements project⁶ were averaged to represent the hypothetical "model" laboratory. Data from the model PHL were then extrapolated to represent "small" and "large" PHLs implementing similar LIMS (see Table 5).

Additional Considerations

The scope of public health LIMS costs is quite extensive. Additional cost components that may be applicable to a PHL include:

- **Application Service Providers (ASP).** In this scenario, the LIMS system would be hosted and managed off-site by the ASP.
- **Connectivity to a PHL's partners.** If not already in place, Internet connectivity would need to be established between the PHL and its associated partners.
- **Disaster recovery.** A disaster recovery process should be

established for all LIMS components (e.g., software, hardware, and data).

- **Project management.** Some PHLs may have the project management staff with the experience to fill the implementation project management role, while other PHLs will have to outsource project implementation management activities.

Conclusions

The total cost of ownership for a COTS LIMS implemented in a public health laboratory ranges from \$300,000–\$1.5 million, depending on the size of the laboratory, the number of LIMS modules, and the number of interfaces. Beyond the acquisition price of a COTS LIMS, a wide range of costs associated with implementation and maintenance must be considered. Costs are also incurred for maintenance and upgrade activities throughout the useful life of a LIMS product. Maintenance costs alone represent four-fifths of the total cost of a LIMS over a useful life of 8 years; upgrade costs are additional.

In order to ensure the success of a new LIMS, all associated costs must be considered. Procurement officers and other PHL staff writing a request for proposal (RFP) for the LIMS need thorough knowledge of the current PHL environment along with the goals of the LIMS implementation before writing an RFP. They should request from the vendor details about all of the software, hardware, and support needed for acquisition, implementation, and maintenance of the LIMS. This information along with accurate pricing information that spans the entire useful life of the LIMS product will guide PHL directors, other PHL staff, and procurement officials in the

detailed, rigorous, strategic planning needed to meet the complex LIMS needs of PHLs.

Recommendations for additional research

This research brief was developed to provide guidelines for decisions about the purchase of a PHL LIMS. Because detailed data about actual costs incurred in implementing LIMS are difficult to obtain, it presents estimates for the total cost of ownership based on information gathered from a limited sample of vendors and then extrapolated for different sizes of PHLs. It notes cost components associated with acquisition, implementation, and maintenance that must be considered when planning and budgeting.

More definitive data about actual costs incurred in acquisition, implementation, and maintenance of LIMS should be gathered from a representative sample of PHLs or their vendors as they implement LIMS. The Association of Public Health Laboratories will continue to partner with the Public Health Informatics Institute to inform local, state, and national partners in the planning and budgeting for successful implementations of LIMS.

Batteries Not Included

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Notes

¹ A license is a one-time fee that the LIMS vendor charges for use of its software. It grants the owner the right to use the software. It does not include the right to support for the software.

² This is the industry standard. Personal communication from four major LIMS vendors.

³ Public Health Informatics Institute and Association of Public Health Laboratories. (2003). *A Public Health Laboratory Collaborative for Laboratory Information Management Systems Business Case*. Unpublished report, Decatur, GA: Public Health Informatics Institute.

⁴ GSA schedules: www.gsa.gov.

⁵ The Institute agreed that no actual PHL or vendor information would be released in order to obtain sensitive pricing information

⁶ Arkansas Department of Health; Connecticut Division of Laboratories; University of Iowa Hygienic Laboratory; Public Health Laboratory, Marion County Health Department, Indianapolis, Indiana; Kansas Division of Health and Environmental Laboratories; Maine Laboratory Operations—Health and Environmental Testing; Massachusetts State Laboratory Institute; New York Wadsworth Center; Utah Division of Epidemiology and Laboratory Services; and the Virginia Division of Consolidated Laboratory Services.

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About Public Health Informatics Institute

The Public Health Informatics Institute is dedicated to advancing public health practitioners' ability to strategically apply and manage information systems.

The Institute assists federal, state, and local public health agencies and other public health stakeholders that are grappling with information systems challenges.

Our services provide clarity about the information systems problems to be solved and identify the solutions to those problems.

The Public Health Informatics Institute is a component of The Task Force for Child Survival and Development.

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