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Benchmarking and Budgeting Techniques for Improved Forensic Laboratory Management

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Abstract *Forensic laboratories are not immune from downturns in the worldwide economy. Recession and economic slowdowns, when coupled with the public's heightened sense of the capabilities of forensic science, put stress on the effectiveness of forensic laboratories. The resources available to forensic laboratories are limited, and managers are under greater pressure to improve efficiency and effectiveness. To this end, the use of internal and external financial and accounting metrics to plan, control, evaluate, and communicate performance is examined. Using data from the QUADRUPOL and FORESIGHT studies, we illustrate the use of external benchmarking through a calculation of laboratory return on investment and the internal development and use of a budget to enhance laboratory performance in light of limited resources.*

Keywords Finance, forensic labs, management, strategic planning

Introduction

Economic realities have forced laboratories to re-examine their procedures and the associated costs at a time when the demand for forensic laboratory services have increased and simultaneously resources have been cut or at best remained stagnant. The identification and monitoring of reliable metrics in the examination of performance have never been more critical to a forensic laboratory's success. In this article we discuss two distinct yet related types of metrics, external benchmarking and internal budgeting, as avenues to successful laboratory management. The metrics discussed in this analysis will assist the management teams of forensic laboratories through improved planning, control, evaluation, and communication to interested parties.

Budgeting provides a tool in the planning process that connects an organization's mission to its strategic plan and offers specific metrics to highlight the laboratory's progress toward meeting that mission. Properly implemented, the budgetary process becomes an integral part of a forensic laboratory's business plan. The process helps to organize a measurable plan, offers control and monitoring mechanisms, provides the necessary metrics for internal and external communication of performance, and has a built-in feedback mechanism for continuous performance improvement.

In this paper we outline a process for a full budgetary feedback loop. We begin in the following section with a look at the link between a forensic laboratory's mission, strategy, and its financial statements. From those financial statements we demonstrate the incremental budget process and build the process around an example using the fingerprint identification investigative area for a hypothetical laboratory. To develop our metrics and examples we use data from two recent studies. The first study (QUADRUPOL 2003) established the groundwork and offered a standardized definition set for measurement of the inputs and outcomes of forensic laboratories in Europe. The second study, FORESIGHT (Houck et al. 2009), adopted the foundation of the European study and extended the standardization to include connections between casework, operational budgets, and personnel detail for forensic laboratories across North America. Next, we introduce the tools to compare a planned budget to actual performance via variance analysis. We demonstrate how that comparison enters into the feedback loop for the next budget cycle and what the information gleaned from the analysis indicates about the attention to the mission of the unit. Finally, the budgetary loop is connected to external benchmarks via an example using fingerprint identification to complete the feedback loop.

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Linking Mission and Strategic Plan to Metrics

The mission of a laboratory may range in complexity from "process all of the forensic requests that investigators send" (Speaker & Fleming 2009, p. 61) to "provide timely and innovative evidence processing and analysis for any investigation that requires support to detect, enhance, or recover evidence, including on-site assistance such as search and seizure and expert testimony."[1] The strategy (and the challenge) is to match the capabilities of the laboratory in a manner to accomplish the mission, and the fiscal plan should be consistent with this objective. How does the laboratory compare to its peers in efficiency and effectiveness? What are the fiscal and operating plans for the laboratory to meet the mission? How do you connect the fiscal measures to a laboratory's professed strategy? The fiscal and strategic plans are symbiotically related; a change in one leads to a change in the other. The role of the budgetary process in corporate planning, goal formation, and the impact on strategic decisions has been outlined elsewhere (e.g., Lin 1979; Mintzberg 1979; Kahalas 1977; King & Cleland 1977). For an organization to meet its mission the budget must be integrated into the plan, and the two cannot be contradictory.

The use of external metrics in the form of benchmarking allows a laboratory to compare facilities with similar missions (Speaker 2009a), and the use internal metrics in the form of budgets allow a laboratory to monitor, control, and evaluate actual performance to expectations (Speaker & Fleming 2009). Describing and relaying these metrics and their link to the mission and strategic plan improve communications with stakeholders both internal and external to the laboratory.

The link between potential metrics and strategic planning follows the dictum that when it comes to selecting a strategy to meet goals, if you can't measure it, then you can't meet it. Thus, it becomes critical for the forensic laboratory to carefully voice its mission, its statutory mandates, and connect the associated goals to the internal management of the laboratory. One case study of a strategic planning change (Dale & Becker 2004) relates the performance goals of one laboratory to attempts to change the traditional personnel model. To evaluate the change, they carefully determine the measures and test these measures against the changes in a particular strategy. Another study (Speaker 2009b) demonstrates how a more generic mission of maximizing cases processed for a given budget, or minimizing the cost per case processed, leads to a series of metrics to explain how individual laboratories meet that goal, and how to compare their performance over time or across all laboratories.

In meeting their mission, laboratories will obtain data from a variety of sources—casework, personnel records, and financial records. As demands for laboratory services are increasing while the funding for laboratory services are somewhat stagnant, the ability to further stretch limited resources becomes the focus for many managers. A key tool for managers to optimize the output from those limited resources is from the planning and monitoring of resources through budget management.

The Budget Process

Budgeting is a management tool used to plan for both financial and operational purposes over a specified period of time. Hagen and Harden (1995, p. 772) describe the budget as "a list of revenues and expenses during a certain period of time . . . It is the answer to the question, who does what, when, and how in the preparation and the implementation of the budget." Additionally they note that the budget is a process to reduce uncertainty, can be used as a device for commitment to fiscal discipline, and that the rules used in the budgetary process affect fiscal performance. Often considered to be solely a planning device, the budget also assists in the control, evaluation, and communication of performance. While many forensic laboratories receive their financial support through legislative dictum, enhanced use of the budget and the budgetary process can improve efficiency and control over the resources provided. Organizations construct budgets to achieve a goal within a boundary of scarce resources that often include time, money, or even talent, and then use those budgets to maintain efficiency and to reduce fiscal surprises.

Different methods exist for developing a budget. *Incremental budgeting* uses the prior period, usually the prior fiscal year, as the foundation and incrementally adds resources to become the new budget. *Zero-based budgeting*, on the other hand, is a budgeting method where each budget is developed and justified from scratch each year. This method is generally considered to be more comprehensive but also more time consuming. Research into the effectiveness of each method is mixed. Wildavsky and Hammond (1965) examine zero-based and incremental budgeting methods and find benefits for each. Zero-based budgeting has educational benefit to those within the organization in the process and appears to have psychological benefits in improving self-esteem of those individuals involved. The researchers also note, though, that the failure to consider the budget as a whole may be characterized as irrational, that agencies generally receive legislative mandates so that no program would be expected to proceed without history or learning based on that history. Lin (1979) suggests that zero-based budgeting may be best utilized in a dynamic business model or industry, and similarly Wetherbe (1976) notes that incremental or traditional budgeting may best be utilized in an organization that is more traditional and manufacturing based. Wetherbe and Montanari (1981) suggest that zero-based budgeting would be effective when incorporated into the planning framework for service-oriented organizational units.

Generally speaking, public forensic laboratories receive their budgetary totals through a governmental allocation process while private laboratories possess greater self-direction and planning autonomy. This being the case, it is suggested that the optimal budgetary process for either type of laboratory would include aspects of both zero-based and traditional incremental budgeting methods. The learned history of laboratory processes and costs related to those processes need not be ignored. The cost of "reinventing the wheel" during each budgeting cycle in all likelihood will exceed the benefit to be gained. It may be beneficial, though, to periodically apply zero-based budgeting to a particular process or program as part of a comprehensive financial and operational review. This approach may allow for the efficiency and expediency of the traditional budgeting method in the budget as a whole while allowing for the benefits of zero-based budgeting to be utilized at a program level.

The budgetary period usually covers a year and is typically aligned with the funding agency's fiscal year or calendar year. The year is often sub-divided into months and/or quarters to allow for better planning and monitoring. The initial budget is often called the *static budget*. The static budget is established and remains unchanged during the year. A *rolling* or *continuous budget* is a budget that is continually updated or recast as new information become available. The budgeting period in a rolling budget is usually the next twelve months regardless of the fiscal or calendar year.

The advantages of budgets and the budgeting process within an organization include improving operational and fiscal coordination, providing a structure for gauging performance, motivating managers and employees, and improving operational and fiscal control. The budget links the purpose of the organization to plans necessary to achieve that purpose; it identifies resource needs, shortfalls, and excesses; it provides a basis for performance evaluation; and it becomes a mechanism from which effective communication can evolve. In essence the budget has four primary uses: plan, control, evaluate performance, and communicate results. Along with an appropriate feedback loop, Figure 1 illustrates the steps in the budgeting process.

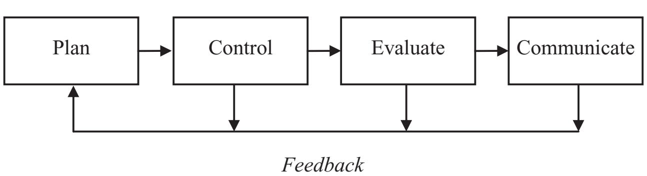

Figure 1. Budgetary Loop

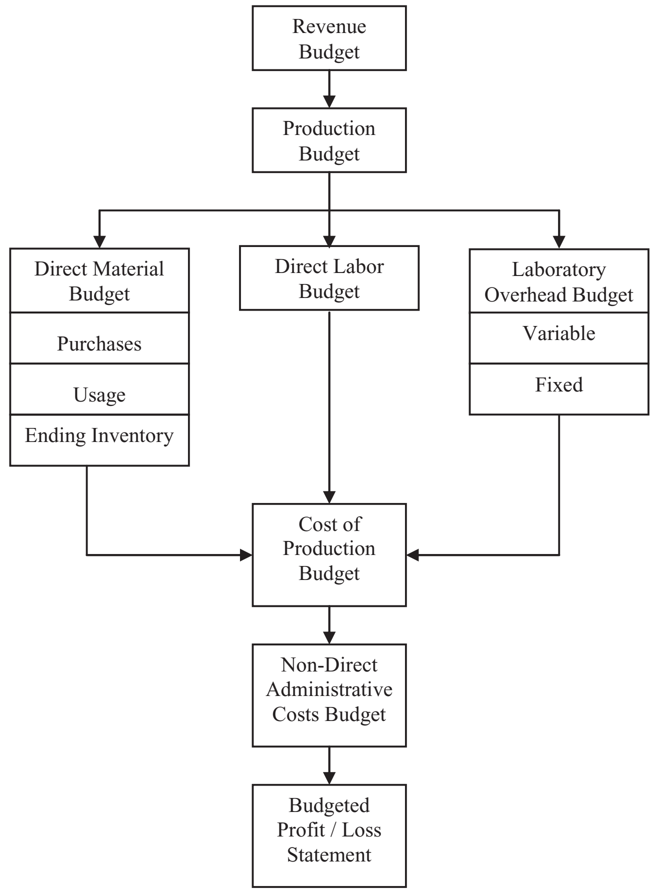

Figure 2. Master Budget and Components

The development of the budget flows from the top of the profit and loss statement to the bottom. The primary starting point is the revenue or services budget, as illustrated in Figure 2, and the most difficult item to budget is the number of tests or procedures, broken down in sub-periods of time such as months or quarters. Once the number of tests or procedures has been budgeted, then variable and fixed laboratory costs can be budgeted, such as materials, labor, and overhead to ascertain a total laboratory cost per test. Finally, non-direct general and administrative costs are budgeted, which leads to a budgeted profit/loss statement. These individual component budgets are compiled together in what is commonly known as the master budget.

There are certain steps to follow in developing, maintaining, and utilizing a budgetary process, and these are used for the overall budget, within each component budget, and within each procedure budget. Elaborating upon the steps depicted in Figure 1, consider what is included in each stage of the budgeting process. *Planning* references the identification of the problem and recognition of uncertainties, obtaining relevant information, and making predictions predicated upon chosen alternatives. The *control* stage includes the monitoring of costs and the motivation of employees. *Evaluation* of performance requires an in-depth analysis including a consideration of static budget variances and a breakdown of flexible variances. The fourth stage, *communicate,* references both the interpretation of those variances and the dissemination of the lessons learned. Finally, the feedback loop implies a constant flow of information through each stage of the process in a given budgetary cycle and across budgetary cycles to continually refine the process.

Within any organization there exist units or centers where similar products, tasks, or services may be grouped for ease of management, marketing, and/or accounting of results. A forensic laboratory is similar to firms in other industries in that there are separate investigative areas for DNA analyses, fingerprint analyses, hair and fiber analyses, etc. To demonstrate the steps in budgeting, we use the investigative area fingerprint identification as the subject center.

The first stage of the budgetary process involves the development of the budget plan. Consider this first step for our sample investigative area, fingerprint identification. Management begins by identifying the problem and uncertainties for fingerprint analysis. For problem identification this could be something as simple as: develop a budget for fingerprint identification to cover the expected number of analytical requests (tests). The uncertainties might include items such as: the number of expected tests; the cost of reagents and materials per test; the time to process a test; the labor required to process the test; the cost of labor for processing; and non-personnel expenditures.

Once the issues have been identified, management begins to assemble supporting information related to the issues. Key information from historical records provides a basis for developing the answers to the uncertainties above. For this example, refer to Table 1 for some historical information regarding a hypothetical budget for the fingerprint identification section of a laboratory.

Table 1 provides a basis by which the incremental budgeting process will be explained. The column “Actual Y1” provides the starting point for our example. Suppose that the figures in this column represent the actual experience in the first year. From that actual experience, management builds its planned budget for year two with a consideration of changes anticipated for the coming year.

Table 1. Incremental Budgeting Example

Personnel Expenditures	*Actual Y1*	*Planned Y2*
Salary & Wages—base	$388,000	$388,000
Salary & Wages—overtime	$63,500	$63,500
Social costs (employer FICA, Medicare, etc.)	$32,500	$32,500
Retirement (Pensions, 401K, etc.)	$38,500	$38,500
Personnel development & training	$1,500	$1,500
Health care/insurance	$55,850	$55,850
Life Insurance	$770	$770
Total Personnel Expenditures	**$580,620**	**$580,620**
Non-Personnel Expenditures		
Chemicals/reagents	$15,000	$16,500
Traveling (non-training related)	$750	$750
QA and accreditation	$9,000	$9,000
Literature purchased	$350	$350
Service of instruments	$7,500	$7,875
Utilities	$37,500	$39,375
Telecommunications	$7,500	$7,875
Capital Expenditures	$25,000	$25,000
Other	$70,000	$73,500
Total Non-Personnel Expenditures	**$172,600**	**$180,225**
TOTAL EXPENDITURES	**$753,220**	**$760,845**

Make Predictions and Choose Alternatives

For forensic laboratories, the basis for predictions may be crime statistics and trends, economic analysis, state directives, or other indicators. For example, we may use federal crime statistics and trends for the estimated annual number of fingerprint tests, employment data and state budgetary figures for pay increases, and supplier figures or the producer price index (PPI) for chemicals and reagents. For this example, we find evidence at the federal level that the crime rate is expected to stay steady but locally the crime rate has been variable; the state has indicated that there will be no raises even though industry average pay increases have been around 5%; and suppliers indicate that cost of chemicals and reagents are expected to increase by 10%, although the inflation measures, such as the Producer Price Index (PPI), are relatively flat.

For this example (illustrated in Table 1), we assume that the laboratory management has projected that the crime rate, and thus the number of expected fingerprint tests, will hold steady; there will be no raises; and chemical and reagent cost will increase by 10%. As the column “Planned Y2” illustrates, the planned budgets include these changes to reflect the expected economic conditions from stagnant salaries to inflated costs for materials.

Figure 1 illustrates the second stage of the budgetary process as one of control. Many of the costs within a budget are considered to be *variable costs*, while others are *fixed costs*. Variable costs are driven by some factor that may or may not be controllable. In the working example, chemical and reagent costs are variable, that is, the total chemical and reagent cost is dependent upon the number of fingerprint tests. As the number of fingerprint tests increase, so does the total reagent cost. But fixed costs are not dependent upon these factors that affect variable costs (within a relevant range), and while some are not controllable, many are. Each cost type should be separated and analyzed. In examining select costs from the QUADRUPOL and FORESIGHT studies, we see that the expected year 2

Table 2. Budget Variance Report

Personnel Expenditures	*(1) Planned Y2*	*(2) Actual Y2*	*(3) Variance*	*(4) Var %*
Salary & Wages—base	$388,000	$370,000	**($18,000)**	−4.64%
Salary & Wages—overtime	$63,500	$109,183	$45,683	71.94%
Social costs (employer FICA, Medicare, etc.)	$32,500	$34,493	$1,993	6.13%
Retirement (Pensions, 401K, etc.)	$38,500	$42,361	$3,861	10.03%
Personnel development & training	$1,500	$2,750	$1,250	83.33%
Health care/insurance	$55,850	$58,269	$2,419	4.33%
Life Insurance	$770	$770	$0	0.00%
Total Personnel Expenditures	**$580,620**	**$617,826**	**$37,206**	**6.41%**
Non-Personnel Expenditures				
Chemicals/reagents	$16,500	$18,048	$1,548	10.32%
Traveling (non-training related)	$750	$1,875	$1,125	150.00%
QA and accreditation	$9,000	$8,852	**($148)**	−1.64%
Literature purchased	$350	$350	$0	0.00%
Service of instruments	$7,875	$9,250	$1,375	18.33%
Utilities	$39,375	$53,156	$13,781	36.75%
Telecommunications	$7,875	$7,925	$50	0.67%
Capital expenditures	$25,000	$32,500	$7,500	30.00%
Other	$73,500	$70,500	**($3,000)**	−4.29%
Total Non-Personnel Expenditures	**$180,225**	**$202,456**	**$22,231**	**12.34%**
TOTAL EXPENDITURES	**$760,845**	**$820,282**	**$59,437**	**7.89%**

cost of travel is $750, the cost of literature is $350, and the cost of utilities is $39,375. Each of these fixed costs can be monitored and controlled, and depending upon the laboratory, some are more controllable than other. Further, by communicating the fiscal goal of each item, employees may be motivated to help contain the costs.

The third step in the budget process calls for an evaluation of performance. A tool to help in that evaluation is budget variance analysis in which the *ex ante* planned budget items are compared to the *ex post* actual revenues and expenditures. The comparison of actual results to the budget is critical for evaluation of performance, particularly when the question is addressed as to whether or not the resulting experience could have been accurately anticipated. Variance analysis helps to determine where to focus managerial efforts.

A demonstration of variance analysis is presented in Table 2. The table begins with the column (1) information, planned Y2, which was initially presented in Table 1 as the budgeted amounts for each category of expenditure. In the next column we have added the actual year 2 experience in a side-by-side comparison to the planned amounts for each expenditure category. The variance is the difference between the actual experience and the budgeted amount for that category. A negative dollar entry in the third column indicates a line item where actual expenditures were less than the amount budgeted (a surplus), while a positive variance indicates expenditures in excess of those planned. The fourth column expresses the variance as a percentage of the planned expenditure.

While a manager might desire perfect foresight for budget planning, the reality is that not all circumstances will be perfectly predicted and therefore some variance is inevitable. Every laboratory director must decide what degree of accuracy is optimal, which in itself is a marginal cost versus marginal benefit problem. To evaluate a marginal cost vs. marginal benefit problem, the gain from increased accuracy must be weighed against the cost of making a more accurate prediction. In that vein, a laboratory should set some standards to trigger a more in-depth analysis for the next budget cycle.

In setting those standards for further investigation, a consideration must be given to both realistic expectations for the degree of accuracy of predictions and the potential gains from greater accuracy. While it is unrealistic to expect 100% accuracy in budget predictions, is it reasonable to expect actual expenditures to be within 99% or 95% or even 90% of the budget plan? That standard for accuracy must be considered in advance as it will lead to corresponding actions after the end of the budget cycle.

Column 4 of Table 2, variance percentage (Var%), is listed to provide a quick review of such a standard. Regardless of the dollar size of the budget category, if performance falls within some predetermined x% of the plan, then planning is deemed reasonable and no elaborate redesign of the planning is required. For demonstration purposes in this example, suppose that the hypothesized laboratory in Table 2 does not conduct a more in-depth budget planning analysis when the variance percentage is within (+/−) 5% of the plan. Using that criterion, the highlighted entries in column 4 indicate all category candidates for further review.

With respect to the second trigger, potential gains, we shift attention to column 3 of Table 2. It is quite possible that a large variance percentage merely reflects a line item that is so small relative to the entire budget that it does not bear much scrutiny, as in-depth analysis would cost more to conduct than the potential gains from the analysis. Again, laboratory management should establish a dollar threshold for the actual variance below which no further review is merited. For this demonstration, suppose the leadership of the laboratory in Table 2 have predetermined that any variance within (+/−) $1,500 of plan does not require more detailed review, but any variance outside those parameters is a candidate for further review.

With these two criteria in mind, the highlighted items in Table 2 can be reviewed. Each of the highlighted items for the variance and variance percentage columns have fallen into the potential investigation area because they are either outside the 5% forecasting accuracy rule on variance percentage or outside the $1,500 level for potential gain from greater accuracy. Notice, however, that personnel development & training, traveling, and service of instruments all have a variance percentage above 5%, but none of these have a dollar variance outside the $1,500 limit. As such, they will not be investigated further since the cost of investigation may well cost more than the potential gains from greater review. Similarly, salary & wages—base, health care/insurance, and other non-personnel expenditures—have dollar variances beyond the $1,500 threshold, yet none fall outside the 5% variance percentage criterion and thus are considered accurate enough to not bear detailed scrutiny. Thus, for the next budget cycle, salary & wages—overtime, social costs, retirement, chemicals/reagents, utilities, and capital expenditures—will all be reviewed in greater detail for potential improvements in forecasting the next budget. An example of such a review, using chemicals/reagents, is conducted below following the introduction of benchmarking standards to assist in that review.

External Metrics and Benchmarking

Public forensic labs generally have limited budgets, vary in size and complexity, and sometimes offer little in the way of direct comparison. One measure, though, lends itself to comparability across labs, and that is return on investment (ROI). One measure of ROI for the forensic industry is the total number of cases processed for a given level of funding, with the inverse being the level of funding divided by the total number of cases, or the average cost per case. The following formula can be used to extract this valuable information:

$$\frac{\text{CASE}}{\text{TOTEXP}} = \frac{\text{Area cases processed}}{\text{Total Expenditures}}$$

These measures are defined in the QUADRUPOL and FORESIGHT studies, where an *area case* refers to a request for examination in one forensic investigation area, and *total expenditures* is the sum of the direct expenses (personnel, operating, and investment) and any administrative or other overhead expenses.

We are able to gain greater insight into the formula using the DuPont expansion technique (Speaker 2009b). First developed in 1919 by DuPont executive F. Donaldson Brown, we transform the ROI measure into component parts. Brown noted that higher ROI was desirable, in general, but could result from too much risk rather than increased efficiency. Such undesirable results should be avoided. To detect such a potential problem, components to consider for addition include: efficiency measures such as cases processed per full-time-equivalent employee; quality/risk management measures such as tests performed per area case; analytical process measures such as personnel expenditures/total expenditures; and market condition measures such as the average compensation per employee

By adding the additional terms we expand the initial formula:

$$\frac{\text{CASE}}{\text{TOTEXP}} = \frac{\text{CASE}}{\text{TOTEXP}} \text{ x } \frac{\text{LEXP}}{\text{LEXP}} \text{ x } \frac{\text{FTE}}{\text{FTE}} \text{ x } \frac{\text{TEST}}{\text{TEST}}$$

Where, following the definitions from the QUADROPOL/FORESIGHT studies:

- LEXP refers to fully loaded labor expenditures and includes the sum of direct salaries, employer contributions (FICA, Medicare, workers comp, and unemployment comp), retirement (employer-only contributions toward pensions, 401K, 403b, etc.), personnel development and training (internal or external delivery, including travel), and occupational health service expenses (employer contribution only).
- FTE is the work input of a full-time employee working for one full year.
- TEST represents tests completed. A test is an analytical process, including but not limited to visual examination, instrumental analysis, presumptive evaluations, enhancement techniques, extractions, quantization, microscopic techniques, and comparative examinations. This does not include technical or administrative reviews.

By manipulating the above formula we can obtain the following:

$$\frac{\text{CASE}}{\text{TOTEXP}} = \frac{\frac{\text{TEST}}{\text{FTE}} \text{ x } \frac{\text{LEXP}}{\text{TOTEXP}}}{\frac{\text{LEXP}}{\text{FTE}} \text{ x } \frac{\text{TEST}}{\text{CASE}}}$$

Or, stated another way:

$$\text{ROI} = \frac{\text{Labor productivity}}{\text{Average compensation}} \text{ x } \frac{\text{Labor Expense ratio}}{\text{Testing Intensity}}$$

From *labor productivity* and *labor expense ratio* we gain a measure of efficiency and utilization, while *average compensation* is a market condition measure and *testing intensity* is a quality measure. These expressions provide a framework for the manager to gauge laboratory performance and to compare metrics to other laboratories.

To illustrate, consider our example laboratory and its fingerprint identification investigative area. Using the aggregate data from the QUADRUPOL and FORESIGHT studies to create a hypothetical laboratory, we use the following metrics for fingerprint identification for their planned activity associated with the planned budget cycle (Planned Y2) illustrated in Tables 1 and 2 above: Total expenditures of \$753,220 and personnel expenditures of \$580,620. Additionally, suppose that plans called for 2,400 cases to be processed and 28,000 tests to be performed by 7.70 full-time equivalent employees. By using the inverse of ROI we can find the average cost per case, and by inserting the data provided we find:

$$\frac{\text{Average Cost}}{\text{Case}} = \frac{\text{Average Compensation}}{\text{Labor productivity}} \times \frac{\text{Testing Intensity}}{\text{Labor Expense ratio}}$$

Using the data above, we can substitute the following values into the components of this expression.

$$\begin{aligned} \text{Average Compensation} &= \text{personnelexpenditures/full}- \\ &\quad \text{time equivalent employees} \\ &= \$580,620/7.70 = \$75,405 \\ \text{Testing Intensity} &= \text{testsperformed/casesprocessed} \\ &= 28,000/2,400 = 11.67 \\ \text{Labor productivity} &= \text{testsperformed/full}- \\ &\quad \text{time equivalent employees} \\ &= 28,000/7.70 = 3.636 \\ \text{Labor expense ratio} &= \text{personnelexpenditures/} \\ &\quad \text{totalexpenditures} \\ &= \$580,620/\$753,220 = 77.09\% \end{aligned}$$

Substituting these values into the expression for the average cost per case yields:

$$\frac{\text{Average Cost}}{\text{Case}} = \frac{\$75,405}{3,636} \text{ x } \frac{11.67}{77.09\%} = \$\ 313.84$$

The decomposition of the cost per case ratio into the four components allows managers to better evaluate the laboratory performance, particularly across the industry. Not only can we examine and compare ROI, but we can examine and compare average compensation, labor productivity, testing intensity, and the labor expense ratio. In turn, this can allow for improved goal setting, communication of performance, and potentially improved performance by allowing the manager to focus on specific areas that affect the ROI measure. Additionally, if a measure appears to be an outlier as compared to the industry, either above or below, then it may merit further investigation as to data completeness and/or accuracy.

The European forensic industry standards (QUADRUPOL 2003) and corresponding North American forensic industry standards in FORESIGHT (Houck et al. 2009) provide a starting point for the acquisition of industry metrics for external comparison. While laboratory managers may be victims of market conditions via the average compensation component of the average cost per case, comparison of the other three ratios to industry standards may suggest some internal goals for process improvement. Establishing such goals for improvement then enters the feedback loop in the budgetary cycle for the next fiscal year.

Return to Budget Review Performance Evaluation—Chemicals/Reagents Example

Recall that the budget variance suggested a few areas for which greater scrutiny was recommended based on the joint criteria of a variance percentage in excess of 5% and a dollar variance in excess of \$1,500. Among these expenditure areas for greater investigation was the expenditure for chemicals/reagents (chemicals, reagents, consumables, and gases). Consider such an investigation into those expenditures as an example of how to conduct such a review. Table 3 highlights some additional detail on personnel and casework to be used along with the budget detail of Table 2 for this demonstration.

Assume the *actual* number of fingerprint tests was 32,000 (compared to the planned budget of 28,000 tests) and the *actual* reagent cost was \$18,048 (compared to the planned budget of \$16,500). Note that the volume exceeded expectations resulting in an increase in cost. The difference between the planned (static) budget and actual results is known as the *static budget variance*, which in this case is \$1,548 *unfavorable* (Speaker and Fleming, 2009, p. 64).

Table 3. Non-Financial Data: Casework and Personnel

Casework			
Total area cases	2,400		
Total items	11,318		
Items examined internally	11,318		
Tests on samples examined internally	28,000		
Area reports	2,304		
Median turnaround time, days from first submission (internal)	193		
Median turnaround time for analyst, days	63		
Open area cases at end of year	623		
Open area cases older than 30 days at end of year (backlog)	208		
Floor area (sq ft)	2,500		
Hrs in casework	8,525		
Personnel	Planned FTE	Actual FTE	Variance
Reporting Scientists/Analysts	4.95	4.25	(0.70)
Scientists in training	2.50	2.50	0.00
Support staff/Administration	0.25	0.25	0.00
Total Full-Time Equivalents	7.70	7.00	(0.70)

Next, we determine how much the laboratory should have spent given the actual volumes. This is the flexible budget, and it shows the amount of spending given complete accuracy of budgetary volumes. To determine the flexible budget we take the actual number of tests and multiply it by the standard cost per test. This standard is based upon the number of tests and chemicals/reagents cost upon which we budgeted. In this case, the standard is the $16,500 reagent cost divided by the 28,000 tests for a standard cost of $0.589/test. To determine how much chemicals/reagents cost should have been expected, we simply multiply the actual number of tests (32,000) by the standard cost per test of $0.589, which equals $18,857.14.

From this analysis, the manager can now decompose the static budget variance into two components, the *volume variance* and the *flexible budget variance*. The *volume variance* illustrates the impact of the increase or decrease of the cost object volume, in this case the number of fingerprint tests; the *flexible budget variance* highlights the spending variance generally controllable by managing operations. In this case, the unfavorable static budget variance is attributable to an increase in testing volume, something that may or may not be within their control, but partially offset by a favorable flexible budget variance.

Through further analysis and decomposition, though, it is possible to examine the operational costs. Although this information is not contained within the QUADRUPOL or FORESIGHT studies, we make the following assumptions to illustrate the point: The budget of 28,000 tests with a cost of $16,500 was based upon the standard of 0.125 liters of reagent per test, for a total of 3,500 liters of reagent at a cost of $4.714 per liter; we actually used 3,840 liters of reagent at an actual cost of $4.700 per liter for the period. By inserting an additional column between the actual results and the flexible budget, we can examine price and efficiency variances relating to reagent spending. Taking the actual liters and multiplying them by the standard cost per liter, we gain an added dimension to the analysis as shown in Figure 5.

The fourth step in the budget process involves communications of the discoveries back into the next budget

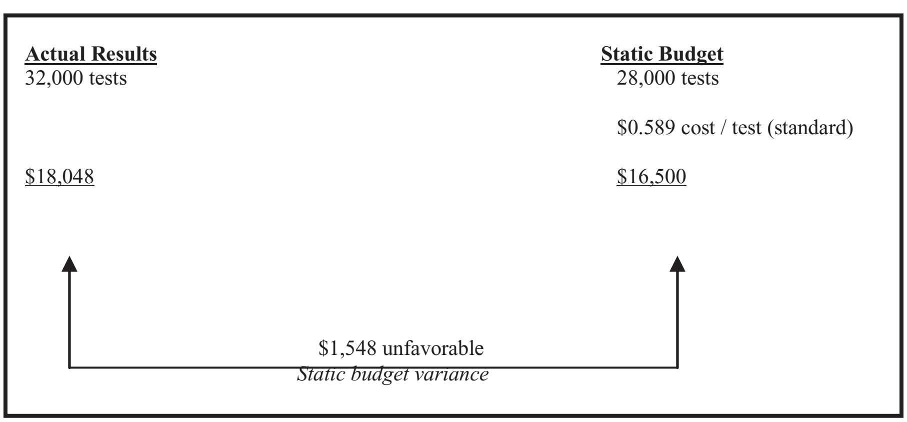

Figure 3. Direct Materials—Reagent Costs: Static Budget Variance

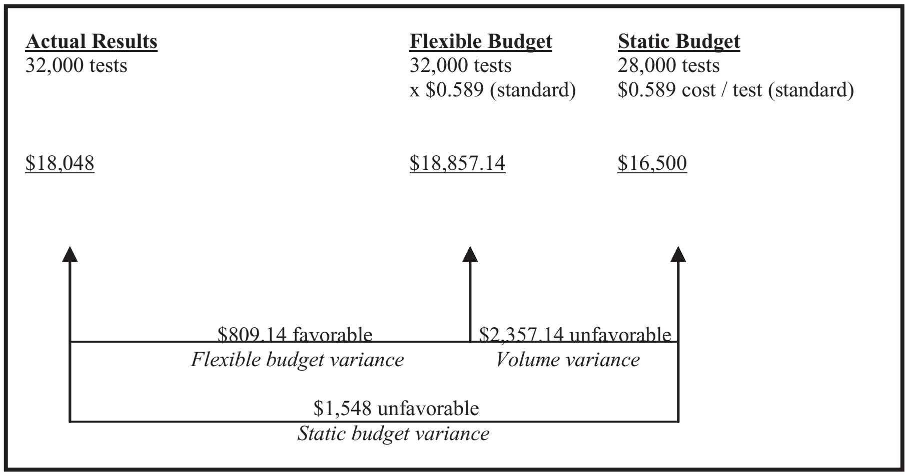

Figure 4. Direct Materials—Reagent Costs: Flexible Budget Variance

cycle. The analysis of the *favorable price variance* shows that the laboratory spent $4.700 per liter versus the expected standard of $4.714; the *favorable efficiency variance* is driven by the efficient use of reagents given the increased volume of tests. Although these numbers are relatively small, the results illustrate important operational aspects of the laboratory and aid management in questions to ask and areas to focus. The better price may be due to a better negotiation, a new supplier attempting to gain a foothold at the lab, or a general price decrease in materials. The reduced consumption of 160 liters of reagent may be due to less intensive or complex testing procedures or protocols, fewer accidental mishandling of reagents, improved inventory controls, or improved testing protocols. Although these are guesses, the laboratory manager would use the information from the variance analysis to follow-up and determine root causes of both favorable and unfavorable outcomes.

As Figure 5 illustrates, the laboratory manager can go beyond the negative and simplistic statement that the laboratory overspent the budget by $1,548 to a more positive statement that, given the increased volume of tests, the laboratory actually spent $809.14 less than it should have. It may be further communicated that operationally the laboratory had a favorable price variance of $54.86 and a favorable efficiency variance of $754.28 for chemicals/reagents purchases and usage, respectfully. This analysis allows for improved communication, and just as importantly, it highlights the area or areas where the manager can apply focus to develop and share best

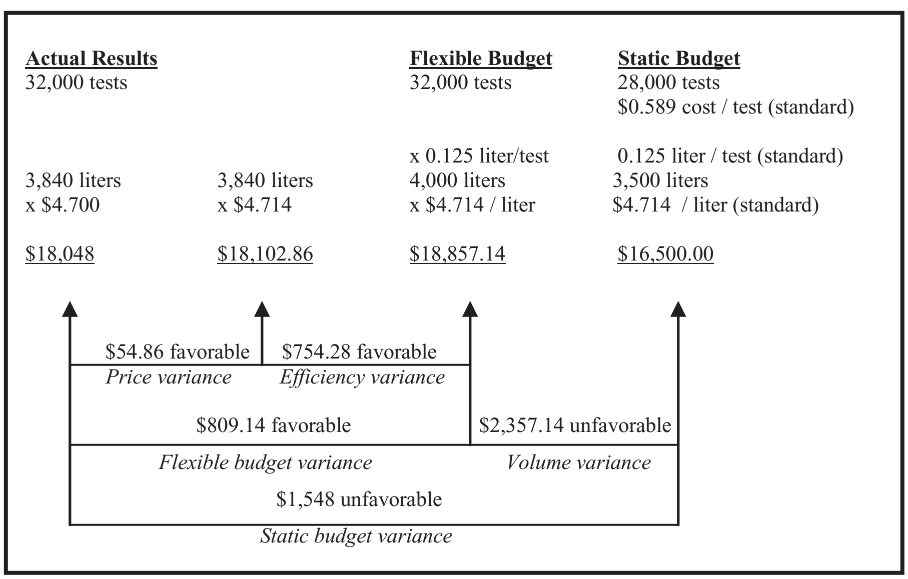

Figure 5. Direct Materials—Reagent Costs: Price & Efficiency Variance

practices or to seek improvement through the identification of inefficiencies or waste. Additionally, the information can supplement the risk assessment of operations and can accentuate areas that may merit further investigation or scrutiny by laboratory management.

The final step in the budget process is the feedback loop. The feedback loop is not a singular event, but rather is a continual process used to improve the budgetary process. As we progress period by period, we learn which indicators used in making predictions are more reliable and accurate; we gauge which standards are theoretical versus practical; we gain operational knowledge from those who help provide input into the budgeting process; and we obtain commentary from users who read and monitor laboratory performance. The feedback obtained is used to enhance and improve the planning, control, evaluation, and communication steps.

It is important to note that feedback is constructive criticism to be used for process enhancement and is not to be taken personally. The laboratory manager should view feedback as an opportunity for improvement and should look to incorporate new data and knowledge where applicable. In the example from above, the amount of reagent per test may be adjusted if it is felt that the decline in usage is permanent versus temporary.

Conclusion

Laboratories vary across jurisdictions in terms of strengths, weaknesses, capabilities, funding, mission, and strategy, but all laboratories have a universal need to monitor performance as compared to peers and within the organization. Further, laboratories need a structure and mechanism to communicate fiscal performance to mission and strategy. This can be accomplished through external benchmarking and internal budgeting. Through the construction of an applicable ROI, labs can externally benchmark to facilities with similar missions, manage and communicate their performance accordingly. Through the budgetary process, labs can improve their internal ability to plan, control, evaluate, and communicate. Utilizing both external and internal metrics optimizes the opportunity to fulfill the lab's mission and strategy.

End Note

[1]The example is an illustrative amalgamation and paraphrase of the mission statement from the DoD Cyber Crime Center (http://www.dc3.mil/dcfl/dcflMission.php).

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