Process Monitoring In Accounting: Implementing Pre-Control Charts

Timothy C. Krehbiel, Miami University
Douglas Havelka, (E-mail: havelkdj@muohio.edu), Miami University
Michael Scharfenort, (E-mail: scharfm@muohio.edu), Miami University

ABSTRACT

This research paper has two primary goals. The first is to briefly discuss how control charts and pre-control charts can be applied to non-manufacturing processes, including how companies can use control charts and pre-control charts to improve business processes, financial reporting processes, auditing methods, and tax accounting processes. The second goal is to illustrate how pre-control can be applied to an accounting process. An example is used to demonstrate implementation of Six Sigma techniques for monitoring company expense budget variances.

INTRODUCTION

Pre-control is a non-statistical process monitoring tool, similar to statistical control charts. Although pre-control has been used widely in manufacturing settings, applications to accounting processes are virtually non-existent. The use of control charts to track accounting or auditing functions is also very minimal, but the number of applications is growing with the increased interest in Six Sigma Management. In general, accounting process results are only summarized quarterly (4 times per year) for financial reporting purposes, making them difficult to control chart with any great effectiveness. Even a process such as expense budgeting which summarizes monthly results (12 points per year) for budgeted expense amount are not the data-rich environments control charts were originally designed for. On the other hand, pre-control charts were originally designed for short-run manufacturing environments, i.e., situations where the lack of data make estimating control limits virtually impossible. Thus, pre-control monitoring can be a viable method to use with quarterly or monthly accounting processes.

This research paper has two primary goals. The first is to briefly discuss some ways control charts and pre-control charts can be applied to non-manufacturing processes. Here we concentrate on how companies can use control charts and pre-control charts to improve business processes, financial reporting processes, auditing methods, and tax accounting processes. The second goal is to illustrate how pre-control can be applied to an accounting process. The example used involves monitoring company expense budget variances. A company can establish its process capability for the budgeting process by analyzing previously budgeted expense amounts in prior years versus corresponding actual expenditure amounts. Pre-control rules can be established thereafter using specification limits calculated from the prior process capability. The specification limits can also be adjusted if tighter variances are desired. Monthly variances in budgeted and actual expenditures can be selected and plotted. Monitoring the actual expense amounts monthly will help assess the accuracy of the budgets and also help initiate discovery of any special causes of variation. The improvements in the budgeting process will come from investigating why such differences exist, if any, and how these differences can be reduced in the future. These insights should allow managers to gain a better understanding of resource consumption. The ultimate benefit to a company using this methodology will be better earnings forecasts that reduce the likelihood of expectations gaps occurring in the market.

The explosion of interest in Six Sigma Management has lead to a greater interest in monitoring accounting processes. Technically speaking, Six Sigma is the rigorous pursuit of variance reduction leading to the design of business processes that produce approximately 3.4 defects per million opportunities. As with other quality management systems, Six Sigma is a packaging of statistical and managerial methods. Although originally intended
for a manufacturing setting, today many companies are reaping bottom-line benefits by using Six Sigma to improve transactional processes, including those in the accounting and finance functions. Six Sigma is a project-based process improvement initiative whose focus is linking together the statistical and management tools into a logical flow. One of the most predominate aspects of the Six Sigma methodology is the five-stage process improvement model: Design, Measure, Analyze, Improve, and Control (DMAIC). The DMAIC model has proven to be an effective method of data-driven decision making leading to quality improvement and increased business performance. Control charts and pre-control charts are used in several of the steps in the DMAIC model, but perhaps none more so than the control stage. The objective of the control stage is to maintain the improvements gained by completing the first four stages of the Six Sigma project. The focus is on ensuring that previously addressed problems remain fixed. The Six Sigma team needs to standardize and document the changes and then develop or improve a monitoring system using key output variables. The control phase might include establishing new standards and procedures, training, and implementing controls such as checklists, balanced scorecards, control charts and/or pre-control charts.

LITERATURE REVIEW

Six Sigma evolved in Motorola during the 1980s (See Evans & Lindsay, 2004) and its financial successes have been highly touted (Hammer, 2002; Currie, 2004; Bisgaard & Freiesleben, 2004; Bottome & Chua, 2005). Although Six Sigma was originally designed for a manufacturing setting, Ograjensek and Thyregod (p. 84, 2004) note that “Six Sigma is a disciplined quantitative approach for improvement of defined indicators (called metrics) in all types of business processes.” This sentiment is echoed by many authors, including Brewer (2004), Patton (2005), Sodhi and Sodhi, (2005), Johnson (2005), and Bisgaard and Mast (2006). In fact, Motorola early on applied Six Sigma to accounting processes. In 1994, Motorola announced that all company-wide finance functions, including auditing, were at 5 sigma quality levels (Ettorre, 1994). Today, Six Sigma is routinely applied to manufacturing processes, as well as non-manufacturing processes typically referred to as transactional processes. Windsor (2006, page ix) defines a transactional process as “any process where an actual product is not produced,” and suggests that the two keys to success in transactional Six Sigma projects are the realization that everything is a process, and that you must have a method to measure the output of the process.

Six Sigma is more evolutionary than revolutionary. The major benchmark initiatives in quality improvement methodologies are Total Quality Control or TQC (See Feigenbaum, 1956), Total Quality Management or TQM (See Deming, 1986), and now Six Sigma management (See, among others, Harry and Schroeder, 2000). Many of the same tools, including control charts, pre-control charts and related SPC tools, have been used (Hahn, Doganaksoy and Hoerl, 2000; Hare, 2003; Whitacre, 2005). Whitacre (2005, page 86) states:

The theories, tools and techniques we quality professionals have learned and applied are not original or unique to any specific product or type of business. Thus, we can apply the same approaches to service related jobs as we can to manufacturing jobs.

As was the case for TQC and TQM, Six Sigma recognizes the invisible factory (see Chase & Garvin, 1989) inherent in all service companies. Finance companies have been early and enthusiastic adopters (Stamatis, 2004), Bank of America adopted Six Sigma as the methodology of choice to improve all aspects of their service quality (Cox & Bossert, 2005). From instituting Six Sigma in 2001 to the end of 2005, Bank of America has experienced a 25% increase in overall customer satisfaction. Volt Information Services has used Six Sigma successfully in day-to-day operations as well, and reports the methodology as “a detailed analysis of any business process to eliminate to the fullest extent possible deviations in intended outcomes of each individual activity” (Diana, 2005, page 24).

Accounting processes are a subset of transactional processes that are present in all companies, and lend themselves to measurable outcomes. Thus it naturally follows that accountants should play key roles in Six Sigma projects. Neuschler-Fritsch and Norris (2001), Friedman and Gitlow (2002), and Rudisill and Clary (2004 & 2005) discuss accountants’ roles and responsibilities in successful Six Sigma projects. Case studies involving successful accounting applications include the elimination of inefficiencies in an accounts payable process (Brewer and Bagranoff, 2004) and improvements to the quarterly financial reporting process (Brewer and Eighme, 2005; Krehbiel, Eighme & Cottell, 2006). Jones and Hain (2005) set up control charts to monitor key performance indicators (KPIs) in
the control stage of a Six Sigma project aimed at reducing obsolete inventory in the materials management branch of a public works facility. The KPIs included accounting metrics such as total labor cost divided by total number or orders. Falton and Falton (2002) discuss the integration of Six Sigma metrics with management dashboards. Recently, two hot topic areas include Six Sigma applications concerning Sarbanes-Oxley (Hofmann, 2005; Liebesman, 2005; LaComb and Senturk, 2006; Senturk, LaComb, Neagu and Doganaksoy, 2006) and Six Sigma applications involving balanced scorecards (Brewer, 2004; Nilakantasrinivasan and Nair, 2005).

The application of control charts for accounting data, but not necessarily for Six Sigma projects, has been discussed by many. Long, Castellano, and Roehm (2002) presents a case study applying control charts to the throughput accounting system of a small manufacturing company. Dull and Tegarden (2004) apply control charts to the quarterly financial reporting of public companies, and logically argue that control charting accounting data will become more common as companies increase the frequency of reporting. Favorable critiques of Dull and Tegarden’s work were published by Davies (2004) and Grabski (2004). Other applications of control charts to accounting data are found in Reeve and Philpot (1988), Walter, Higgins, and Roth (1990), Bruch (1994), and Diana (2005). Our literature search, however, did not uncover any applications of pre-control charts applied to accounting processes.

So what about the future? Hammer (2002) suggests that six sigma is a valuable tool, but only one initiative of several that should reside under the umbrella of process management for some problems and opportunities of improvement are best served by six sigma and others by tools such as lean and balanced scorecards. Other authors see a more dominant role, including Snee (2004), who argues that you have to let it spread to all areas of the organization, including finance and accounting functions. Moreover, Rudisill and Clary (2005, page 25) state:

*Six Sigma, or something similar to it, is here to stay as companies continue to report that it saves them millions of dollars annually. Management accountants and financial managers should embrace its philosophy and methodology and strive to become a Six Sigma resource for their organizations.*

So what tools will be necessary in the future? Hahn, Doganaksoy and Hoerl (2000, page 324) argue that Six Sigma experts will need to pick the tools based on the needs of their specific audience and to “adapt the available tools to best meet the problem at hand.” We believe that in some situations pre-control charts are the best available tool for monitoring data-sparse accounting processes.

**ACCOUNTING PROCESSES SUBJECT TO MONITORING**

Control charts and pre-control charts are used predominately to monitor manufacturing processes. Table 1 below highlights some of the different accounting, financial reporting, and business processes that can be analyzed with these charts. Roth (1990) discusses some of these practical uses, including those used with customer billing, payroll procedures, tax return preparation, and the authorization of travel and entertainment expenses. Other processes included in Table 1 are discussed below for the purpose of highlighting other potential uses for control charts and pre-control charts in financial and business processes.

Accounts receivable collection is very important in any organization. Receiving payments from credit sales more quickly will improve a firm’s cash to cash cycle and produce operating cash flows for payment of capital expenditures, inventories, debt, or dividends. Process monitoring charts can be used to analyze the accounts receivable collections process in order for a firm to improve collection and credit policies.

Control charts and pre-control charts can also be used to analyze the amount of sales returns by each sales person, when commissions are based off of gross receipts. For example, a salesperson may sell large amounts of product at the end of a period in order to attain a bonus or earn a larger commission in that period. Analyzing the amount of sales returns per person can be useful in identifying the percentage of net sales to gross sales for that particular salesperson. Many different measurement variables are candidates for monitoring in this situation; the average amount of sales returns per salesperson, the percentage of net sales to gross sales per salesperson, or the number of partially returned orders per salesperson.
Table 1: Financial and Business Processes

<table>
<thead>
<tr>
<th>Area</th>
<th>Process</th>
<th>Measurement Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Operations</td>
<td>Customer Billing</td>
<td>Cycle Time</td>
</tr>
<tr>
<td></td>
<td>A/R collection</td>
<td>Average Age of A/R</td>
</tr>
<tr>
<td></td>
<td>Purchase Payment</td>
<td>Number of Purchase Discounts Lost</td>
</tr>
<tr>
<td></td>
<td>Sales Returns</td>
<td>Sales Returns Per Person (when commission based on gross sales)</td>
</tr>
<tr>
<td>Financial Reporting</td>
<td>Financial Statement Creation</td>
<td>Time or Labor Expenses</td>
</tr>
<tr>
<td>Internal Auditing</td>
<td>Payroll Accounting</td>
<td>Error Rates</td>
</tr>
<tr>
<td></td>
<td>Quarterly Audit Reviews</td>
<td>Time or Labor Expenses</td>
</tr>
<tr>
<td>External Auditing</td>
<td>Analytical Procedures for Common Sized Income Amounts</td>
<td>Dollar Amount Differences Compared to Industry Averages</td>
</tr>
<tr>
<td></td>
<td>Authorization of Travel and Entertainment expenses</td>
<td>Error Rates</td>
</tr>
<tr>
<td>Tax Accounting</td>
<td>Preparation of Tax Returns</td>
<td>Error Rates or Fraction Defective</td>
</tr>
</tbody>
</table>

There are many applications for control charts and pre-control charts in conjunction with financial reporting, business transactions, and internal and external auditing. Pre-control monitoring is especially attractive when data are sparse and/or data collection points infrequent. The balance of this paper will discuss how pre-control might be used to monitor company expense budgets.

PRE-CONTROL

Pre-control is non-statistical process monitoring that is used predominately with manufacturing processes. Bhote (1991) describes the mechanics of pre-control using four easy rules. The purpose of each of the four rules is:

1. To establish red, yellow, and green zones used for evaluating whether a data point is within the defined specification limits,
2. Determine whether the process is currently in control by sampling the current “production,”
3. During production, to sample periodically to monitor and evaluate the process, and
4. Determine the frequency of the process sampling for rule 3.

To present the mechanics of pre-control a simple example follows. Assume a small cookie manufacturer wants to use pre-control to monitor the level of chocolate chips in chocolate chip cookie dough. For each batch of dough the manufacturer wants to ensure that between 20 to 40 pounds of chips are used. The first rule establishes the red, yellow, and green zones by dividing the specification width by four and separating the width into quartiles with the middle two quartiles as the green zone, the outer two as the yellow zone, and the anything outside the specification width is the red zone. The specification width in this example is 20 (40 – 20) pounds and the quartiles would be 5 pounds wide (20 / 4). So, our quartiles would be 20 to 25, 25 to 30, 30 to 35, and 35 to 40. The green zone is 25 to 35. The yellow zone is 20 to 25 and 35 to 40.

To determine whether the process is in control (rule 2) we sample five consecutive batches. If all the samples yield chip amounts within the green zone, we assume we are in control. If any of the samples fall outside the green zone, we should investigate the cause and try to correct. Once an acceptable variation is established, we begin production.

During production we will periodically take two consecutive samples to monitor the production (rule 3). Depending on where the chip amounts fall in the zones determines our actions. If they are in the green zone, continue. If one is green and the other yellow, continue. If both are yellow in the same zone, we adjust the process. If they are both yellow in different zones, we need to stop production and investigate. If one is in the red zone we need to stop, investigate, correct, and restart with five consecutive greens.
Rule 4 is used to determine how frequently we perform the sampling in rule 3. The frequency is determined by determining the average time period between stoppages and dividing this by six. So, if we had an average time between stoppages of six weeks, we would sample once a week.

Pre-control also looks for certain trends in the data that may have an identifiable cause and may compromise the process in some way. For example, if the samples show a steady increase (or decrease) in the amount of chips over several samples, the process may need to be investigated to see if there is a cause for the trend that could be corrected. Analysts should look for these nonrandom trends and their possible explanations (Bhote 1991).

While the benefits of using pre-control have not been universally proven, there are good arguments for its use, perhaps most particularly in the service industries. Shainin and Shainin (1989) discuss the flexibility, applicability, and usefulness of pre-control. These authors claim that pre-control charts are better than control charts when data are sparse, and especially when data include trends, cycles, and other dynamic, rapidly changing situations. Traver (1985) points out that the major advantages of pre-control of control charts are their simplicity and flexibility. Not all authors are as positive about pre-control. Ledolter and Swersey (1997) find value in pre-control but argue the charts are less effective with skewed data and, in general, lead to too many process adjustments. Mackertich (2001) also noted the problem with too many process adjustments and concluded that whereas pre-control is better than no process charting at all, control charts (when possible) are typically optimal. Logothetis (1990) and Ermer and Roepke (1991) both give mixed reviews. Published case studies include applications in the pharmaceutical industry (Torbeck, 2005) and the military aircraft industry (Vermani, 2000). Vermani notes that the pre-control methodology was part of a larger initiative that moved Boeing’s focus from product inspection to process validity. Readers interested in a straightforward textbook presentation are referred to Montgomery (2005, pages 474-476).

OVERVIEW OF PRE-CONTROL AND EXPENSE BUDGETS

Budgeting expenses accurately can be an imperfect process. Companies attempt to project how resources will be consumed over a specific period by using historical expense amounts as a basis for projecting future amounts. In addition, budget managers must factor in predictions of future expense amounts based on company-specific information as well as industry and economic factors. Budget accuracy is important for firms to meet market projections for earnings and to plan for adequate financial and human resources for on-going operations. Companies compile budgets in order to limit spending and remain efficient in their resource allocation. It is important for firms to analyze budgeted expense amounts versus actual expense amounts in order to control costs and to understand their business operations. Managing budgeting processes are not only the duty of company managers. Internal auditors should apply methods to increase efficiency in expense allocations. Hutchins (2002) explains that audit value comes from managing risks, strengthening internal controls, measuring operational effectiveness, reducing costs, eliminating waste, and assuring stakeholder business requirements are satisfied. Helping to improve budget accuracy is one way to add value to internal and even external audits.

Companies should benefit from using a methodology that allows them to create specifications for variances in actual expenses from budgeted amounts before action is taken to find causes of this deviation. All processes and systems exhibit variation, resulting in performance measurement data that are also subject to variation. Pre-control charts can allow managers to have greater confidence with regard to whether this variation means anything. Traditional analysis of accounting data, such as budgeted vs. actual data, often makes all variation appear as if it came from special causes of variation, when in fact, it may just be common cause variation or noise (Long, Castellano, and Roehm, 2002). We will illustrate an example of how pre-control can be used to monitor expense data. The methodology for using pre-control with our example is first discussed.

METHODOLOGY

This paper will show how the mechanics of pre-control can be utilized to analyze and manage company expense budgets. In the manufacturing sector, pre-control is used on capable processes that have been tested and proven to be in-control. Creating expense budgets can be a process fraught with difficulty and uncertainty. The established pre-control rules discussed earlier must be adjusted somewhat when analyzing expenditures for a
company. For our analysis, we will follow the conventions of Rule 1 for establishing the zones. Rules 2, 3, and 4 will be modified for application to our problem domain. Modifications are necessary as we are not testing manufactured products that are continuously produced and easily tested. Also, instead of sampling products, we will be looking at every expense. Though changes to original rules are needed, pre-control monitoring may be a better method to use than standard control charts since data points occur infrequently. Ledolter and Swersey (1997) discuss the excessive data requirements for control charts, with control limits usually based on data from at least 20 to 25 samples. They also claim that pre-control is preferred over control charts since pre-control is not concerned with whether the process is in control, but only whether the process is meeting specifications. In the case of expense data, meeting specifications according to pre-control rules is the primary concern of process operators. Moreover, Shainin and Shainin (1989) state that pre-control recognizes incapable processes much quicker, which is important when only limited data points are measured each year.

In order to use pre-control monitoring, a company must establish a process mean; determine if the mean is acceptable, and decide what specification limits are appropriate. In establishing the process mean, the company should look at historical expense data and determine actual expense deviations from budget.


**SETTING UP THE PRE-CONTROL CHART**

Table 2 presents the data and calculations used in our example. It shows historic monthly averages for advertising expenses for a fictitious KHS Company. To establish the foundation for using pre-control monitoring, KHS Company compiled the monthly values for budgeted advertising expense and for the actual advertising expense and used these to determine monthly averages for budgeted and actual advertising expense. Using these values KHS is also able to determine a monthly deviation for advertising expense, the deviation is the absolute value of the difference between budgeted and actual. While we are using advertising expense as our example, other expenses could be treated using the same approach: selling and marketing, management salary, employee travel and entertainment, and raw material, direct labor and overhead costs. It is important to look at each expense separately, because each expense may be managed by someone different. Once the monthly differences are calculated, we have established the variables needed for using pre-control monitoring. The KHS must decide if these means are at acceptable levels or if they feel the deviations are too large. If they are not acceptable, the company may consider taking a closer look at the budgeting process in order to make improvements that will reduce the mean to an acceptable level. If mean levels of deviation are acceptable, the company can determine how tight a variation from these values it will tolerate. This is done by management setting specification limits (Rule 1 of pre-control monitoring).

<table>
<thead>
<tr>
<th>Table 2: KHS Company – Advertising Expense Data and Pre-Control Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2004 Average Monthly Budgeted Expense</td>
</tr>
<tr>
<td>2001-2004 Average Monthly Actual Expense</td>
</tr>
<tr>
<td>2001-2004 Average Monthly Deviation (absolute)</td>
</tr>
<tr>
<td>Specification Width: 4% of Budgeted Average</td>
</tr>
<tr>
<td>Green Zone Upper Boundary: Mean plus (½ * Spec Width)</td>
</tr>
<tr>
<td>Yellow Zone Upper Boundary: Mean plus Spec Width</td>
</tr>
</tbody>
</table>

Specification limits can be determined at a company’s discretion using management judgment. No control limit calculations are needed when using pre-control monitoring. (As mentioned earlier, traditional control charts require 20 to 25 samples to establish control limits.) The company should gain an understanding of the process and decide how much deviation from the mean is acceptable before action needs to be taken. Specifications are then developed by the company; in the case of KHS specification limits were set only for differences greater than the mean, i.e. when actual expenses were greater than that budgeted. This amounts to using only one-sided pre-control limits. After analysis, the company decided to set the specification limits for each expense item at 4% of the average monthly budgeted amount for the 4-year period 2001 to 2004. So for advertising expenses, the average budgeted monthly amount for KHS Company from 2001 to 2004 was $568.75. Therefore, the specification width for advertising expense is $22.75.
After the specification width is determined, pre-control zones must be constructed. Using the mechanics of pre-control discussed earlier, Rule #1 is used to determine the pre-control zones. For the analysis of KHS, one-sided specifications are being used. Therefore, the width of the specification limit is divided by two instead of four. The green zone for advertising expense would be the area from the average deviation from the budgeted amount to the average deviation plus one-half of the specification width. (Actually, the green zone in this example would include the entire area under the upper boundary of the zone as we are not concerned when actual expenses are less than budgeted).

For KHS, the average monthly deviation from budget for advertising expense is 21.33 (the absolute value of the budgeted amount – actual amount). Using the specification width of 22.75, we determine the green zone boundary by adding one-half of 22.75 (11.38) to the average deviation, 21.33, to get 32.71. So, our green zone would be from 22.31 to 32.71. The yellow zone for advertising expense would be the area from the upper bound of the green zone, 32.71, to the value equal to the average advertising expense plus the specification width. This is 22.31 plus 22.75, which yields 44.08.

For the next phase of the analysis, a decision must be made on what constitutes an out of control signal in analyzing the difference between budgeted and actual expense amounts. For a process as difficult as budgeting expenses, complete precision is difficult to attain. The goal of a process monitor in analyzing the deviations of budgeted versus actual is to make sure that an observed expense value does not go beyond management’s prescribed specification limits. Therefore, an out of control signal for purposes of this analysis is any observed red zone value for a monthly expense amount. If an observed value falls in the red zone in any month for any of the expense categories, the process monitor is to take action and consult the expense budget manager on why an out of control signal occurred. A negative value indicates that the observed value was over budget. It stands to reason that if this value is positive, then the actual expense is below budgeted amount, therefore no action needs to be taken by the process monitor.

In conclusion, after an out of control signal is recognized, the process monitor should inquire as to why the expense amount was out of control according to the pre-control rules established. The process monitor should ask some of the following questions with respect to the out of control observation:

1. What circumstances caused the actual expense amount to deviate so far from budget?
2. Was this deviation from budget an anomaly that would not be expected to occur in the future?
3. Does this type of deviation occur seasonally and therefore should budgeted amounts be adjusted higher in the future for a certain time period?
4. Did an error in the calculation of the actual expense amount cause this type of deviation from the budgeted amount?
5. Should future monthly expense amounts be lower because of this large deviation in the current month’s expense from budget?
6. Should the yearly budget be adjusted because of such a large deviation in the current month’s budgeted and actual expenses?

It is also important when monitoring monthly budgeted amounts to verify whether the yearly budget is over or under (positive or negative) for each expense category. This keeps the company aware of how accurately yearly expenses are being measured. This way, a company can track whether an adjustment to budget needs to be made or not for each expense category. Specification levels can be set for yearly variations from budget as well.

**USING THE PRE-CONTROL CHART TO MONITOR THE PROCESS**

Expanding our example for using pre-control to monitor company expenses at KHS Company, we now examine how pre-control is used once “production” begins. We can do this by applying the pre-control methods to KHS budgeted versus actual expense amounts for 2005 data. We assume that pre-control limits and zones were established for all the expense items, these are presented in Table 3.
Table 3: Specification Limits for all Expenses

<table>
<thead>
<tr>
<th>Expense Type</th>
<th>Average Deviance</th>
<th>Spec. Width</th>
<th>Green Zone</th>
<th>Yellow Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertising</td>
<td>21.33</td>
<td>22.75</td>
<td>32.71</td>
<td>44.08</td>
</tr>
<tr>
<td>Other Marketing and Selling</td>
<td>11.92</td>
<td>11.17</td>
<td>17.50</td>
<td>23.08</td>
</tr>
<tr>
<td>Management Salary</td>
<td>14.42</td>
<td>11.00</td>
<td>19.92</td>
<td>25.42</td>
</tr>
<tr>
<td>Employee Travel and Entertainment</td>
<td>17.50</td>
<td>9.42</td>
<td>22.21</td>
<td>26.92</td>
</tr>
<tr>
<td>Raw Material Costs</td>
<td>15.25</td>
<td>20.25</td>
<td>25.38</td>
<td>35.50</td>
</tr>
<tr>
<td>Direct Labor Costs</td>
<td>20.25</td>
<td>16.00</td>
<td>28.25</td>
<td>36.25</td>
</tr>
<tr>
<td>Overhead Costs</td>
<td>24.67</td>
<td>20.00</td>
<td>34.67</td>
<td>44.67</td>
</tr>
</tbody>
</table>

For example, if the difference between budgeted and actual direct labor costs for any month in 2005 is greater than 36.25, this is considered an out of control observation for monthly direct labor costs. The difference must be a negative value in order to be investigated as an exception (since this means that actual expense exceeded the monthly budgeted amount). Table 4 presents data for the differences from budgeted amounts for each expense for the first six months of 2005.

Table 4: KHS Company Expense Deviations for 2005

<table>
<thead>
<tr>
<th>Expense Type</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertising</td>
<td>9.00</td>
<td>24.00</td>
<td>(47.50)</td>
<td>8.00</td>
<td>(42.00)</td>
<td>(19.00)</td>
</tr>
<tr>
<td>Other Marketing and Selling</td>
<td>(21.00)</td>
<td>13.00</td>
<td>11.00</td>
<td>(18.00)</td>
<td>(14.00)</td>
<td>12.00</td>
</tr>
<tr>
<td>Management Salary</td>
<td>12.00</td>
<td>(21.00)</td>
<td>(22.00)</td>
<td>4.00</td>
<td>12.00</td>
<td>26.00</td>
</tr>
<tr>
<td>Employee Travel &amp; Entertainment</td>
<td>(14.00)</td>
<td>(17.00)</td>
<td>(21.00)</td>
<td>(25.00)</td>
<td>(26.00)</td>
<td>30.00</td>
</tr>
<tr>
<td>Raw Material Costs</td>
<td>(24.00)</td>
<td>(22.00)</td>
<td>(19.00)</td>
<td>(16.00)</td>
<td>(13.00)</td>
<td>(11.00)</td>
</tr>
<tr>
<td>Direct Labor Costs</td>
<td>(9.00)</td>
<td>(14.00)</td>
<td>(2.00)</td>
<td>(40.00)</td>
<td>(6.00)</td>
<td>(38.00)</td>
</tr>
<tr>
<td>Overhead Costs</td>
<td>(6.00)</td>
<td>19.00</td>
<td>45.00</td>
<td>(18.00)</td>
<td>(11.00)</td>
<td>22.00</td>
</tr>
</tbody>
</table>

The red (bold) highlighted cells indicate that the data point falls in the red zone, i.e. beyond pre-control specification limits. The yellow (italics) cells indicate the data point falls in the “caution” zone. This table shows three monthly expense amounts have fallen beyond pre-control specification limits. For this expense budget analysis, we are only concerned with the negative values that exceed the control limits. Therefore, even though the overhead cost for March exceeds the red zone boundary limit, as it is a positive value (meaning the actual is less than budgeted amount) we consider this to be in the green zone because we are using the one-sided pre-control limits.

For example, direct labor costs in April 2005 show a deviation of $40. Upon reviewing the historical direct labor costs for this month from 2001 to 2004, the manager discovers that actual expenses exceeded budgeted expenses by $40.00 on average every April. This may cause the manager to suggest an increase in budgeted expenses for April in future years given that it appears that the company has historically under-budgeted the expense in this month. This change can improve the budget accuracy for future years’ month of April and consequently the entire year. This may be the appropriate action to take; however, the pre-control chart may indicate further issues. Note that the direct labor costs for June are also “in the red.” This may indicate that there is more to the story than just April being under-budgeted. The fact that two months are going outside of the pre-defined specification limits may indicate that this budget process is out of control and further investigation should be performed for direct labor cost deviations.
Using the pre-control as suggested earlier would also lead us to investigate the management salary expense after March, as both February and March are in the “caution” zone. While this may indicate a problem, the rules for having two data points in the yellow zones for non-manufacturing processes may not be as stringent, i.e. we probably would not “shut down the production line” for management salary expenses. We also should take advantage of the pre-control data to watch for trends and to evaluate corrective action taken. For example, the employee travel and entertainment expense item appears to show a clear trend from January through May when a corrective action was taken that appears to have been very effective. Also, it appears that corrective action taken after February for raw material costs continues to lower the deviation from budget for this item.

In addition to using the pre-control monitoring approach for monthly expenses, pre-control could be used to monitor more specific expenses, e.g. sales representatives’ expense vouchers, and to monitor larger slices of accounting data, e.g. quarterly or annual account balances. These applications would simply require compiling data in different formats for analysis and monitoring.

CONCLUSION

We are advocating the use of pre-control monitoring to provide accountants, managers and other business process monitors additional information for improving transactional business processes. In this paper we reviewed the use of pre-control in manufacturing and explored how this technique could be used in accounting processes, specifically budgeting. We presented an example to demonstrate the viability of using pre-control for accounting processes and to highlight the usefulness of the technique. We believe that the increased interest in transactional Six Sigma will lead to many opportunities to apply pre-control in the finance and accounting functions of numerous organizations. The tool appears most applicable during the Control Stage of the DMAIC model.

REFERENCES


33. LaComb, C., and D. Senturk. 2006. The house that fraud built. *Quality Progress* (January) 52-60.


NOTES