

The Pure Rate Variance

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Abstract

The direct material cost variance can be subdivided into a price variance, a quantity variance and a price-quantity interaction variance. The price-quantity interaction variance is rarely mentioned in the literature because the traditional price variance does not acknowledge an interaction variance. For a number of pragmatic reasons, this approach may be justified for the direct material price variance. The direct labor cost variance is conceptually similar to the direct material cost variance. Accordingly, the traditional direct labor rate variance also includes a rate-efficiency interaction variance. However, the justifications for incorporating the interaction variance into the direct material price variance do not apply to the direct labor rate variance. This paper explores the possibility of separating the rate-efficiency interaction variance from the direct labor rate variance. This approach may be more aligned with the concept of responsibility accounting than the traditional method of calculating the direct labor rate variance. Thus, it may provide more reliable information feedback for decision-making purposes.

Keywords: Variance Analysis, Direct Material, Direct Labor, Price Variance, Quantity Variance, Rate Variance, Efficiency Variance, and Interaction Variance

INTRODUCTION

This paper examines a “new” method of calculating the direct labor rate variance. This method may provide more reliable information for decision making than the method currently in use. This latter point is more than simply an interesting matter for academic consideration. Variance information is widely used by decision makers (Cheatham and Cheatham 1996; Pierce and O'Dea 2003). It is important to perform variance analysis correctly. Variances are symptoms of problems that require management attention.

VARIANCE CALCULATIONS

Although the two uses of the word share some similarities, the term ‘variance’ as used in this paper does not refer to the term ‘variance’ that is widely used in statistics. A variance as used here is the outcome of a comparison of an actual result with a standard (expected) result. The variance is either considered favorable, neutral or unfavorable. In terms of direct labor, an actual labor rate substantially above the standard rate is judged to be unfavorable, an actual labor rate near the standard rate is neutral and an actual labor rate substantially below the standard rate is favorable. The direct labor efficiency variance operates similarly. Actual labor hours substantially above standard hours is unfavorable, actual labor hours near standard is neutral and actual labor hours substantially below standard hours is favorable.

The focus of this paper is on the cost of direct material, and especially the cost of direct labor of a manufacturing organization. The total cost variance for each of these inputs to the manufacturing process can be defined as the difference between the actual total cost of the input item and the standard total cost of the input item. Therefore, a general model for the total cost variance of an input to the production process is

$$\text{Total Cost Variance} = P_A Q_A - P_S Q_S, \quad (1)$$

where P is the price of the input factor and Q is the quantity of the input factor, and subscript A identifies the price or quantity as an actual amount, and subscript S identifies the price or quantity as a standard amount.

Variance information is used for controlling the operations of the organization and for performance evaluation. Great care must be exercised when using variances for these purposes to avoid misinterpreting the variance information. One of the first things to note is that the total variance defined by Equation 1 is not particularly useful in itself because it consists, traditionally, of two variances combined.

Traditional Two-Variance Method of Analysis

For decision-making purposes, it is desirable to identify the components of the total variance. For direct material, this is done by calculating a price variance and a quantity variance. The traditional price variance is

$$\text{Price Variance} = (P_A - P_S) Q_A. \quad (2)$$

It is the product of the difference between the actual price and the standard price, and the actual quantity. The traditional quantity variance is

$$\text{Quantity Variance} = (Q_A - Q_S) P_S. \quad (3)$$

It is the product of the difference between the actual quantity and the standard quantity, and the standard price.

Equations 2 and 3 are referred to here as traditional approaches to variance calculation. How traditional are they? They have been expressed in those forms since at least 1948 (Matz 1948).

For convenience of discussion, it is assumed in this analysis that a standard cost system is in operation. Furthermore, direct material and direct labor costs are assumed to be fully variable costs of production.

Equations 2 and 3 are learned with difficulty by accounting students and used with ease by organizations, largely without question. But there is something interesting about the two equations. In Equation 2, the difference in price is multiplied by the actual quantity Q_A , and, in Equation 3, the difference in quantity is multiplied by the standard price P_S . Why is there this asymmetry in the multipliers? Why don't both equations use either actual or standard amounts as the multiplier? A short ad hoc answer is that if they did, the total of the two variances would not sum to the total cost variance. That is undeniably true, in the general case, but it is not a very satisfactory answer.

It intuitively seems that the variance calculations should be based on a more substantial conceptual foundation. And there is reason for concern. Even though the price variance is almost universally accepted as being defined by equation 2, it is not theoretically correct (Drury 2000 685). A further investigation of the variance formula will help illuminate this theoretical deficiency.

Three-Variance Method of Analysis

As in Kwang and Slavin (1962), let the change in price over the period be

$$\Delta P = P_A - P_S.$$

The change in quantity over the period is

$$\Delta Q = Q_A - Q_S.$$

Therefore, the actual price is

$$P_A = P_S + \Delta P.$$

The actual quantity is

$$Q_A = Q_S + \Delta Q.$$

Thus, the total actual cost is

$$(P_S + \Delta P) (Q_S + \Delta Q).$$

Multiplying terms gives the total actual cost as

$$P_S Q_S + P_S \Delta Q + \Delta P Q_S + \Delta P \Delta Q.$$

The total variance is equal to the total actual cost minus the total standard cost. Thus the total variance is

$$P_S Q_S + P_S \Delta Q + \Delta P Q_S + \Delta P \Delta Q - P_S Q_S.$$

After subtracting the total standard cost, the total variance is

$$P_S \Delta Q + \Delta P Q_S + \Delta P \Delta Q.$$

This results in three variances:

- a quantity variance $P_S \Delta Q$,
- a price variance $\Delta P Q_S$, and
- a third variance $\Delta P \Delta Q$.

Substituting for the Δ terms in the three variances above permits the quantity variance to be written as $(Q_A - Q_S)P_S$, the price variance as $(P_A - P_S)Q_S$ and the third variance as $(P_A - P_S)(Q_A - Q_S)$.

Therefore, the total cost variance can be expressed as

$$\begin{aligned} \text{Total Variance} &= (P_A - P_S)Q_S \\ &\quad + (Q_A - Q_S)P_S \\ &\quad + (P_A - P_S)(Q_A - Q_S). \end{aligned} \tag{4}$$

Equation 4 consists of a price variance, a quantity variance and a third variance, which appears to be neither, both or perhaps something else. Notice that the quantity variance part of Equation 4 $(Q_A - Q_S)P_S$ is identical to the quantity variance, see Equation 3, which has been traditionally used in management accounting. The price variance $(P_A - P_S)Q_S$, however, is different from the traditional calculation, see Equation 2. The price variance of Equation 4 is equal to the difference in price multiplied by the standard quantity Q_S , rather than by the actual quantity Q_A . This version of the price variance is based on the standard quantity and will be referred to here as a pure price variance to distinguish it from the traditional price variance. There is also the third variance $(P_A - P_S)(Q_A - Q_S)$ which appears to be part price variance and part quantity variance. Given those characteristics, it is referred to here as a price-quantity interaction variance.

The variances that are shown in Equation 4 can be readily reconciled to the traditional price variance by adding the pure price variance to the price-quantity interaction variance as follows:

$$\begin{aligned} \text{Pure Price Variance} + \text{Interaction Variance} &= (P_A - P_S)Q_S \\ &+ (P_A - P_S)(Q_A - Q_S). \end{aligned}$$

Multiplying terms yields

$$\begin{aligned} \text{Pure Price Variance} + \text{Interaction Variance} &= P_A Q_S - P_S Q_S \\ &+ P_A Q_A - P_A Q_S - P_S Q_A + P_S Q_S. \end{aligned}$$

Combining terms simplifies the expression to the

$$\text{Traditional Price Variance} = P_A Q_A - P_S Q_A.$$

This can also be expressed as $(P_A - P_S)Q_A$.

The traditional variance analysis consists of a price variance and a quantity variance and can be termed a two-variance method. The variance analysis model developed in equation 4 can be called a three-variance method. In simple words, the traditional price variance, which is based on actual quantity, consists of the pure price variance plus the price-quantity interaction variance. The difference between the two-variance method and the three-variance method is that the three-variance method, Equation 4, does not automatically include the interaction variance as part of the price variance, although nothing has yet been said about what should be done with the interaction variance.

Now that the issue has been raised, an obvious question is: Which method is preferable? From a theoretical viewpoint and from the viewpoint of responsibility accounting, the three-variance method has advantages over the traditional calculation, the two-variance method. The price-quantity interaction variance $(P_A - P_S)(Q_A - Q_S)$ is partly caused by the difference in price and partly caused by the difference in quantity. The price-quantity interaction variance can only occur when there is a difference in the actual price from the standard price, *and* there is a simultaneous difference between the actual quantity of material used and the standard quantity allowed. The person responsible for the price variance and the person responsible for the quantity variance both contribute to the price-

quantity interaction variance. Therefore, it is not obvious that all of the interaction variance should be automatically attributed to the person responsible for the price variance. The latter, however, is the traditional and current practice.

For example, Wood and Townsley (1989) observe that the interaction variance “... *is really an area which is common to both usage and price. Sometimes, although not very often, this would be treated as a separate variance, but as detail is necessarily limited in this book we will just add it to the price variance ...*” (Wood and Townsley 1989, 109). It is unfortunate, for the purposes of advancing knowledge of the interaction variance, that details of this issue are limited in their book, to the extent that they are prevented from disclosing the circumstances under which they think the interaction variance should be treated as a separate variance.

The application of Equation 4 would result in variances, which many management accountants will never have encountered. However, these ideas are certainly not new. A similar analysis was developed at least by 1962 (Kwang and Slavin 1962), and versions of models similar to Equation 4 are presented in a few recent textbooks; see for example Demski (1997).

So is the three-variance approach of Equation 4 the answer to the variance analysis issue, or is the three-variance approach simply academic musing with no practical purpose? Traditionalists might be quick to respond that the latter answer is correct. For control purposes, the traditional price variance for direct material is preferred over the pure price variation. The traditional approach to the price variance permits the variance to be known earlier than if the pure price variance were used. It is generally thought to be advantageous for the organization to have the variance information earlier rather than later because corrective action can be taken by management at the earliest possible stage to prevent further economic loss to the organization.

In summary, one can meditate profoundly on the theoretical merits of the correct method of calculating price variances, but pragmatically it makes no difference. The consensus is

that the traditional direct material price variance provides more decision-relevant information than the pure price variance. This is, understandably perhaps, about the point where most discussion of this issue stops. Any further analysis is presented in varying degrees of comprehensiveness and enthusiasm for the benefit of knowledge completeness rather than for practical reasons.

This paper argues that the traditional direct material price variance calculation deviates from its mathematical foundation. As explained earlier, however, there may be good practical reasons for this deviation.

Direct labor is generally treated similarly to direct material, except the analysis of direct labor variances is often considerably briefer than the analysis of direct material variances. The basic assumption is that the direct labor variance is nearly perfectly analogous to the direct material variance. If direct material and direct labor are truly variable costs of production, the assumption is fundamentally correct.

It is in the calculation of the direct labor rate variance that this paper diverges from the traditional approach. Similar to the situation with direct material, the traditional direct labor rate variance calculation also deviates from its mathematical basis. However, there are not obvious persuasive practical reasons for doing so. Thus, the direct labor rate variance issue is worthy of investigation.

DIRECT LABOR DIFFERS FROM DIRECT MATERIAL

The direct labor rate variance is traditionally calculated similar to the direct material price variance as

$$\text{Rate Variance} = (R_A - R_S)H_A. \quad (5)$$

R is the average wage rate incurred during the period and H is the hours worked during the period. The rate variance is the difference between the actual average wage rate R_A and the standard average wage rate R_S multiplied by the actual quantity of hours worked H_A . The direct labor efficiency variance is

$$\text{Efficiency Variance} = (H_A - H_S)R_S. \quad (6)$$

It is the difference between the actual hours H_A and the standard hours H_S multiplied by the standard average wage rate R_S .

Direct labor variances are also analogous to direct material variances in the three-variance approach, which is the focus of this paper. Thus, substituting the equivalent terms for direct labor into Equation 4, the formula for the total direct labor cost variance can be expressed as

$$\begin{aligned} \text{Total Variance} &= (R_A - R_S)H_S \\ &+ (H_A - H_S)R_S \\ &+ (R_A - R_S)(H_A - H_S). \end{aligned} \quad (7)$$

The direct labor rate variance is $(R_A - R_S)H_S$. $(H_A - H_S)R_S$ is the direct labor efficiency variance and $(R_A - R_S)(H_A - H_S)$ is the labor rate-efficiency interaction variance.

Notice that the direct labor efficiency variance of Equation 7 is identical to the traditional direct labor efficiency variance, see Equation 6. The direct labor rate variance in Equation 7, however, is different, from the traditional direct labor rate variance shown in Equation 5. The rate variance of Equation 7, referred to here as the pure rate variance, uses the standard quantity as the multiplier for the variance. This is analogous to the pure direct material price variance of Equation 4. The third variance of Equation 7 is the direct labor rate-efficiency interaction variance. This interaction variance appears to be part rate variance and part efficiency variance. Thus, the labor rate-efficiency interaction variance is conceptually similar to the direct material price-quantity interaction variance.

ANALYSIS AND DISCUSSION

As it is for the direct material price variance, the total of the traditional direct labor rate variance includes the previously unacknowledged direct labor rate-efficiency interaction

variance as well as the pure rate variance. This practice is harder to justify, however, than it is for the analogous situation with the direct material price variance.

The traditional rate variance is calculated based on the actual amount of labor used, the H_A of Equation 5. However, there are no apparent compelling reasons why the direct labor rate variance should be based on the actual hours of labor used. Direct labor, unlike direct material, cannot be stored and used later. The actual direct labor cost that was incurred during the production period of interest exactly equals the actual cost of the direct labor that was purchased during the production period. Thus, there is no advantage to using the actual amount purchased as part of the rate variance calculation. Furthermore, the actual hours of direct labor are not known until the end of the production period. This is the same time the standard hours allowed for production are known. Thus, the rate variance information based on the actual hours H_A of labor will not be available to management any earlier than the rate variance based on the more conceptually correct standard hours H_S . There is no time advantage to using the actual hours as the multiplier for the labor rate variance. Therefore, the three-variance method of analyzing direct labor cost variances has the potential to yield information for decision making that more closely reflects the underlying economic factors than does the two-variance method of analyzing direct labor costs.

Since the analysis presented to this point disagrees with the traditional approach, it is useful to consider arguments for and against the two approaches to calculating the rate variance for direct labor. Defenders of the status quo can argue that the rate variance should be calculated on actual hours because it is too confusing to treat labor differently from direct material. That argument has some merit. Cognitive complexity is an important factor in information design, but direct labor has different characteristics from direct material and may deserve different treatment. Another defense of the traditional approach is that, since the interaction variance is the product of the differences in rates per hour and the difference in hours, the interaction variance will always be an immaterial amount compared to the other variances. If the interaction variance is immaterial, then it matters little how the variance is disposed of. If that case, a cost

benefit analysis would favor the traditional approach. The view that the rate-efficiency interaction is an immaterial amount may be true, but it is an empirical question. It does not deny the concept. In an illustrative example discussed later, it is clear that it is mathematically possible for the interaction variance to be a material amount compared to other variances.

Perhaps the strongest stance that can be taken in favor of the traditional method of calculating the direct labor rate variance is to say that, as a practical matter, that is where the interaction variance should be incorporated. This argument seems initially to have merit because it is beyond dispute that *all* the labor H_A needed for production during a period must be purchased, not just the standard amount H_S of labor. That argument is undeniable, but it seems likely that it is based more on tradition rather than reason. The argument could be turned around and applied to the efficiency variance equally well. The labor hours that were used during a period must be paid at the actual rate R_A not the standard rate R_S . Therefore, the labor rate-efficiency interaction variance could be added to the efficiency variance instead of the rate variance.

Exhibit 1 illustrates the interaction variance and shows how the two-variance approach, Panel B, and the three-variance approach, Panel A, relate to each other in the situation where the actual rate exceeds the standard rate and the actual hours exceed the standard hours. The relative magnitude of the variances in the graph is not intended to represent any actual set of variances. They are presented only to illustrate the concepts.

Insert Exhibit 1 here

It should be noted that Exhibit 1 might appear to be representative of the general case involving the two-variance method and the three-variance method. Exhibit 1 is almost always the only graph that is presented when discussions of the three-variance method are considered. Nevertheless, as shown later, it is worthwhile to examine other situations where the relationship between actual and standard costs differs in ways that are not shown in Exhibit 1.

Exhibit 1 shows how the traditional rate variance, Panel B, includes the rate-efficiency interaction variance. Whether it should or not is the focus of this paper. Exhibit 1 also shows how the efficiency variance is the same under either method. This exhibit presents a clear picture of how the actual cost, represented by the area enclosed by the solid lines, exceeds the standard cost, represented by the area enclosed by the dashed lines, and how that difference can be explained by traditional rate and efficiency variances under the two-variance approach, or by the pure rate, efficiency, and the rate-efficiency interaction variances, under the three-variance approach, Panel A.

Exhibit 2 shows how the traditional approach to the direct labor rate variance can distort the variance over time. The assumptions of Exhibit 2 are that the organization has operated two periods. In each periods, the actual average wage rate R_A remained the same, and in each period, the standard average wage rate R_S remained the same. The standard hours H_S also remained the same in each period. The actual hours H_A differed between the two periods. In period 1, the actual hours are H_{A1} , and in period 2, the actual hours increased to H_{A2} even though output remained the same in the two periods.

Insert Exhibit 2 here

Under the three-variance method, Panel A of Exhibit 2, the pure rate variance would be the same in both periods; that is the area $(R_A - R_S)H_S$ indicated by the left diagonal lines. This seems intuitively sensible since the output did not change over the two periods, and neither did the actual nor the standard average wage rates.

Under the traditional approach, Panel B of Exhibit 2, the rate variance would differ between the two periods. In period 1, the rate variance would comprise the area $(R_A - R_S)H_{A1}$ denoted by the right diagonal line and in period 2, the rate variance would consist of the area $(R_A - R_S)H_{A2}$ indicated by the left diagonal lines. The rate variance is clearly distorted over the two periods due to efficiencies in the first period and inefficiencies in the second period within the production department. The rate variance is

less than it should be in period 1, and it is greater than it should be in period 2. In this analysis, the human resource department is assumed to be responsible for the labor rate variance. However, the human resource department has no control over how many actual hours the production department works to produce the goods needed for the period. Thus, it seems sensible that the rate variance should only be charged based on the standard amount of production hours, not the actual amount of hours.

This paper argues that Equation 7 is the fundamental basis for the variance analysis of direct labor costs. Traditional and current practice deviate from this basic model.

NUMERICAL EXAMPLE

A numeric example will help clarify the issues. Consider the cost information contained in Table 1 for direct labor for a production period. The data relates to a manufacturing organization operating in a relatively stable environment over four accounting periods. The same amount of output, 1000 units, is achieved each period. Table 1 presents data and variance calculations for a matrix of possibilities that accounts for the situations:

- where the actual rate exceeds the standard rate, and the actual hours exceed the standard hours;
- where the actual rate exceeds the standard rate, and the actual hours is less than the standard hours;
- where the actual rate is less than the standard rate, and the actual hours exceed the standard hours; and
- where the actual rate is less than the standard rate, and the actual hours is less than the standard hours.

Insert Table 1 here

Table 1 does not cover the hypothetical periods where either the actual and standard rates are the same or the actual and standard hours are the same. In both such periods, the

interaction variance is zero and the rate variance is the same under both the traditional and the three-variance method.

It is interesting to consider the difference in the rate variance between Period 1 and Period 2. In both periods the output is the same, 1000 units, and the average wage rate is the same, \$11 per hour. The standard wage rate is also the same, \$10 per hour. It is therefore reasonable to conclude that the rate variance would also be the same in both periods, and that is the case when using the pure rate variance approach. However, the rate variance is not the same over the two periods using the traditional rate variance approach. The traditional rate variance in Period 1 is \$700U, and the traditional rate variance in Period 2 is \$500U. In Periods 1 and 2, the traditional rate variance is distorted because of the level of inefficiency and efficiency, respectively, achieved in the production department in its use of direct labor hours in those two periods. The difference between the traditional method and the pure method in this case equates over the two periods, and it seems likely that it would tend to do that in the general case. But accounting must provide useful information to an organization's management for each period of time as well as over aggregated periods of time. From this example, it is clear that the traditional method does not provide the most useful information per period that could be supplied.

The numbers in Table 1 are suitable for illustrating arithmetic relationships between the two approaches to variance analysis, but the numbers are entirely hypothetical. If these numbers were representative of a real situation, then the argument about the insignificance of the rate-efficiency interaction variance would be in doubt. In Period 2, in absolute terms, the rate-efficiency interaction variance equates to $\$100/\$600 = 16.7\%$ of the pure rate variance.

To explore further the relationships between the variances, the rates, hours, costs and variances for all four Periods in Table 1 are presented using graphs in Panels A and B of Figures 1, 2, 3 and 4. These graphs provide a visual perspective of the data that is unavailable from Table 1.

Figure 1 represents Period 1. Panel A shows clearly that the rate variance at standard does not include the interaction variance, which of course, the rate variance at actual does, as Panel B of Figure 1 illustrates. This difference in the two methods would seem to have the potential to influence managers' decision making.

Insert Figure1 here

Figure 1 is a specific example of Exhibit 1. Versions of Figure 1 and, as mentioned previously, versions of Exhibit 1 are almost always the only visual representations offered to explain the interaction effects of variances. Even when versions of Exhibit 1 or versions of Figure 1 are shown, they are almost always presented only for direct material costs. It seems likely that Exhibit 1 and Figure 1 are presented because they are the easiest to visualize and to understand. This point will be made clear by the analysis below of the other figures, Figures 2, 3 and 4.

It can be seen clearly in Panel A of Figure 1 that the pure rate variance stops at the point of the standard hours line, and that the efficiency variance stops at the standard rate line. These two variances seem, after a period of reflection, intuitively sensible. But it is also clear that the two variances do not cover the entire difference between the actual cost and the standard cost. There is the interaction variance left in the upper right corner of the graph. And it is also clear that this leftover variance is caused partially because the average actual rate paid for labor was above standard average rate and partially because the actual amount of hours used was beyond the standard amount expected to be used considering the level of production that was achieved during the period.

Figure 2 represents Period 2. Panel A of Figure 2 shows the interesting case where the rate variance at standard appears to include the interaction variance, but of course it does not. The two variances are in opposite directions. The pure rate variance is unfavorable, and the rate-efficiency interaction variance is favorable, see Period 2 in Table 1 above. Panel B of Figure 2 appears to not include the interaction variance at all. This reconciles

with the three-variance approach since in the three-variance method, the rate and interaction variance oppose each other.

Insert Figure2 here

Figure 3 presents an interesting picture of Period 3. Panel A appears to show the efficiency variance at standard encompassing the interaction variance, but of course it does not. Again the two are in opposite directions. In Panel B of Figure 3, the rate and efficiency variances appear to cover partly the same area.

Insert Figure3 here

Figure 4 is the representation of Period 4. In Panel A, it may appear that the interaction variance is included in both the rate and efficiency variances at standard, but of course it is not included in either.

Insert Figure1 here

The perspectives illustrated by Figures 2, 3 and 4 are difficult to explain in a satisfying way. It is probably not surprising, therefore, that they are almost never, if ever, presented when discussions of these issues are raised. Only Figure 1, with its clear rate-efficiency interaction variance separate from its rate and efficiency variances is occasionally used in the few texts or articles that touch on the interaction variance issue. For example, Martin and Laughlin (1988) present multiple graphs dealing with direct material, and variable and fixed overhead variances, and all of the graphs are of the form of Exhibit 1 and Figure 1.

INTERACTION VARIANCE

The three-variance method of analysis outlined in this paper raises interesting issues that require further thought. How would the variances be recorded in the accounts? The

assumption here is that the organization is operating a standard costing system. Therefore, the three variances, the pure rate variance, efficiency variance, and rate-efficiency interaction variance, can be recorded in the general ledger. Table 2 provides a set of journal entries illustrating how the variance information resulting from the three variances of Period 1 could be recorded in the general journal, prior to posting the amounts in the general ledger.

Insert Table 2 here

Options for the Treatment of the Interaction Variance

A more difficult question than how to record the interaction variance relates to its role in the control system of the organization. Variances are assigned to managers for information feedback. Managers are expected to take action to investigate important variances and to amend the operations of the organization based on the result of that investigation. Who, if anyone, is going to be given responsibility for the rate-efficiency interaction variance? There are several options to choose from. Four of these options are discussed immediately following.

Option 1: Assign to the Human Resource Manager

One option is to assign the full amount of the interaction variance to the person responsible for the pure rate variance. This would be similar to the status quo, where the traditional rate variance incorporates the interaction variance. The only difference is that under the three-variance method, there would be the option of assigning the rate-efficiency interaction variance and the pure rate variance separately, or the interaction variance and the pure rate variance could be combined and assigned exactly as the traditional labor rate variance is now. Combining the interaction variance and the pure rate variance would have the advantage of familiarity. Managers would already have experienced this model.

Option 2: Assign to the Production Manager

Another option is to assign the full amount of the interaction variance to the person responsible for the efficiency variance. This may seem counter intuitive at first because it is against tradition, but it is hard to think of a conceptual reason why this could not be done.

Option 3: Allocate to the Human Resource Manager and the Production Supervisor

A third option is to allocate part of the variance to the person responsible for the rate variance and part of the variance to the person responsible for the efficiency variance. This approach opens up a vast area for management accountants to exercise their expertise in selecting appropriate bases and methods for such an allocation.

Possible methods of allocation are limited only by the creative, cognitive abilities of the accountant. One way to allocate the direct labor interaction variance would be to use the amounts attributed to the rate and efficiency variances as the basis for the allocation. The interaction variance would then be allocated to the pure rate variance and the efficiency variance based on the relative proportions of these items to their total. Under this approach, the amount of the rate-efficiency interaction variance to be allocated to the pure rate variance would be determined by multiplying the interaction variance by

$$\left(\frac{\text{Pure Rate Variance}}{\text{Pure Rate Variance} + \text{Efficiency Variance}} \right)$$

Similarly, the amount of the interaction variance to be allocated to the efficiency variance would be determined by multiplying the interaction variance by

$$\left(\frac{\text{Efficiency Variance}}{\text{Pure Rate Variance} + \text{Efficiency Variance}} \right)$$

In Period 1, for example, the amount of the pure rate variance is \$600 (U) and the efficiency variance is \$1,000 (U). Therefore, the amount of the interaction variance to be allocated to the pure rate variance is

$$(\$100)\left(\frac{\$600}{\$600 + \$1,000}\right) = \$37.50 .$$

The amount of the rate-efficiency interaction variance to be allocated to the efficiency variance is

$$(\$100)\left(\frac{\$1,000}{\$600 + \$1,000}\right) = \$62.50 .$$

This allocation increases the pure rate variance to \$637.50 (\$600 + \$37.50) unfavorable (U) and the efficiency variance to \$1,062.50 (\$1,000 + 62.50) (U).

This result disposes of the rate-efficiency interaction variance in a systematic manner, but as is often the case with allocations, the outcome of the process might incite disagreements among the people held responsible for the variances.

For example, the purchaser charged with the pure rate variance might be pleased since under the traditional variance calculation, the person would have been charged with a \$700 (U) rate variance. But this person might also be displeased because under the three-variance approach the person would only have been charged a variance of \$600 (U) if the rate-efficiency interaction variance had not been allocated. Furthermore, the person responsible for the efficiency variance is almost sure to be unhappy with the result of the allocation, because under either approach the efficiency variance would only have been \$1,000 (U) without the allocation.

This method of allocating the rate-efficiency interaction variance based on the totals of the other variances in the three-variance method might work even less well in the periods where the signs of the pure rate variance and the efficiency variance differ. In Period 2, for example, the calculation would allocate to the rate variance

$$(- \$100)\left(\frac{\$600}{\$600 + (- \$1,000)}\right) = \$150 ,$$

and to the efficiency variance

$$(- \$100)\left(\frac{- \$1,000}{\$600 + (- \$1,000)}\right) = -\$250 .$$

This allocation method is mathematically sound (Weber 1963). It has disposed of the interaction variance in such a manner that the rate and efficiency variances now reconcile the total actual cost with the total standard cost, but it has produced some strange results. The unfavorable pure rate variance increased to \$750 ($\$600 + \150) and the favorable efficiency variance increased to $-\$1,250$ ($-\$1,000 + (-\$250)$). Increasing one variance by \$150 (U) and the other variance by \$250 (F) is not an obvious way to allocate a variance with a magnitude of \$100 (F). This allocation results in the person responsible for the rate variance receiving an additional unfavorable allocation that is substantially larger than the entire total cost of the variance to be allocated. That result hardly seems likely to convince the manager that the allocation has produced a fair result.

Option 4: Do Not Assign the Variance to Anyone

Given the difficulty encountered in attempting to allocate the interaction variance to managers, perhaps it is worthwhile considering the option of not allocating the variance to anyone. This, the fourth option, would treat the interaction variance as an unassignable variance. This method might seem unusual at first thought, since the total of the direct labor variances assigned would not add up to the total direct labor cost variance. But for control purposes, this need not be a problem. The rate-efficiency interaction variance would still have to be recorded in the accounts in some way and included in the income statement. Table 2 presents an example of how these variances could be recorded in the accounting records.

In Period 1, management's focal point is the actual labor cost of \$7,700 ($700 H_A \times \$11 R_A$) incurred and any cost variances that can be used as meaningful feedback on actual performance. The cost variances that fully fit this criterion are the pure rate variance and the efficiency variance. There is a pure rate variance of \$600 [$(\$11 R_A - \$10 R_S) \times 600 H_S$] unfavorable and an efficiency variance of \$1,000 [$(700 H_A - 600 H_S) \times \$10 R_S$] unfavorable. Thus, there is a net total labor cost variance of \$1,600 unfavorable based on operational information for which certain managers are held accountable.

For management purposes, the fact that this unfavorable net \$1,600 labor cost variance when combined with the actual labor cost of \$7,700 incurred does not equate to the total planned labor cost of \$6,000 ($600 H_S \times \$10 R_S$) is immaterial. What is important is the more reliable information feedback provided by the labor pure rate and the improved decision making that is a result of the investigations made by the responsible managers into the causes of the variances.

Management accountants focus on meeting the information feedback requirements of management. It has been shown that the incorporation of the interaction variance into the rate variance has distorted the rate variance in Period 1 and all the other periods. The only unquestionably valid purpose of this interaction variance is its use in a standard costing system for balancing the accounts. If that is so, then perhaps it should be listed separately as an interaction variance and not as part of the rate variance. There may not be any plausible reason for allocating it between the rate and efficiency variances.

The four options discussed above are summarized in Panel A of Table 3. These options are not intended to be an exhaustive list of solutions to the question of what to do with the interaction variance. Other options are possible. Combinations of options could also be used, and rather than using the same option all the time, different options could be applied in different periods.

Insert Table 3 here

To consider this latter point further, it is useful to consider the different combinations of favorable and unfavorable variances that can occur. These combinations are presented in Panel B of Table 3. The first period is probably the simplest to consider. Any of the four options could be applied to the variances in that period.

In the second period, however, it does seem sensible to reject some options as infeasible. It does not seem advisable to use option 1 because assigning the entire favorable

interaction variance to the unfavorable pure rate variance would send conflicting signals to the manager responsible for that variance. Option 2 seems like a better choice. The favorable interaction variance probably could be added to the favorable efficiency variance, but the logic supporting option 2 is not very convincing either. It is not clear why the efficiency variance should be increased by the full amount of the interaction variance since the interaction variance is caused by actions taken by the production department and by the human resource department. As illustrated earlier, the allocation of the interaction variance to the other two variances, option 3, did not work well. Option 4, that is, do not allocate the interaction variance to anyone, would not appear to produce any misinformation, and may be the overall best option.

Options that appear most feasible are presented for each period in Table 4. It is interesting to note that the only option that appears in all periods is option 4; that is, do not assign the rate-efficiency interactions variance to anyone.

Insert Table 4 here

CONCLUSIONS

This paper presents arguments for using a method of calculating the direct labor rate variance that differs from the traditional method. The traditional method lacks theoretical support. The pure method, using the standard hours rather than the actual hours, has the potential to provide information that is superior to the information provided by the traditional method.

This paper argues that the three-variance approach is the fundamental model for the analysis of variable input cost elements, and that deviations from it must be justified. It is acknowledged that there may be good reasons why the calculation of the traditional direct material price variance deviates from the mathematically sound method.

The main reason direct material variances are calculated the way they are is that academics and practitioners share the view that the direct material price variance should be calculated on the amount of material purchased, not on the amount of material used in production. Aside from tradition, this is done for control reasons, not theoretical ones. It is done so that management can know the price variance information as soon as it is available. That reason, however, does not extend to the calculation of the direct labor variances.

The actual hours of direct labor used must always equal the hours of direct labor actually purchased, since direct labor cannot be stored and used later. Therefore there does not seem to be a strong case for calculating the direct labor rate variance using the actual hours of direct labor used. The person purchasing the labor should only be responsible for controlling the rate for labor not the amount of labor that was actually used in a particular production period. Therefore, the direct labor rate variance should be calculated based on the standard amount of hours allowed for production.

Of course, it may be the case that the person responsible for the direct labor rate variance and the direct labor efficiency variance is the same person; that is, the production supervisor. Even in this situation, however, there is still reason to calculate the rate variance at standard. The magnitude of the labor rate variance should be based on the standard hours used in the production process. It should not be contaminated by the inefficiency or efficiency of the production process.

Even though the method of calculating the direct labor pure rate variance discussed in this paper is theoretically sound, and the traditional method is not, there are those who would argue that the question of the best way to calculate the direct labor rate variance is irrelevant. They argue that direct labor is not a variable cost of production. Labor is paid for 40 hours regardless of output. Workers are not brought in and released as production needs vary. Labor variances are obsolete according to this view. This may be true in some organizations, but it is certainly not true for all organizations. Banker, Devaraj, Schroeder and Sinha (2002) conducted field research over a three year time period in 18

plants of a large manufacturing organization to examine the effects of eliminating direct labor variance reporting. They observed that the plants that eliminated direct labor reporting experienced a slight gain in overall product quality. However, these plants also experienced a substantial decline in productivity compared to plants that continued the use of direct labor variance reporting. In dollar terms, the decline in productivity outweighed the gain in quality.

Many organizations still view direct labor as a variable cost and a valuable mechanism for controlling the operations of the organization. For those organizations, the method of calculating the direct labor pure rate variance that is described in this paper may provide information that is more attributable to persons actually responsible for the variance than does the traditional and current method of calculating the direct labor rate variance. Thus, this information should be more useful for their managerial decision making.

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Table 1**Examples of Direct Labor Variance Analysis using the Two-Variance Method and the Three-Variance Method**

Direct Labor Information	Period 1	Period 2	Period 3	Period 4
Actual Rate	\$11	\$11	\$9	\$9
Standard Rate	\$10	\$10	\$10	\$10
Actual Output (units)	1000	1000	1000	1000
Actual Hours	700	500	700	500
Standard Hours	600	600	600	600
Total Actual Labor Cost	\$7,700	\$5,500	\$6,300	\$4,500
Less Total Standard Cost	<u>\$6,000</u>	<u>\$6,000</u>	<u>\$6,000</u>	<u>\$6,000</u>
Total Direct Labor Cost Variance	<u>\$1,700</u> U	-\$ <u>500</u> F	\$ <u>300</u> U	-\$ <u>1,500</u> F
Traditional Rate Variance	\$ 700 U	\$ 500 U	-\$ 700 F	-\$ 500 F
Pure Rate Variance		\$ 600 U	\$ 600 U	-\$ 600 F
Efficiency Variance	\$1000 U	\$1,000 U	-\$1,000 F	-\$1,000 F
Labor Interaction Variance	_____	\$ <u>100</u> U	_____	-\$ <u>100</u> F
Verify Total Labor Cost Variance	<u>\$1,700</u> U	<u>\$1,700</u> U	-\$ <u>500</u> F	-\$ <u>500</u> F
			\$ <u>300</u> U	\$ <u>300</u> U
				-\$ <u>1,500</u> F

Note:

Variances denoted by U are unfavorable. Variances denoted by F are favorable.

Table 2

Example of Journal Entries for the Three-Variance Method of Direct Labor Cost Variances for Period 1

	Account Affected	Debit	Credit
1.	Work-in-process (at standard) Payroll clearing (Recording the standard labor cost allowed)	\$6,000	\$6,000
2.	Labor rate variance (unfavorable cost) Payroll clearing (Responsibility of Human Resource Manager)	\$600	\$600
3.	Labor efficiency variance (unfavorable cost) Payroll clearing (Responsibility of Production Manager)	\$1,000	\$1,000
4.	Labor interaction variance (unfavorable cost) Payroll clearing (Unfavorable cost variance caused by rate and efficiency interactions)	\$100	\$100

Table 3

Responsibilities and Signs for the Rate-Efficiency Interaction Variance

Panel A: Responsibility (Assumed) for the direct labor rate-efficiency interaction variance under options 1 - 4

Option	Manager Assumed Responsible
1	Human resource manager
2	Production manager
3	Allocate portion to each manager
4	Neither manager

Panel B: Signs of Variances for each Period

Period No.	Variance		
	Pure rate	Efficiency	Rate-efficiency
1	+	+	+
2	+	-	-
3	-	+	-
4	-	-	+

Note:

1. Positive (+) signs indicate unfavorable variances.
2. Negative (-) signs indicate favorable variances.

Table 4

Feasible Options Results Summary

Period No.	Feasible Options.
1	1, 2, 3, 4
2	2 4
3	1 4
4	4

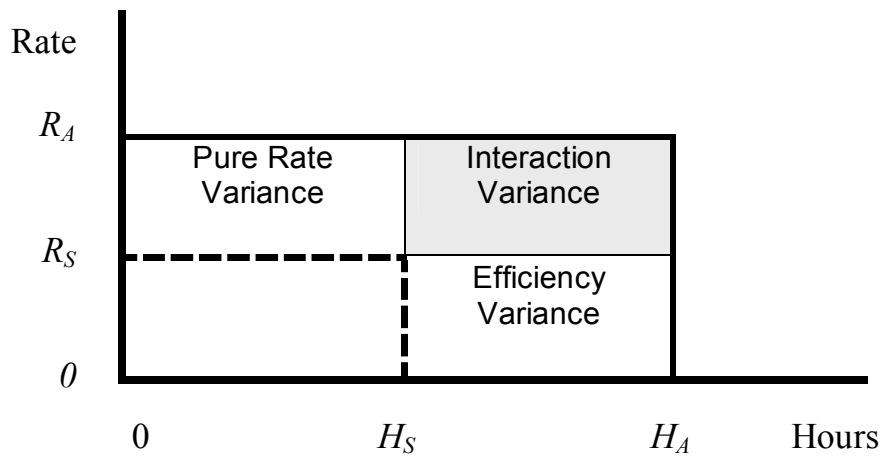
Note:

The suggested options are not in rank order in the sense that, in Period 1 for example, Option number 2 is not necessarily preferred over Option 3 or 4.

Exhibit 1

Illustration of the pure rate variance and the traditional rate variance

Panel A: Illustration of direct labor rate, efficiency and interaction variances.
Actual rate and hours greater than standard hours.



Panel B: Illustration of traditional direct labor rate and efficiency variances.
Actual rate and hours greater than standard hours.

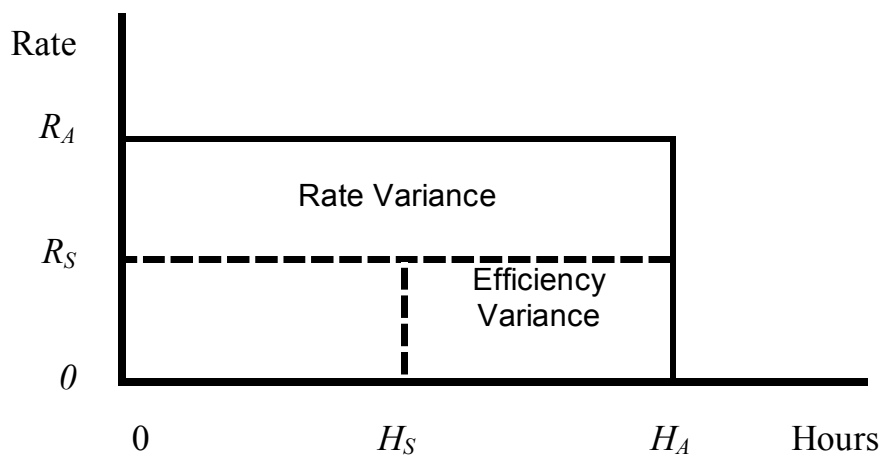
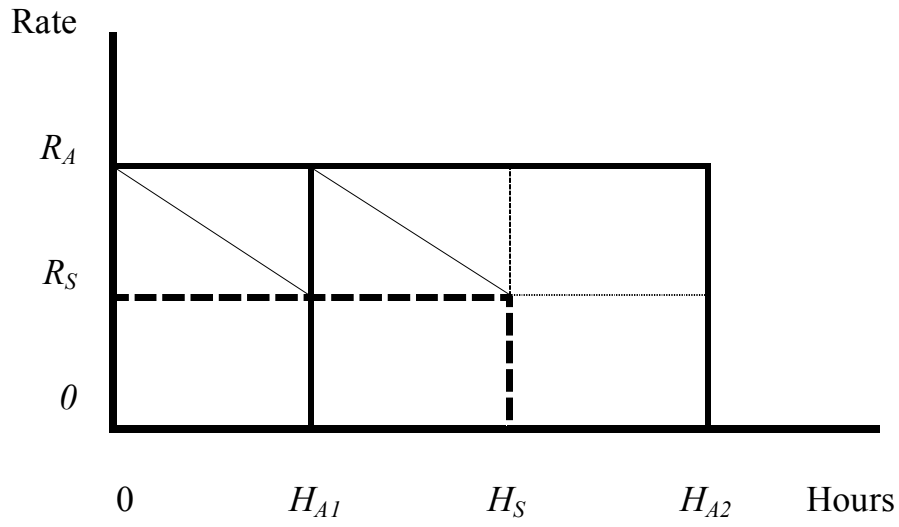


Exhibit 2

Illustration of the rate variance for a hypothetical two-year period H_{A1} and H_{A2}

Panel A: The Three-Variance Method



Panel B: The Traditional Method

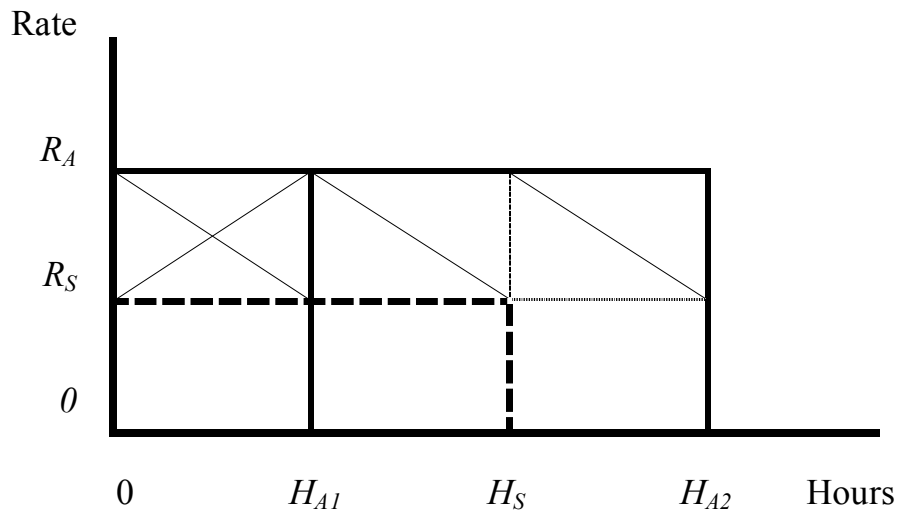
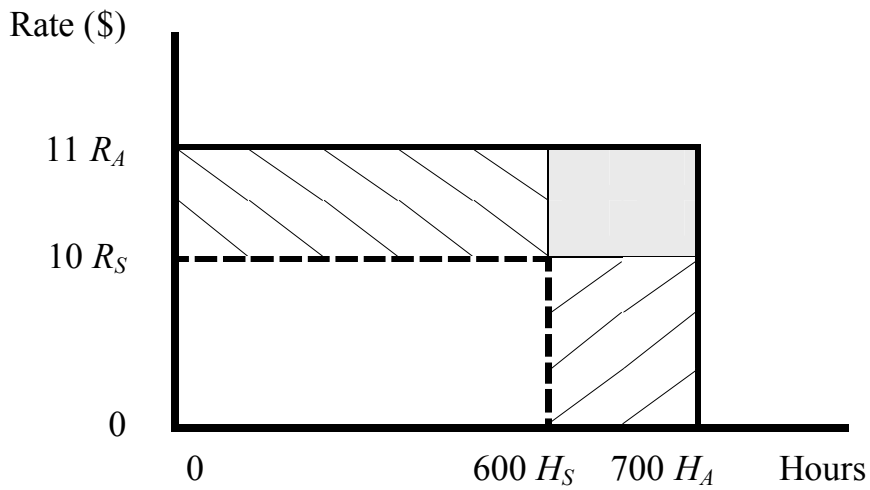


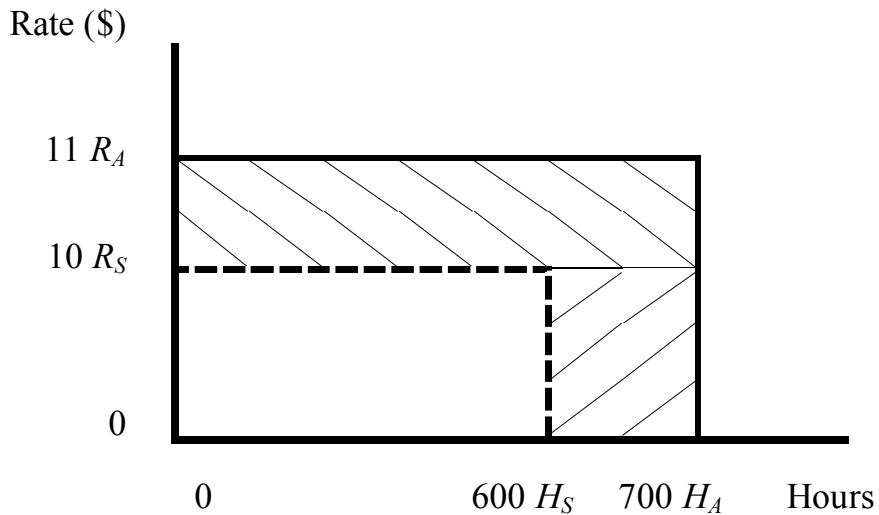
Figure 1

Period 1 - Actual rate greater than standard rate and actual hours greater than standard hours *

Panel A: Three-variance method.



Panel B: Traditional method.

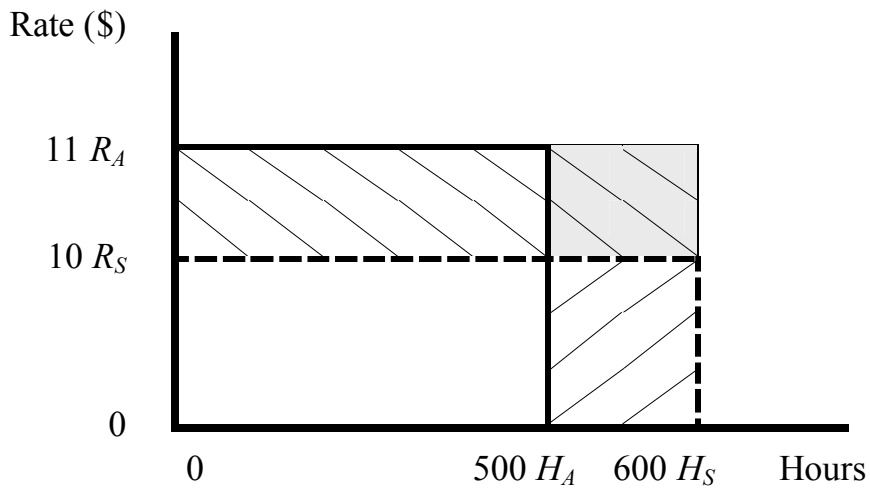


- * Graphs not drawn to scale.
- Rate variance = Left diagonal ruled area.
- Efficiency variance = Right diagonal ruled area.
- Rate and efficiency interaction variance = Shaded area.

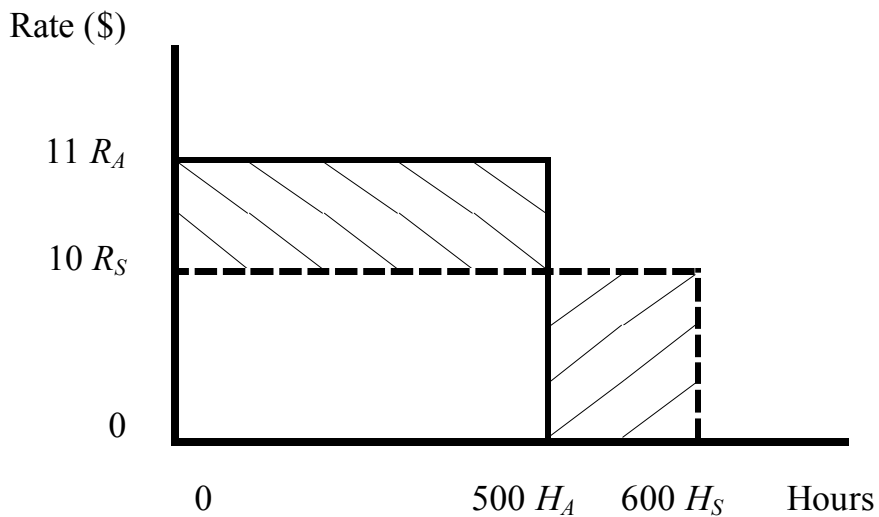
Figure 2

Period 2 - Actual rate greater than standard rate and actual hours less than standard hours *

Panel A: Three-variance method.



Panel B: Traditional method.

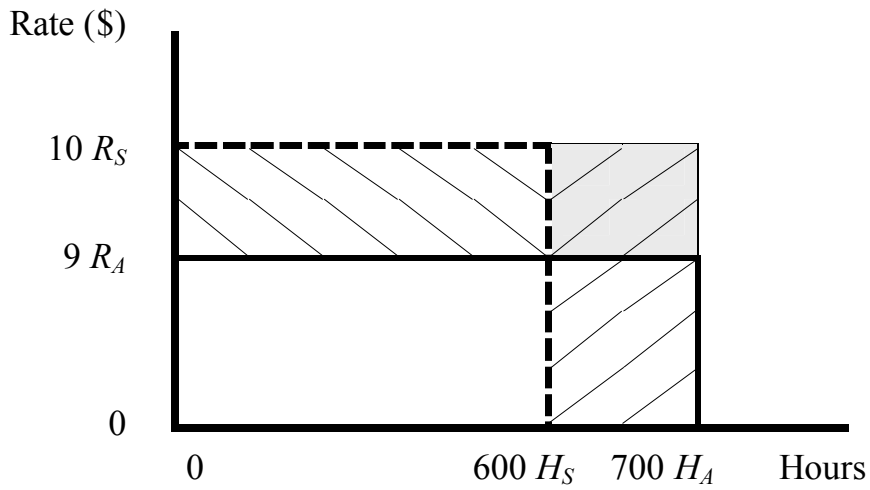


* Graphs not drawn to scale.
Rate variance = Left diagonal ruled area.
Efficiency variance = Right diagonal ruled area.
Rate and efficiency interaction variance = Shaded area.

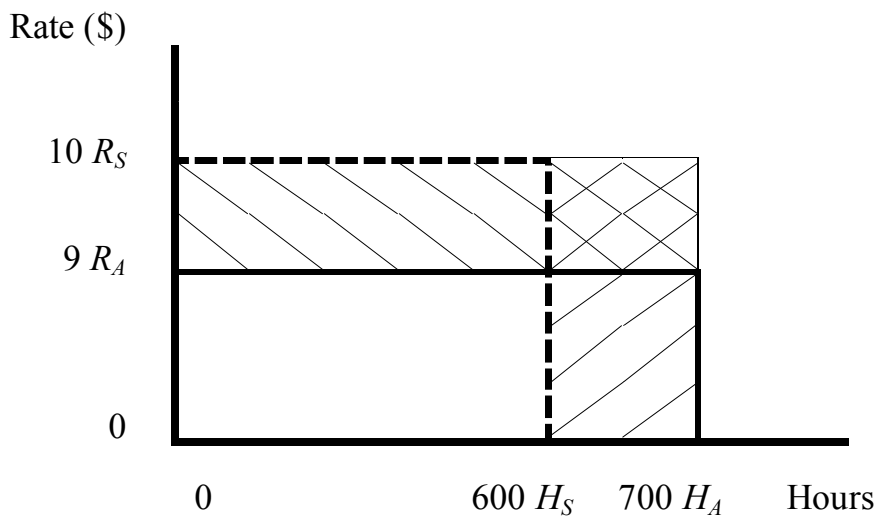
Figure 3

Period 3 - Actual rate less than standard rate and actual hours greater than standard hours *

Panel A: Three-variance method.



Panel B: Traditional method.

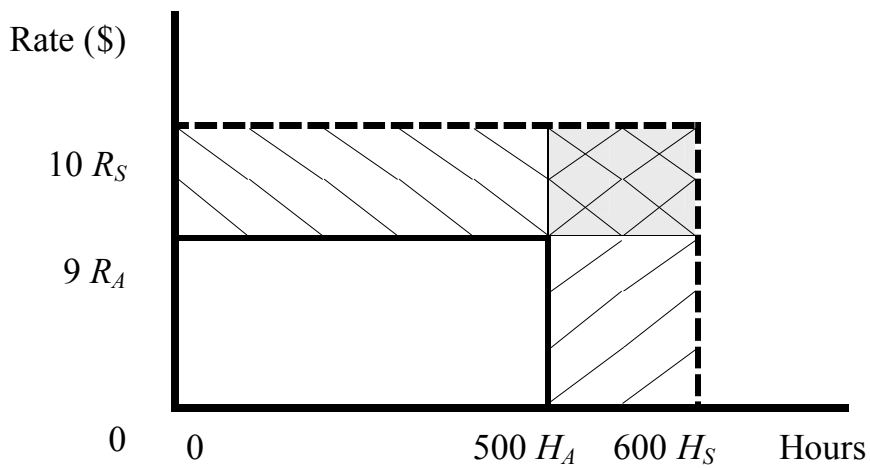


- * Graphs not drawn to scale.
- Rate variance = Left diagonal ruled area.
- Efficiency variance = Right diagonal ruled area.
- Rate and efficiency interaction variance = Shaded area.

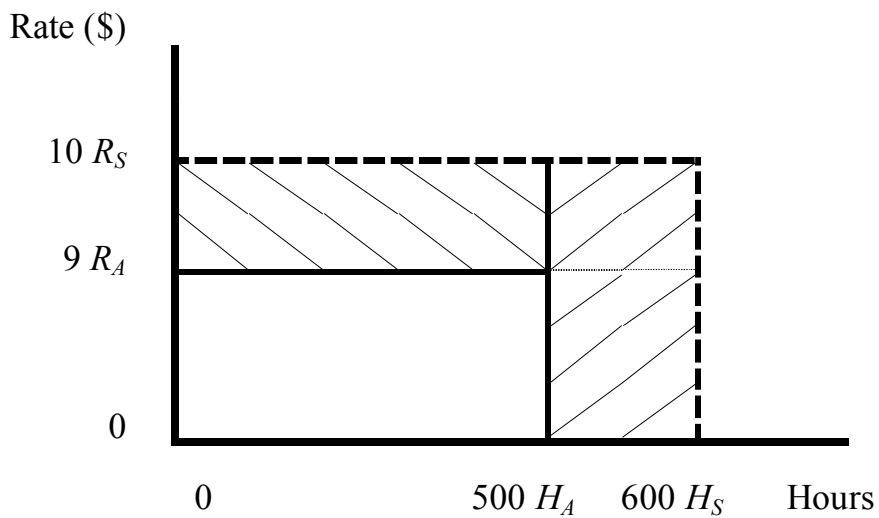
Figure 4

Period 4 - Actual rate less than standard rate and actual hours less than standard hours *

Panel A: Three-variance method.



Panel B: Traditional method.



* Graphs not drawn to scale.
Rate variance = Left diagonal ruled area.
Efficiency variance = Right diagonal ruled area.
Rate and efficiency interaction variance = Shaded area.