MATERIALS MIX
YIELD

RELEVANT TO ACCA QUALIFICATION PAPER F5

Since long ago, variance analysis has been an area that evokes fear in students worldwide. Students enter the exam hall, desperately running through the formulae used to calculate all the different variances, fearful of forgetting them before they have managed to put pen to paper. Then the inevitable happens: they turn over the exam paper and a variance question stares back at them. Frantically, they scribble down all the formulae before they are lost forever. Alas, they can't remember it quite accurately enough. Is it actual quantity x standard price or standard quantity x actual price? Panic grips them. Logic flies out of the window. They move desperately on to the next question.

Does this sound like a familiar story to you? If it does, carry on reading. This article might help you. Many articles have been written about variance analysis over the years, but the purpose of this one is to cover the area of calculating materials mix and yield variances. While the calculation of a mix variance can also be done for sales, this is not covered by the Paper F5 syllabus at present. Therefore, I shall concentrate purely on the materials variance here.

THE MATERIAL USAGE VARIANCE ANALYSES THE DIFFERENCE BETWEEN HOW MUCH ACTUAL MATERIAL WE USED FOR OUR PRODUCTION RELATIVE TO HOW MUCH WE EXPECTED TO USE, BASED ON STANDARD USAGE LEVELS.

Material usage variance

Most students have relatively little difficulty in calculating a straightforward material usage variance. As a reminder, let's recap on what the material usage variance is and how it is calculated. The material usage variance analyses the difference between how much actual material we used for our production relative to how much we expected to use, based on standard usage levels. So, for example, if we made 5,000 items using 11,000kg of material A and our standard material usage is only 2kg per item, then we clearly used 1,000kg of material more than we expected to (11,000kg – [2 kg x 5,000 items]). In terms of how we value this difference, it must be at standard cost. Any difference between standard and actual cost would be dealt with by the material price variance.

There can be many reasons for an adverse material usage variance. It may be that inferior quality material have been purchased, perhaps at a lower price. This may be reflected in a favourable material price variance: the materials were cheaper but as a result there was perhaps more waste. On the other hand, it may be that changes to the production process have been made, or that increased quality controls have been introduced, resulting in more items being rejected. Whatever the cause, it can only be investigated after separate material usage variances have been calculated for each type of material used and then allocated to a responsibility centre.

AND
VARIANCES

Further variance analysis where several materials are used

The fact that most products will be comprised of several, or sometimes hundreds of different materials, leads us back to the more detailed materials mix and yield variances that can be calculated in these instances. In many industries, particularly where the product being made undergoes a chemical process, it may be possible to combine different levels of the component materials to make the same product. This, in turn, may result in differing yields, dependent on the mix of materials that has been used. Note, when we talk about the materials 'mix' we are referring to the quantity of each material that is used to make our product ie we are referring to our inputs. When we talk about 'yield', on the other hand, we are talking about how much of our product is produced, ie our output.

Materials mix variance

In any process, much time and money will have been spent ascertaining the exact optimum mix of materials. The optimum mix of materials will be the one that balances the cost of each of the materials with the yield that they generate. The yield must also reach certain quality standards. Let us take the example of a chemical, C, that uses both chemicals A and B to make it. Chemical A has a standard cost of $20 per litre and chemical B has a standard cost of $25 per litre. Research has shown that various combinations of chemicals A and B can be used to make C, which has a standard selling price of $30 per litre. The best two of these combinations have been established as:

THE OPTIMUM MIX OF MATERIALS WILL BE THE ONE THAT BALANCES THE COST OF EACH OF THE MATERIALS WITH THE YIELD THAT THEY GENERATE. THE YIELD MUST ALSO REACH CERTAIN QUALITY STANDARDS.

Mix 1: 10 litres of A and 10 litres of B will yield 18 litres of C; and

Mix 2: 8 litres of A and 12 litres of B will yield 19 litres of C.

Assuming that the quality of C produced is exactly the same in both instances, the optimum mix of materials A and B can be decided by looking at the cost of materials A and B relative to the yield of C.

Mix 1: (18 x $30) – (10 x $20) – (10 x $25) = $90 contribution

Mix 2: (19 x $30) – (8 x $20) – (12 x $25) = $110 contribution

Therefore, the optimum mix that minimises the cost of the inputs compared to the value of the outputs is mix 2: 8/20 material A and 12/20 material B. The standard cost per unit of C is (8 x $20)/19 + (12 x $25)/19 = $24.21. However, if the cost of materials A and B changes or the selling price for C changes, production managers may deviate from the standard mix. This would, in these circumstances, be a deliberate act and would result in a materials mix variance arising. It may be, on the other hand, that the materials mix changes simply because managers fail to adhere to the standard mix, for whatever reason.

Let us assume now that the standard mix has been set (mix 2) and production of C commences. 1,850kg of C is produced, using a total of 900kg of material A and 1,100kg of material B (2,000kg in total). The actual costs of materials A and B were at the standard costs of $20 and $25 per kg respectively. How do we calculate the materials mix variance?

The variance is worked out by first calculating what the standard cost of our 1,850kg worth of C would have been if the standard mix had been adhered to, and comparing that figure to the standard cost of our actual production, using our actual quantities. My preferred approach has always been to present this information in a table as shown in **Table 1** below.

The materials mix variance will be $46,000 – $45,500 = $500 favourable.

Remember: it is essential that, for every variance you calculate, you state whether it is favourable or adverse. These can be denoted by a clear 'A' or 'F' but avoid showing an adverse variance by simply using brackets. This leads to mistakes.

The formula for this is shown below, but if you were to use it, the variance for each type of material must be calculated separately.

(Actual quantity in standard mix proportions – actual quantity used) x standard cost

As a student, I was never a person to blindly learn formulae and rely on these to get me through. I truly believe that the key to variance analysis is to understand what is actually happening. If you understand what the materials mix variance is trying to show, you will work out how to calculate it. However, for those of you who do prefer to use formulae, the workings would be as follows:

Material A: (800kg – 900kg) x $20 = $2,000 Adverse

Material B: (1,200kg – 1,100kg) x $25 = $2,500 Favourable

Net variance = $500 favourable

In this particular example, I have kept things simple by keeping all actual costs in line with the standards. The reality is that, in the real world, actual costs will often vary from standards. Why haven't I covered this above? Because any variance in materials price is always dealt with by the materials price variance. If we try and bring this into our mix variance, we begin distorting the one thing that we are trying to understand – how the difference in materials mix has affected our cost, rather than how the difference in price has affected our cost.

Why haven't I considered the fact that although our materials mix variance is $500 favourable, our changed materials mix may have produced less of C than the standard mix? Because this, of course, is where the materials yield variance comes into play.

The materials mix variance focuses on inputs, irrespective of outputs. The materials yield variance, on the other hand, focuses on outputs, taking into account inputs.

TABLE 1: CALCULATING THE STANDARD COST OF 1,850KG WORTH OF C (STANDARD MIX)

Actual usage in standard proportions:	$	Actual usage in actual proportions:	$	Var. $
A = 800kg (8/20 x 2,000kg) x $20	16,000	A = 900kg x $20	18,000	**2,000A**
B = 1,200kg (12/20 x 2,000kg) x $25	30,000	B = 1,100kg x $25	27,500	**2,500F**
Total	**46,000**	**Total**	**45,500**	**500F**

Materials yield variance

Where there is a difference between the actual level of output for a given set of inputs and the standard output for a given set of inputs, a materials yield variance arises. In our optimum mix, we calculated that 20kg of inputs of A and B should produce 19kg of our output, C. We are effectively saying that there is a loss rate of 5% (20 – 1/20) in our process, ie our outputs, in kg, should be 95% of our inputs. Applying this to our example then, we can say that we would have expected our inputs of 2,000kg to yield an output of 95% of 2,000kg, ie 1,900 kg. Our actual yield was only 1,850kg, which is 50kg less than we would have expected. To calculate the materials yield variance, all we have to do is value this difference between the actual yield (1,850kg) and the expected yield for our given set of inputs (1,900kg) at the standard cost of our output, C, ie at $24 per kg. It is easy to see how to calculate this when we look at it logically and present it in a very simple table as shown in **Table 2**.

No formula really needs to be learnt if you understand the logic behind the materials yield variance and grasp the principle that any price differences between actual and standard are always dealt with by the price variance alone. However, for those who do prefer to use a formula, the materials yield variance formula is:

(Actual yield – standard yield from actual input of material) x standard cost per unit of output

(1,850kg – 1,900kg) x $24 = $1,200 Adverse

Making observations about variances

From our example, it can be seen that there is a direct relationship between our materials mix variance and our materials yield variance. By using a mix of materials that was different from standard, we have resulted in a saving of $500, in standard cost terms. However, the downside of this is that our cheaper mix of materials has resulted in a significantly lower yield of material C than we would have got had our standard mix of materials been adhered to. This yield was $1,200 lower than it would have been, which is over double the amount that we saved by using a cheaper mix of materials. Overall, by netting the two variances off against each other, we have an adverse material usage variance of $700 ($1,200 A less $500 F). As indicated earlier on in the article, this could have been calculated on its own, without breaking it down further into its mix and yield elements, by comparing the quantity of materials we expected to use (based on standard usage) for our actual production to the quantity of material we actually did use for our production. Using my preferred method of a table, our calculations would look like **Table 3** on .

Actual production of 1,850kg requires an input of 1,947kg (1,850 x 100/95) in total of A and B

WHERE THERE IS A DIFFERENCE BETWEEN THE ACTUAL LEVEL OF OUTPUT FOR A GIVEN SET OF INPUTS AND THE STANDARD OUTPUT FOR A GIVEN SET OF INPUTS, A MATERIALS YIELD VARIANCE ARISES.

TABLE 2: VALUE DIFFERENCE BETWEEN ACTUAL AND EXPECTED YIELD AT STANDARD COST OF C

Actual yield	Standard yield for actual quantities input	Difference	Standard cost per kg	Var.
1,850kg	1,900kg	50kg	$24	$1,200A

TABLE 3: CALCULATING THE ADVERSE MATERIAL USAGE VARIANCE ($700)

Standard quantity for actual production	$	Actual quantity	$	Var. $
A = 780kg (1,947 x 8/20) x $20	15,600	A = 900kg x $20	18,000	**2,400A**
B = 1,168kg (1,947 x 12/20) x $25	29,200	B = 1,100kg x $25	27,500	**1,700F**
Total	**44,800**	**Total**	**45,500**	**700A**

Again, if you like to learn the formula, this is shown below, although it would have to be applied separately to each type of material.

(Standard quantity for actual production – actual quantity) x standard cost

Understanding the bigger picture

Now that you understand how to deal with the numerical side of materials mix and yield variances, and the fact that these are simply a detailed breakdown of the material usage variance, it is also important to stress the fact that quality issues cannot really be dealt with by this variance analysis. I have mentioned the fact that there is a direct relationship between the mix and the yield variance and that neither of these can be considered in isolation. In addition to this, however, it is also essential to understand the importance of producing products that are of a consistently good quality. It can be tempting for production managers to change the product mix in order to make savings; these savings may lead to greater bonuses for them at the end of the day. However, if the quality of the product is adversely affected, this is damaging to the reputation of the business and hence its long-term survival prospects. While substituting poor quality input materials may in some cases lead to yield volumes that are the same as those achieved with higher quality materials, the yield may not be of the same quality.

Unfortunately, this factor cannot be incorporated into the materials yield variance. In the long run, it may be deduced from an adverse sales volume variance, as demand for the business's product decreases, but it is likely to take time for sales volumes to be affected. Any sales volume variance that does arise as a result of poor quality products is likely to arise in a different period from the one in which the mix and yield variances arose, and the correlation will then be more difficult to prove.

Similarly, poorer quality materials may be more difficult to work with; this may lead to an adverse labour efficiency variance as the workforce takes longer than expected to complete the work. This, in turn, could lead to higher overhead costs, and so on. Fortunately, consequences such as these will occur in the same period as the mix variance and are therefore more likely to be identified and the problem resolved. Never underestimate the extent to which a perceived 'improvement' in one area (eg a favourable materials mix variance) can lead to a real deterioration in another area (eg decreased yield, poorer quality, higher labour costs, lower sales volumes, and ultimately lower profitability). Always make sure you mention such interdependencies when discussing your variances in exam questions. The number crunching is relatively simple once you understand the principles; the higher skills lie in the discussion that surrounds the numbers.

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