How to Apply Three-Point Estimating
(Program Evaluation and Review Technique - PERT)

According to the *PMBOK,* "The accuracy of single-point activity duration estimates may be improved by considering estimation uncertainty and risk."

One way to address this uncertainty and risk is to use a probabilistic approach, such as the one proposed in the program evaluation and review technique (PERT). The three-point estimating concept is originated with the PERT, which uses three estimates to define the range for an activity duration based on a probability distribution for the duration of the activity.

This technique can be used if there are no previous records, in which case it is very difficult to estimate an activity duration, or it can also be used if there are databases with historical information for any given activity duration.

The three-point estimating technique can be used to estimate either time or cost, but in this section we'll focus on its application for time estimation.

In order to use the PERT technique, three different scenarios must be considered for each activity duration.

Most likely (tM): this time estimate is based on the most likely duration of the activity.

Optimistic (tO): this time estimate is based on the best-case scenario for the duration of the activity, based on how many working periods are the minimum required to complete the activity.

Pessimistic (tP): this time estimate is based on the worst reasonable case scenario for the duration of the activity.

Based on the PERT concepts, and considering the three time estimates, a probability distribution for the duration of each activity is assumed. The probability distribution, referred to as Beta, provides the following formula to estimate the expected duration (tE):

$$tE = (tO + 4tM + tP) / 6 \quad (1)$$

Also, the variance (σ^2) for the activity duration can be estimated with the following formula:

$$\sigma^2 = ((tP - tO) / 6)^2 \quad (2)$$

Finally, the standard deviation (σ) for the activity duration can be estimated as the square root of the variance with the following formula:

$$\sigma = \sqrt{\sigma^2} \quad (3)$$

Let's study these concepts with a simple example. A consulting firm uses databases and estimates the durations in the following table to perform the conceptual design of a remodeling project.

Table 1. Activity sequencing and duration

ID	DESCRIPTION	PREDECESOR	tO	tM	tP
1	Start	NA	0	0	0
2	Existing Structures Survey	1	3	5	7
3	Architectural Design	2	10	13	16
4	Drawings	3	4	8	18
5	Review	4	2	6	10
6	End	NA	0	0	0

Based on formula (1), the expected duration (tE) can be calculated for each activity. The results are shown in Table 2.

Table 2. Expected duration based on the three-point estimate approach

ID	DESCRIPTION	PREDECESOR	tO	tM	tP	tE
1	Start	NA	0	0	0	0
2	Existing Structures Survey	1	3	5	7	5
3	Architectural Design	2	10	13	16	13
4	Drawings	3	4	8	18	9
5	Review	4	2	6	10	6
6	End	NA	0	0	0	0

Now, considering that the three activities are in a finish-start relationship, we can calculate that the total project duration is 33 days[1].

Based on the PERT theoretical basis, once the critical path is established, the critical path activities follow a normal probability distribution (Gauss Bell), such as the one shown in Figure 1.

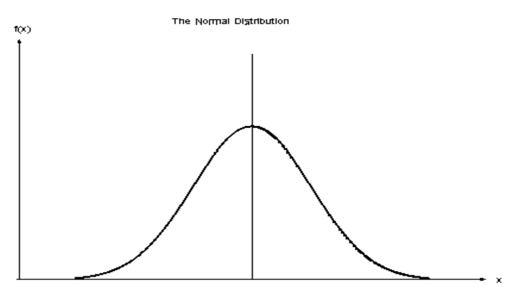

Figure 1. Normal probability distribution.

[1] Notice that in this simple example all the activities are part of the critical path and therefore, the project duration can be calculated as the sum of the expected duration (tE) of each activity. For any given project the critical path must be calculated in order to determine the critical path activities and to add up all critical path activities to determine the project duration.

Considering that the critical path activities follow a normal probability distribution it can be established that there is a 50% probability of finishing the project in the project duration of 33 days.

Also, in terms of standard deviation, which represents how much variation or dispersion exists from the expected duration, different probabilities can be calculated for different ranges of variation from the expected duration. Figure 2 shows the approximate range of probabilities that are established for a normal probability distribution.

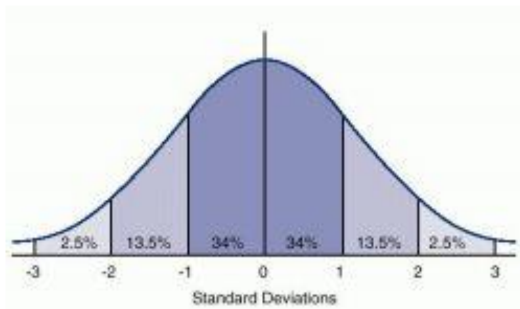

Figure 2. Normal probability distribution and probabilities relative to standard deviations from the average.

Based on our previous calculations and what is shown in Figure 2, we can estimate that the project has a 50%[2] probability of finishing in 33 days. If we want to increase that probability to 84%, we just need to add one standard deviation.

In order to calculate the standard deviation we need to add up the variances of the critical path activities to determine the variance of the critical path, then to calculate the standard deviation we take the square root of that total of variances as per formula (3).

Table 3. Variance calculation

ID	DESCRIPTION	PREDECESOR	tO	tM	tP	tE	Variance
1	Start	NA	0	0	0	0	0
2	Existing Structures Survey	1	3	5	7	5	0.44
3	Architectural Design	2	10	13	16	13	1.00
4	Drawings	3	4	8	18	9	5.44
5	Review	4	2	6	10	6	1.78
6	End	NA	0	0	0	0	0

Based on the information presented, the total variance is 8.66 (0 + 0.44 + 1 + 5.44 + 1.78 + 0 = 8.66), the standard deviation is 2.94 (the square root of 8.66), and the time the project will

[2] Notice that the sum of the three standard deviations to the left of the average value in Figure 2 add up to 50% (2.5% + 13.5% + 34% = 50%).

take with a probability of 84% is 35.94 days (33 + 2.94 = 35.94).

Some of the most important things that need to be considered when applying the three-point estimate techniques include the following:

1. Remember that you are using a probabilistic approach.
2. Remember that you need to determine the critical path.
3. When calculating the standard deviation for the critical path, remember to add up the variances of all critical path activities (just the critical path activities) and then calculate the square root of that variance (notice that the result is different if you add the variances and then calculate the square root of that sum, than when you calculate the square root of each variance and then add them up).