Expected Monetary Value (EMV) Analysis

First, don’t confuse EMV with the term EVM! The latter stands for earned value management, whereas EMV stands for expected monetary value, which is completely different. EMV is a tool and technique for the “Perform Quantitative Risk Analysis” process (or simply, quantitative analysis), where you numerically analyze the effect of identified risks on overall project objectives.

The formula for EMV of a risk is this:

Expected Monetary Value (EMV)
*= Probability of the Risk (P) * Impact of the Risk (I)*
or simply,

*EMV = P * I*

EMV calculates the average outcome when the future includes uncertain scenarios — positive (opportunities) or negative (threats). Opportunities are expressed as positive values, while threats have negative values. Both the values will be considered by adding them together.

Example: There’s a negative risk (or threat) with a 10 percent probability of prohibiting the execution of a work package. If that risk happens, the impact of not executing the package is estimated at $40,000. For the same work package, there’s a positive risk with a 15 percent probability and impact estimated at a positive $25,000. Should you execute the work package?

Answer:
*EMV for the threat = P * I = 10% * (-$40,000) = -$4,000*
*EMV for the opportunity = P * I = 15% * (+$25,000) = $3,750*
Now, the EMV = – $4,000 + $3,750 = -$250

Obviously, you don’t want to execute the work package, because you’ll lose money on it. When a work package or activity is associated with a risk, you can find the individual EMV. In other words, you quantify the individual risks.

That covered EMV for an individual work package. How about the overall project risk? A project, after all, will have many work packages, right?

To figure this out, you calculate the EMV by multiplying the value of each possible outcome (impact) by its likelihood of occurrence (probability) and then adding the results — which leads us back to our original topic. A common use of EMV is found in decision tree analysis.

Explanation Expected monetary value is calculated by EMV probability x impact. We need tocalculate both positive and negative values and then add them:0.6 x $100,000 = $60,0000.4 x ($100,000) = ($40,000)Expected monetary value $60,000 - $40,000 = $20,000 profit

Decision Tree Analysis

Decision tree analysis (DTA) uses EMV analysis internally. A decision tree, as the name suggests, is about making decisions when you're facing multiple options.

Here are some of the key points you should note about DTA:

- DTA takes future uncertain events into account. The event names are put inside rectangles, from which option lines are drawn.
- There will be decision points (or "decision nodes") and multiple chance points (or "chance nodes") when you draw the decision tree. Each point has different symbols: a filled up small square node is a "decision node"; a small, filled-up circle is a "chance node"; and a reverse triangle is the end of a branch in the decision tree. These are noted in this table:

Notation	Shape	Meaning
	Filled-up square	Decision node
●	Filled-up circle	Chance (condition) node
◀	Reverse triangle	End of branch

- Because this format results in a diagram that resembles a tree branching from left to right, decision tree is an apt name!To analyze a decision tree, move from left to right, starting from the decision node. This is where the branching starts. Each branch can lead to a chance node. From the chance node, there can be further branching. Finally, a branch will end with end-of-branch symbol.
- The probability value will typically be mentioned on the node or a branch, whereas the cost value (impact) is at the end.
- Next come the calculations on the branches of the tree. To calculate, move from right to left on the tree. The cost value can be on the end of the branch or on the node. Just follow the branch to do the calculation.
- The best decision is the option that gives the highest positive value or lowest negative value, depending on the scenario.

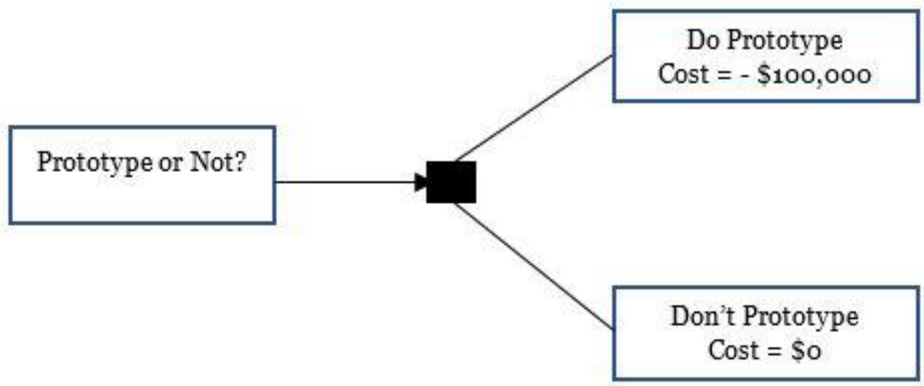
Let's work through an example to understand DTA's real world applicability.

Example: You're doing a prototype for your project, but you're not sure whether to proceed with this prototype. If you do the prototype, it will cost you $100,000; and, of course, if you don't pursue it, there will be no cost. If you do the prototype, there is 30 percent chance that the prototype might fail, and for that the cost impact will be $50,000. However, if the prototype succeeds, the project will make $500,000. If you do not do any prototype, you're already taking a risk, the chance of which is 80 percent with a failure impact of $250,000. But, again, without a prototype, should you succeed, the project will make the same money as mentioned before. What should you do?

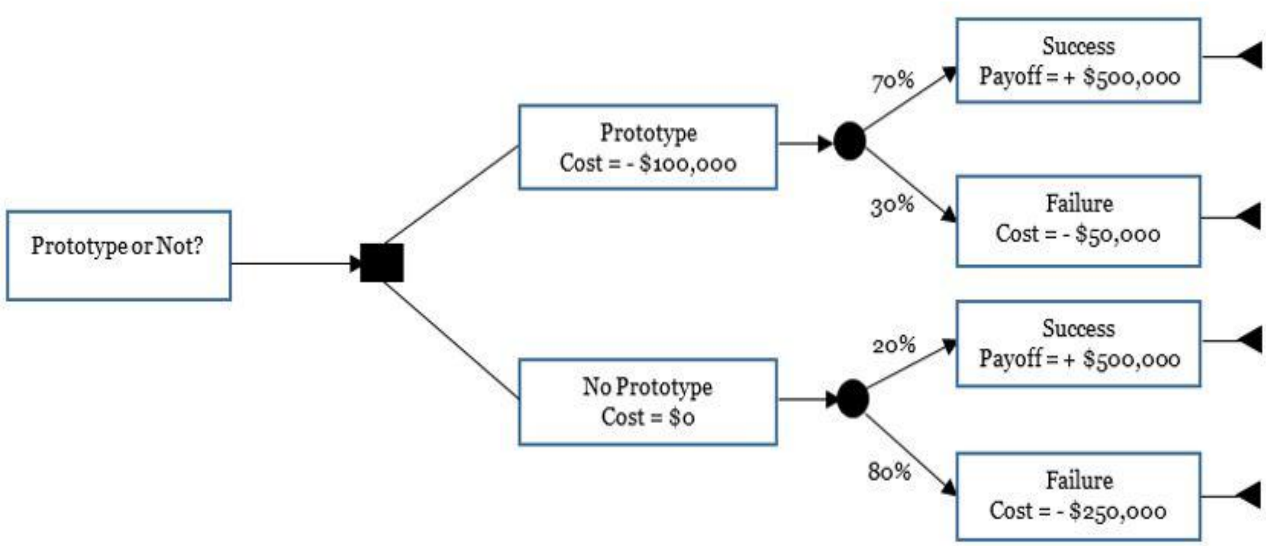
Answer:

To begin your analysis, start from the left and move from the left to the right. First, draw the event in a rectangle for the event — “Prototype or Not.” This obviously will lead to a decision node (in the small, filled-up square node as shown below).

From there, you have two options — “Do Prototype” and “Don’t Prototype.” They are also put in rectangles as shown below.



Each option will lead to two events or chances — success or failure — branching out from the chance nodes. Taking the first option, if it fails, which has a 30 percent chance, the impact will be $50,000. If it succeeds (a 70 percent chance), there’s no cost, but there is a payoff of $500,000. These are noted on the arrows. Similarly, for the second decision, “Don’t Prototype”:



By looking at it, can you conclude anything? I can't. So let's do the EVM analysis. To calculate, as noted before, you move from right to left. First, calculate the net path value along each branch of the decision tree. The net path value for a path over the branch is the difference between payoff minus costs. Next, at every chance node, calculate the EMV. From these EMVs, we can find out the EMV of at the decision node. The decision giving the highest positive value or lowest negative value is selected.

This is summarized in this table.

Decision definition	**Decision node**	**Condition (or chance) node**	**Net path value**
Decision to be made	Input: Cost of each option Output: Decision made Decision node is a black rectangle or square.	Input: Scenario probability, reward or penalty if it occurs. Output: EMV Chance node is a circle.	Computed cost: Payoff minus costs along the path. End path is shown with a reverse arrow mark.

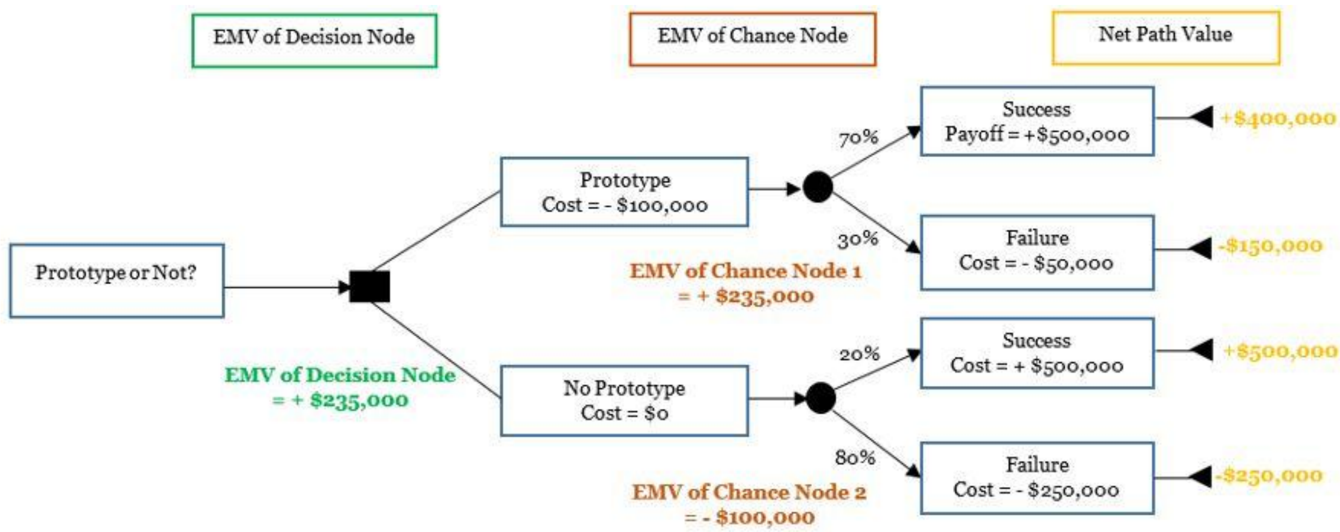
EMV for Chance Node 1, the first circle:

The net path value for the prototype with 70 percent success = Payoff – Cost:
= +$500,000 – $100,000
= +$400,000
The net path value, for the prototype with a 30 percent failure = Payoff – Cost:
= -$50,000 – $100,000
= -$150,000
*EMV of chance node 1 = [70% * (+$400,000)] + (30% * (-$150,000)]*
= +$280,000 – $45,000
= +$235,000

EMV for Chance Node 2 (the second circle):

The net path value for the prototype with a 20 percent success = Payoff – Cost:
= +$500,000 – $0
= +$500,000
The net path value for the prototype with 80 percent failure = Payoff – Cost:
= -$250,000 – $0
= -$250,000
*EMV of chance node 2 = [20% * (+$500,000)] + (80% * (-$250,000)]*
= +$100,000 – $200,000
= -$100,000

These results are shown in this figure:



Which alternative would you take? Look at the EMV of the decision node (the filled-up square). That's +$235,000. With the other option — no prototyping — you're losing money. Hence, you should go for the prototype.