INSE 6230
Total Quality Project Management

Lecture 6

Project Risk Management

The Importance of Project Risk Management

- Project risk management is the art and science of identifying, analyzing, and responding to risk throughout the life of a project

- Risk management is often overlooked in projects, but it can help improve project success by
  - helping select good projects
  - determining project scope
  - developing realistic estimates

Research Shows Need to Improve Project Risk Management

- Risk has the lowest maturity rating of all knowledge areas!

KEY: 1 = LOWEST MATURITY RATING 5 = HIGHEST MATURITY RATING

Knowledge Area	**Engineering/ Construction**	**Telecommunications**	**Information Systems**	**Hi-Tech Manufacturing**
Scope	3.52	3.45	3.25	3.37
Time	3.55	3.41	3.03	3.50
Cost	3.74	3.22	3.20	3.97
Quality	2.91	3.22	2.88	3.26
Human Resources	3.18	3.20	2.93	3.18
Communications	3.53	3.53	3.21	3.48
Risk	**2.93**	**2.87**	**2.75**	**2.76**
Procurement	3.33	3.01	2.91	3.33

Project Risk Management Processes

- **Planning risk management:** deciding how to approach and plan the risk management activities for the project ➔ *Risk Management Plan*
- **Identifying risks:** determining which risks are likely to affect a project and documenting the characteristics of each ➔ *Risk Register*
- **Performing qualitative risk analysis:** prioritizing risks based on their probability and impact of occurrence
- **Performing quantitative risk analysis**: numerically estimating the effects of risks on project objectives
- **Planning risk responses:** taking steps to enhance opportunities and reduce threats to meeting project objectives
- **Monitoring and controlling risks:** monitoring identified risks, identifying new risks, carrying out risk response plans, and evaluating the *effectiveness of risk strategies* throughout the life of the project

Project Risk Management Summary

Planning

Process: **Plan risk management**
Output: Risk management plan
Process: **Identify risks**
Output: Risk register
Process: **Perform qualitative risk analysis**
Output: Risk register updates
Process: **Perform quantitative risk analysis**
Output: Risk register updates
Process: **Plan risk responses**
Outputs: Risk register updates, risk-related contract decisions, project management plan updates, project document updates

Monitoring and Controlling

Process: **Monitor and control risks**
Outputs: Risk register updates, organizational process assets updates, change requests, project management plan updates, project document updates

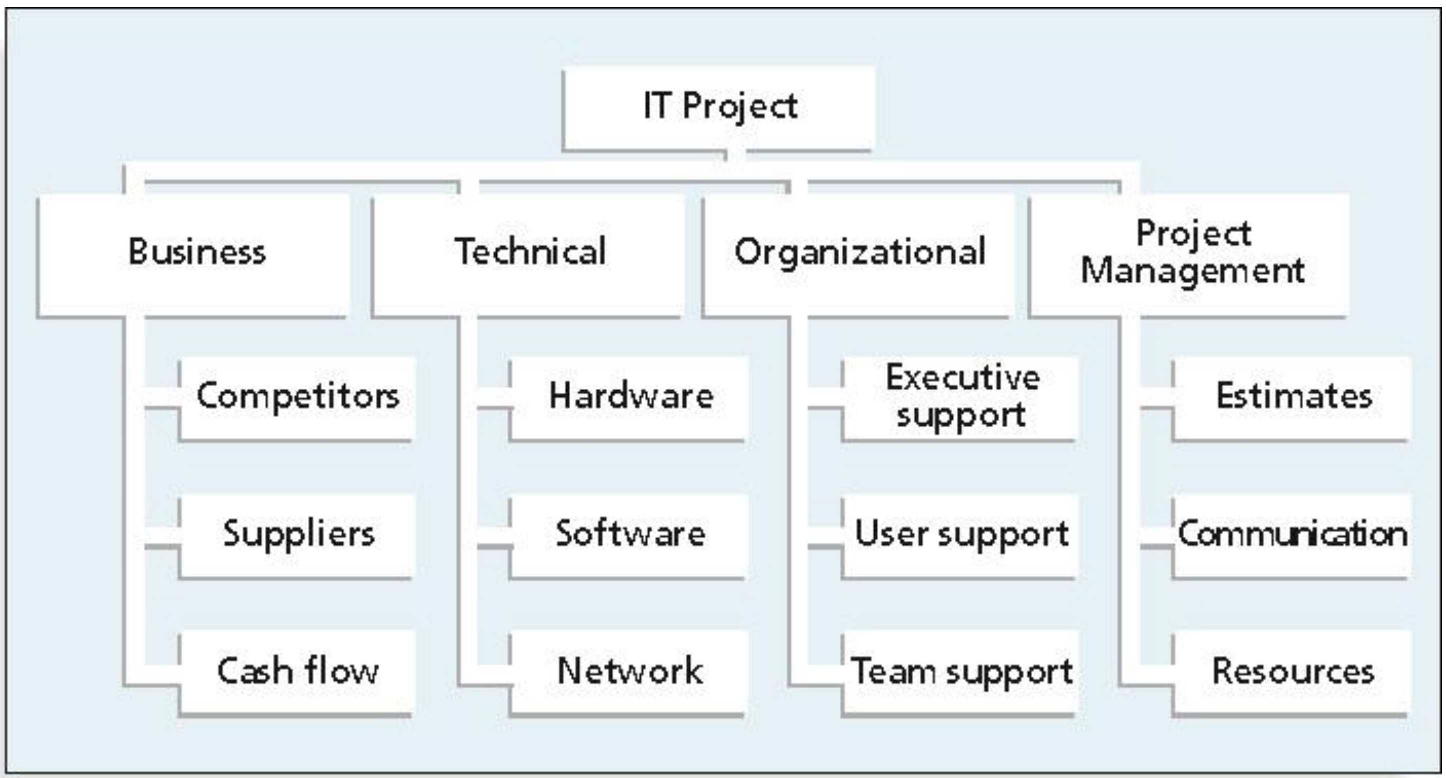
Project Start **Project Finish**

Risk Management Planning

- The main output of risk management planning is a **Risk Management Plan** — a plan that documents the procedures for managing risk throughout a project
  - **Contingency plans** are predefined actions that the project team will take if an identified risk event occurs
  - **Fallback plans** are developed for the risks that have a high impact on meeting project objectives and are put into effect if contingency plans are not effective
- Broad categories of risks:
  - Market risk (*e.g.* user acceptance, competition)
  - Financial risk (*e.g.* investment, cost objectives)
  - Technology risk (*e.g.* technical feasibility, maturity)
  - People risk (*e.g*. human resources requirements)

Risk Breakdown Structure

- **A risk breakdown structure** is a hierarchy of potential risk categories for a project
- Similar to a work breakdown structure but used to identify and categorize risks



Identifying Risks

- Identifying risks is the process of understanding what potential events might hurt or enhance a particular project (should be done early, should be up to date, every item should be considered)
- Risk identification tools and techniques include:
  - **Brainstorming**
    - A technique by which a group attempts to generate ideas or find a solution for a specific problem by amassing ideas spontaneously and without judgment
  - **Interviewing**
    - Face-to-face, phone, e-mail, or instant-messaging discussions
  - **SWOT analysis** (strengths, weaknesses, opportunities, and threats)
    - Helps identify the broad negative and positive risks that apply to a project
  - **Diagramming techniques**
    - Cause-and-effect diagram, flow charts, influence diagram

Risk Register

- The main output of the risk identification process is a list of identified risks and other information needed to begin creating a risk register
- A **risk register** is:
  - A document that contains the results of various risk management processes and that is often displayed in a table or spreadsheet format
  - A tool for documenting potential risk events and related information
- **Risk events** refer to specific, uncertain events that may occur to the detriment or enhancement of the project

No.	Rank	Risk	Description	Category	Root Cause	Triggers	Potential Responses	Risk Owner	Probability	Impact	Status
R44	1										
R21	2										
R7	3										

Qualitative Risk Analysis

- Assess the likelihood and impact of identified risks to determine their magnitude and priority
- Tools and techniques include:
  - Probability/impact matrices
  - The top ten risk item tracking
  - Expert judgment

Probability/Impact Matrix

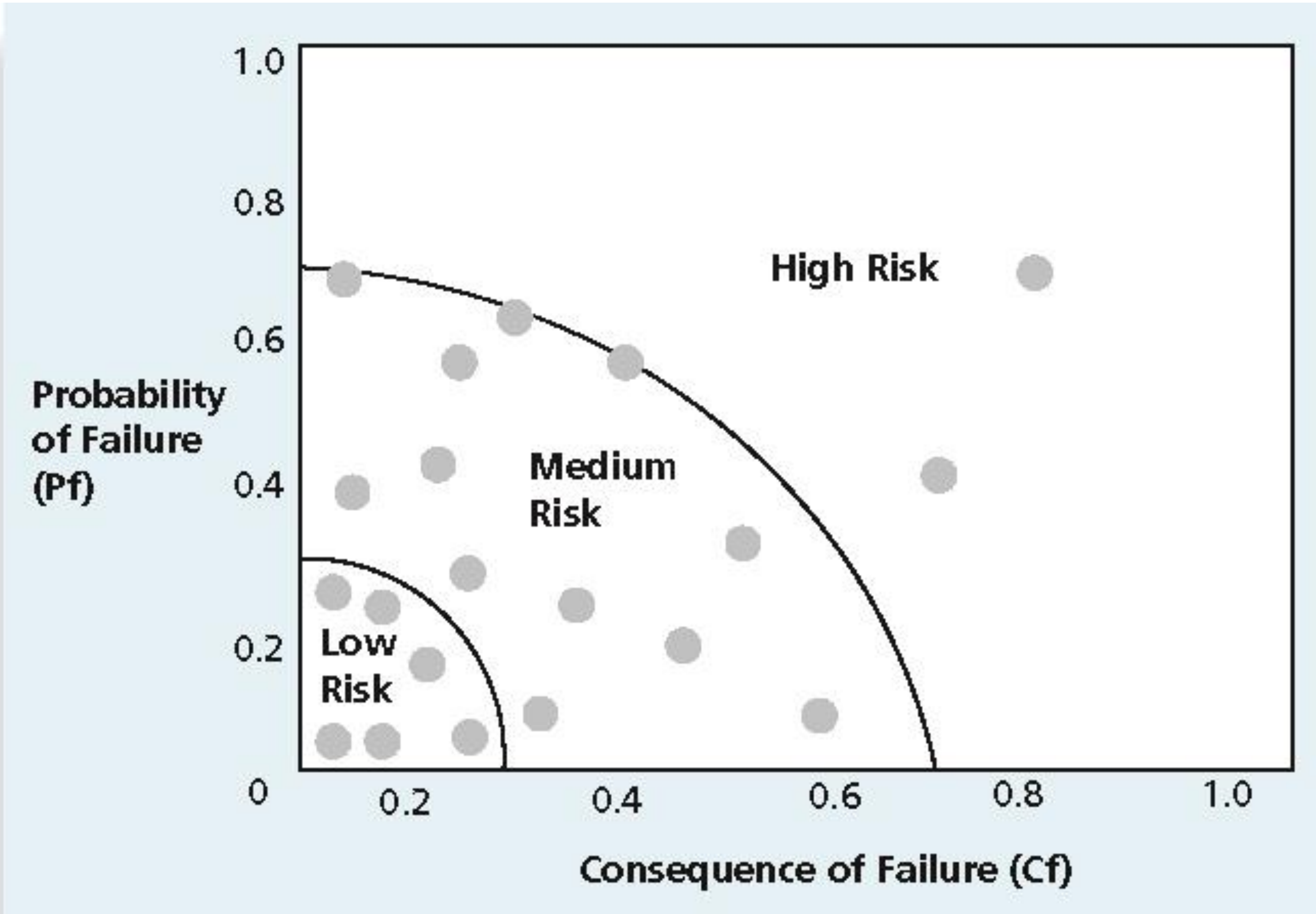
- A **probability/impact matrix** or chart lists the relative probability of a risk occurring on one side of a matrix or axis on a chart and the relative impact of the risk occurring on the other
- List the risks and then label each one as high, medium, or low in terms of its probability of occurrence and its impact if it did occur
- Can also calculate **risk factors**
  - Numbers that represent the overall risk of specific events based on their probability of occurring and the consequences to the project if they do occur

Sample Probability/Impact Matrix

Probability \ Impact	Low	Medium	High
High	risk 6	risk 9	risk 1 risk 4
Medium	risk 3 risk 7	risk 2 risk 5 risk 11	
Low		risk 8 risk 10	risk 12

- **Top Ten Item Tracking:**
  - Based on the results of the probability matrix the 10 most risky items may be listed and monitored throughout the project

Chart Showing High-, Medium-, and Low-Risk Technologies



Example of Top Ten Risk Item Tracking

	MONTHLY RANKING			
RISK EVENT	RANK THIS MONTH	RANK LAST MONTH	NUMBER OF MONTHS IN TOP TEN	RISK RESOLUTION PROGRESS
Inadequate planning	1	2	4	Working on revising the entire project management plan
Poor definition	2	3	3	Holding meetings with project customer and sponsor to clarify scope
Absence of leadership	3	1	2	After previous project manager quit, assigned a new one to lead the project
Poor cost estimates	4	4	3	Revising cost estimates
Poor time estimates	5	5	3	Revising schedule estimates

Quantitative Risk Analysis

- Often follows qualitative risk analysis, but both can be done together or separately
- Large, complex projects involving leading edge technologies often require extensive quantitative risk analysis
- Main techniques include:
  - Decision tree analysis
  - Simulation
  - Sensitivity analysis

Decision Trees and Expected Monetary Value (EMV)

- **A decision tree** is a diagramming analysis technique used to help select the best course of action in situations in which future outcomes are uncertain
- Symbols used in a decision tree:

□ **Decision node** from which one of several alternatives may be selected

Alternative — a course of action or strategy that may be chosen by the decision maker

○ **State-of-nature node** out of which one state of nature will occur

State of nature — an occurrence or a situation over which the decision maker has little or no control

- **Expected monetary value (EMV)** is the product of a risk event probability and the risk event's monetary value (payoff)

Decision Trees and Expected Monetary Value (EMV)

- Procedure:
  1. Define the problem and structure, and draw the decision tree
  2. Assign probabilities to the states of nature
  3. Estimate payoffs for each possible combination of decision alternatives and states of nature
  4. Solve the problem by working backward through the tree computing the EMV for each state-of-nature node

Decision Trees and EMV – *Example 1*

- Getz Products Company is investigating the possibility of producing and marketing backyard storage sheds. Undertaking this project would require the construction of either a large or a small manufacturing plant. The market for the product produced—storage sheds—could be either favorable or unfavorable. Getz, of course, has the option of not developing the new product line at all.

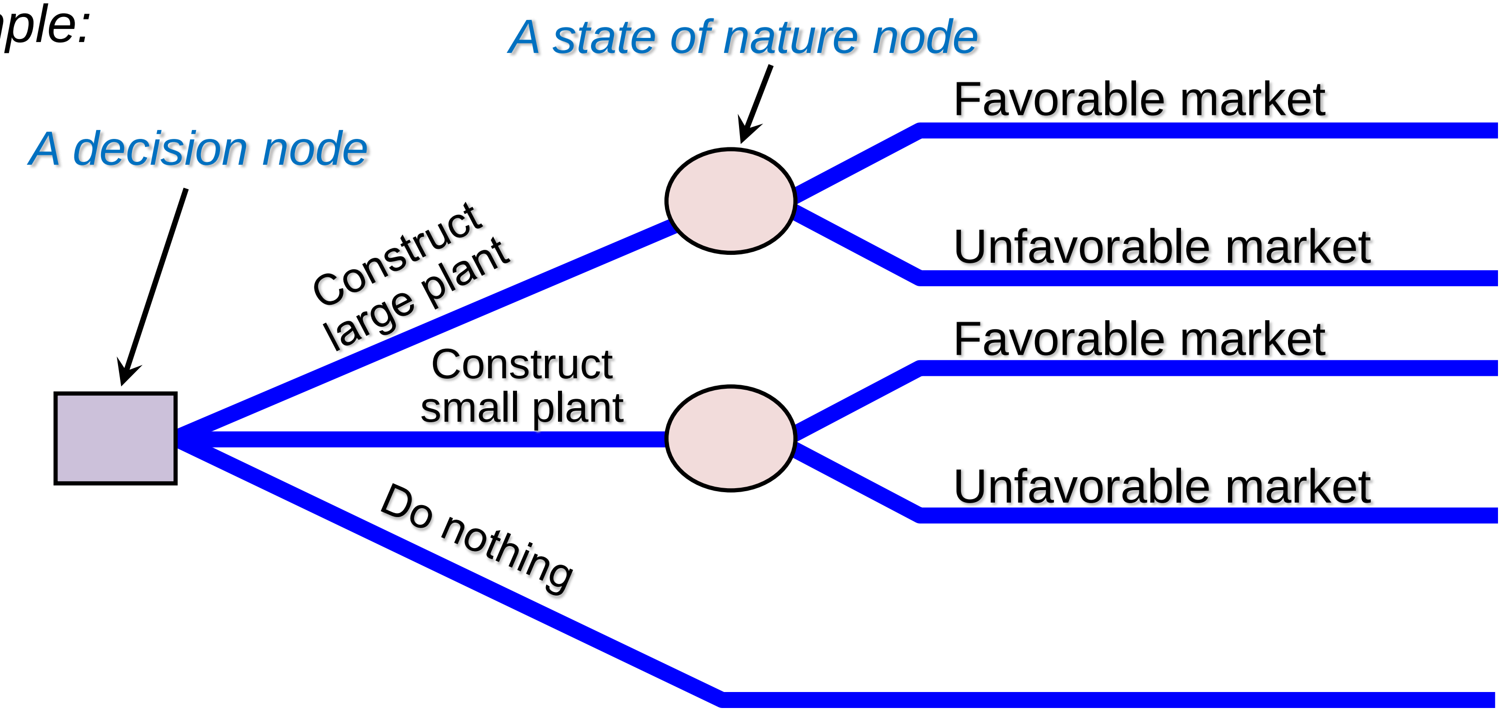
- With a favorable market, a large facility will give Getz Products a net profit of $200,000. If the market is unfavorable, a $180,000 net loss will occur. A small plant will result in a net profit of $100,000 in a favorable market, but a net loss of $20,000 will be encountered if the market is unfavorable. The probabilities of the market being favorable or unfavorable are estimated to be equal.

- Should Getz build small or large manufacturing facility, or not build any plant at all?

Decision Trees and EMV – *Example 1*

1. Define the problem and structure, and draw the decision tree

Example:

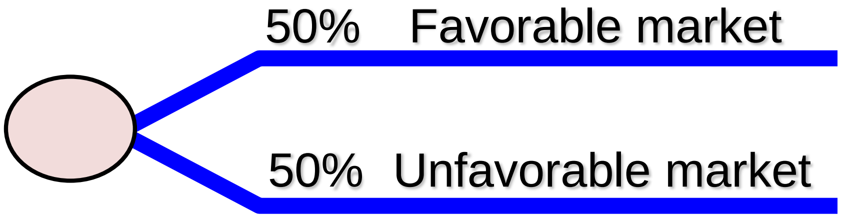


Decision Trees and EMV – *Example 1*

2. Assign probabilities to the states of nature

- Each possible state of nature has an assumed probability
- States of nature are mutually exclusive
- Probabilities must sum to 1

- *Example:* The probabilities of the market being favorable or unfavorable are equal ➔ 50% for favorable and 50% for unfavorable

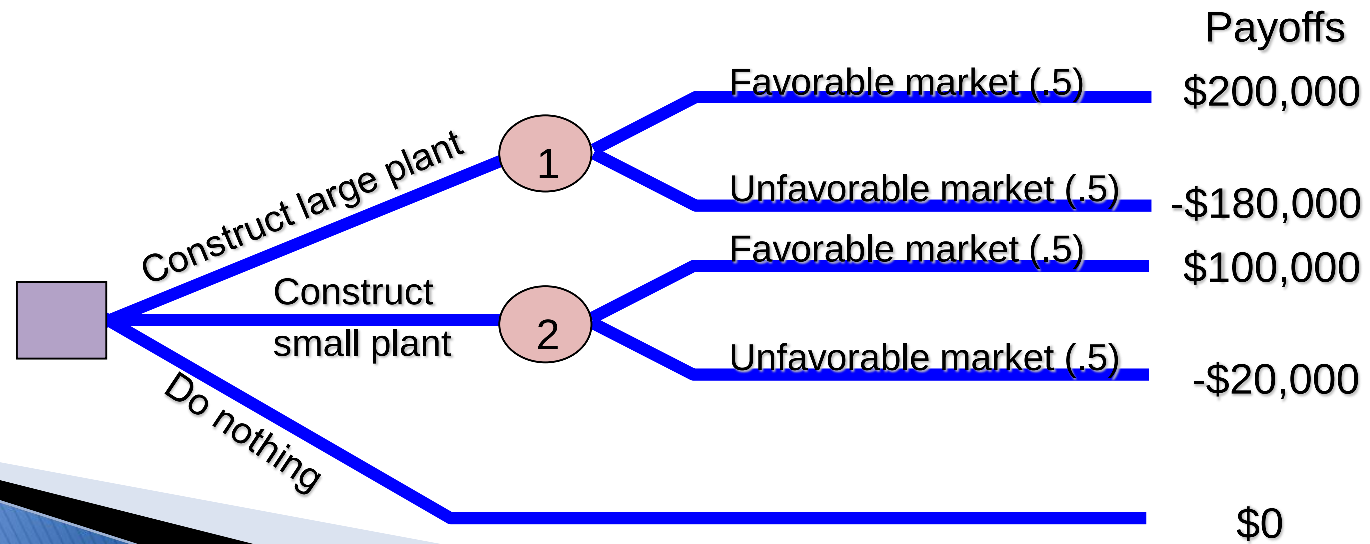


Decision Trees and EMV – *Example 1*

3. Estimate payoffs for each possible combination of decision alternatives and states of nature

Example:

Alternatives	***State of Nature*** Favorable Market	Unfavorable Market
Construct large plant	$200,000	–$180,000
Construct small plant	$100,000	–$ 20,000
Do nothing	$ 0	$ 0



Decision Trees and EMV – *Example 1*

4. Solve the problem by working backward through the tree computing the EMV **for each state-of-nature node**

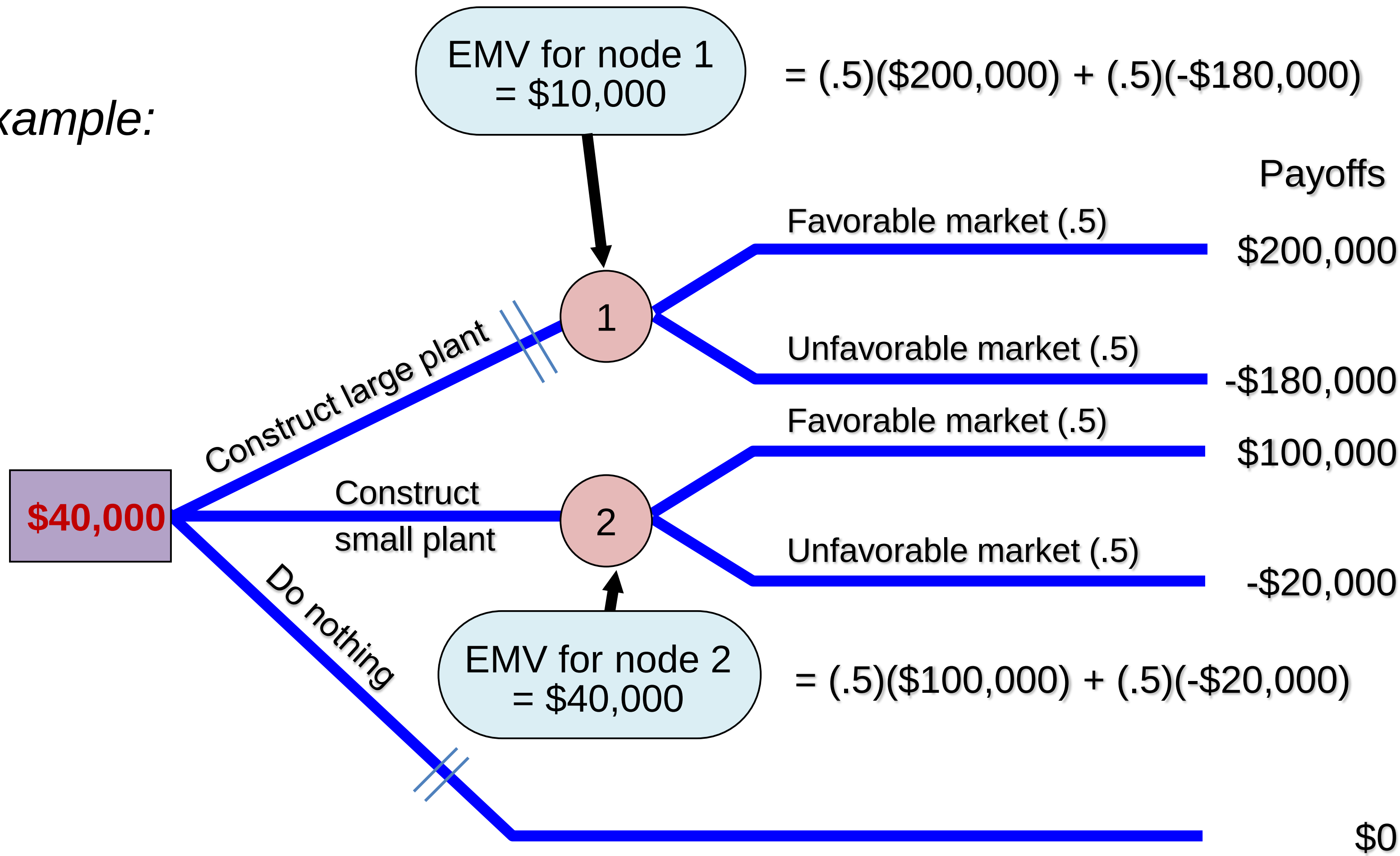
EMV = (Payoff of 1st state of nature) x (Probability of 1st state of nature)

+ (Payoff of 2nd state of nature) x (Probability of 2nd state of nature)

+…+ (Payoff of last state of nature) x (Probability of last state of nature)

Decision Trees and EMV – *Example 1*

Example:



Decision Trees and EMV – *Example 1*

Example:

Alternatives	States of Nature: Favorable Market	States of Nature: Unfavorable Market
Construct large plant (A1)	\$200,000	-\$180,000
Construct small plant (A2)	\$100,000	-\$20,000
Do nothing (A3)	\$0	\$0
Probabilities	.50	.50

1. $EMV(A_1) = (.5)(\$200{,}000) + (.5)(-\$180{,}000) = \$10{,}000$
2. $EMV(A_2) = (.5)(\$100{,}000) + (.5)(-\$20{,}000) = \$40{,}000$
3. $EMV(A_3) = (.5)(\$0) + (.5)(\$0) = \$0$

Best Option

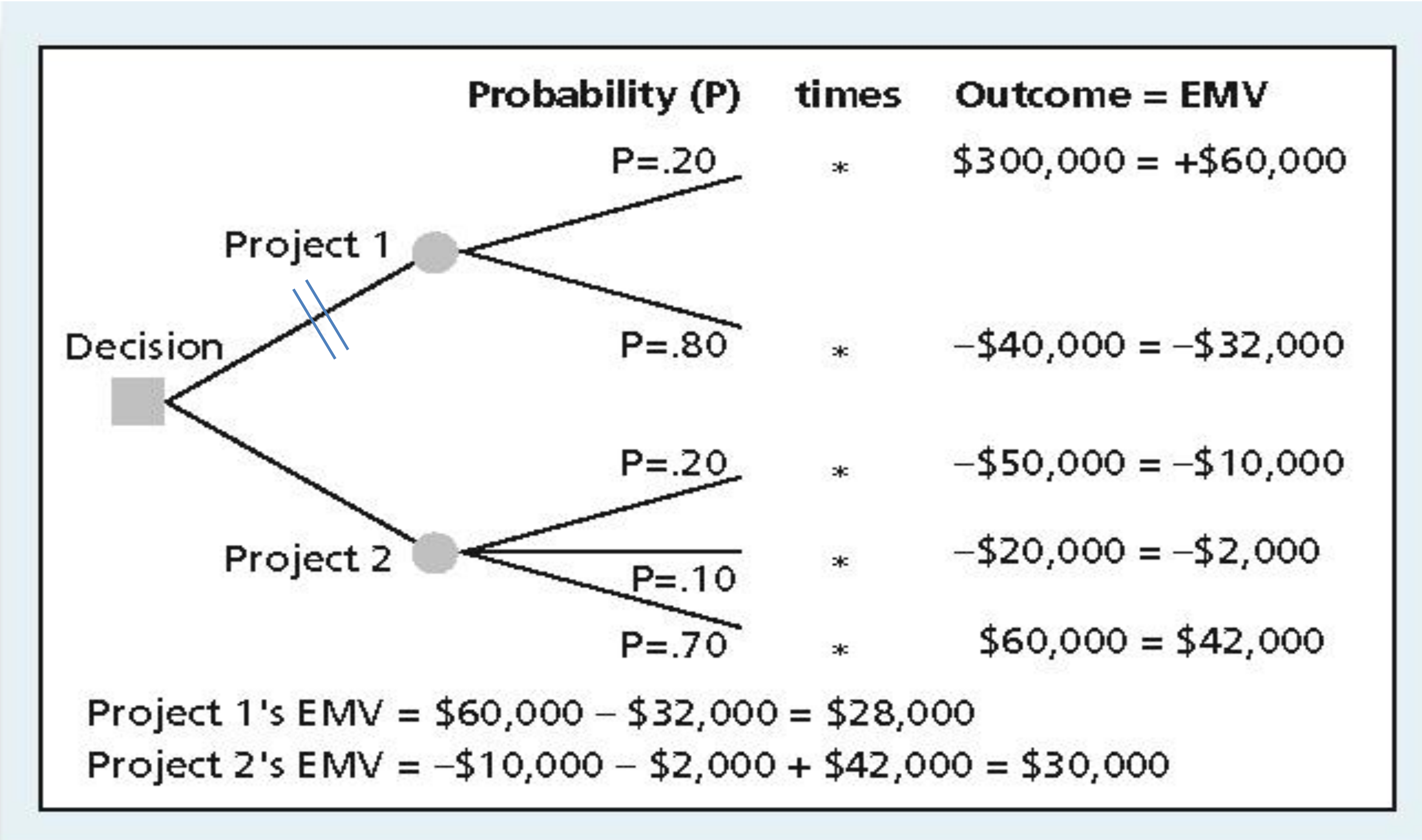
Getz should build a small manufacturing plant. This option has the highest EMV = \$40,000.

Decision Trees and EMV – *Example 2*

- An IT firm can submit a bid for Project 1 or Project 2. For Project 1, there is 20% chance that the firm will win the contract, which is estimated to be $300,000 in profits. There is however 80% probability that it will not win the contract for Project 1. In this case the firm first invests $40,000 and then gets zero reimbursement for this investment. For Project 2 , there is a 70% probability that the firm will gain $60,000, a 20% probability that it will lose $50,000 and a 10% probability that it will lose $20,000.

- Based on the EMV analysis, which of the projects should the firm bid on?

Decision Trees and EMV – *Example 2*



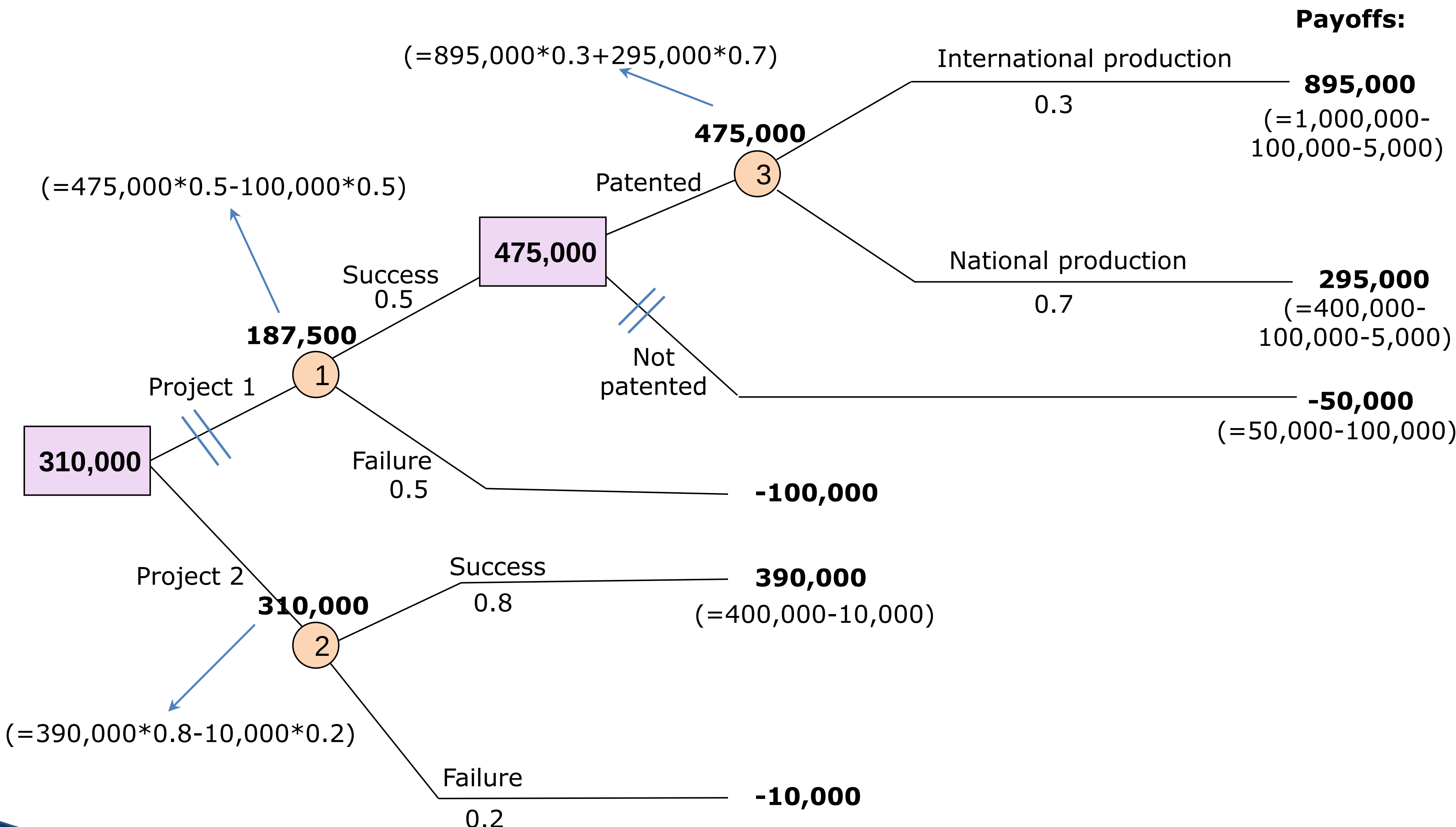
- EVM for Project 1 is **$28,000** and for Project 2 it is **$30,000.**
- If there is only one project the firm can bid on, it should be **Project 2.**

Decision Trees and EMV – *Example 3 (final exam)*

- IT firm considers 2 projects for investment whose outcomes, probabilities, investments and benefits are shown in the table. It is expected that in case of the success of Project #1, the created product can be patented. The registration of the product at Patent Office costs $5,000. If it is not patented, the competition will soon copy the product and take over the market, so the potential benefits are low ($50,000 as seen in table). However, in case that the firm decides to register the patent at the Patent Office, the competitors cannot copy and produce this product, so the market will be all served exclusively by our IT firm. In this case, the product can gain either national or international recognition and production. There is only 30% probability that the production will be international. It is estimated that if the product is produced internationally, the total benefits will amount to $1,000,000, but if it is produced only nationally, the total benefits will be $400,000.
- What are the best decisions at each decision point?
- Draw decision tree and calculate EVM for each project.

	Investment	Outcome	Probability of outcome	Estimated benefits	Possibility to patent the product
Project #1	100,000	Success	50%	50,000 (if not patented)	YES
		Failure	50%	0	
Project #2	10,000	Success	80%	400,000	NO
		Failure	20%	0	

Decision Trees and EMV – *Example 3 (final exam)*



- EVM for Project 1 is **$187,500** and for Project 2 it is **$310,000.**
- The firm should thus select **Project 2**. If for any reason it selects Project 1 then it should **patent the product**.

Decision Trees and EMV – *Example 1 – cont.*

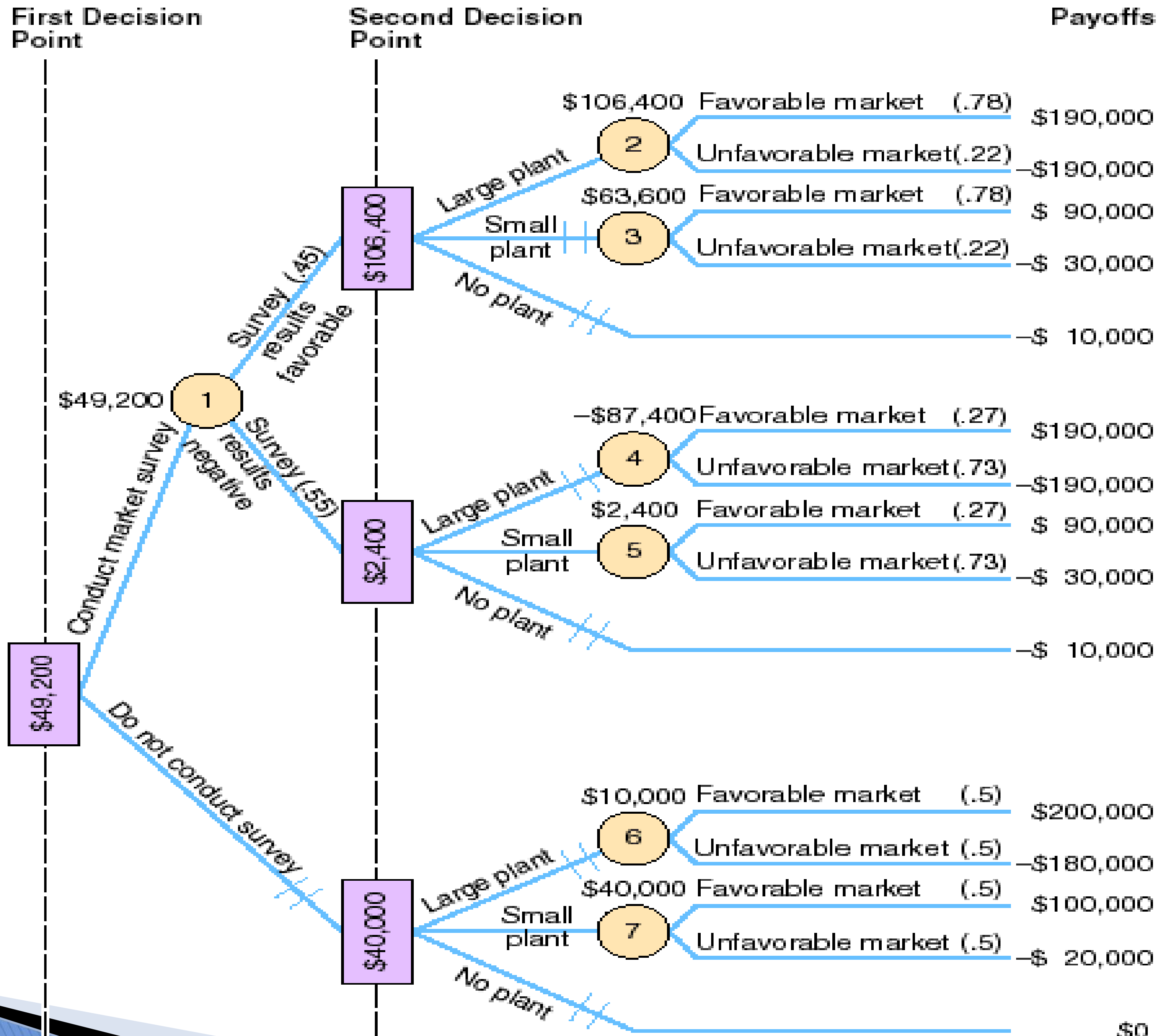
Example 1 continued!

- Before deciding about building a new plant, Getz has the option of conducting its own marketing research survey, at a cost of $10,000. The information from this survey could help it decide whether to build a large plant, to build a small plant, or not to build at all.

- There is a 45% chance that the survey results will indicate a favourable market for the storage sheds. Given positive results from the market survey there is 78% probability that the market will really be favourable, whereas if the results of the survey are negative there is only a 27% chance that the market for sheds will be favourable.

- Should Getz conduct the marketing survey?

- If yes, which size of the plant it should select based on the survey results?


First Decision Point
Second Decision Point
Payoffs
$49,200
Conduct market survey
$49,200
1
Survey (.45) results favorable
$106,400
Large plant
$106,400
2
Favorable market (.78)
$190,000
Unfavorable market(.22)
–$190,000
Small plant
$63,600
3
Favorable market (.78)
$ 90,000
Unfavorable market(.22)
–$ 30,000
No plant
–$ 10,000
Survey (.55) results negative
$2,400
Large plant
–$87,400
4
Favorable market (.27)
$190,000
Unfavorable market(.73)
–$190,000
Small plant
$2,400
5
Favorable market (.27)
$ 90,000
Unfavorable market(.73)
–$ 30,000
No plant
–$ 10,000
Do not conduct survey
$40,000
Large plant
$10,000
6
Favorable market (.5)
$200,000
Unfavorable market (.5)
–$180,000
Small plant
$40,000
7
Favorable market (.5)
$100,000
Unfavorable market (.5)
–$ 20,000
No plant
$0

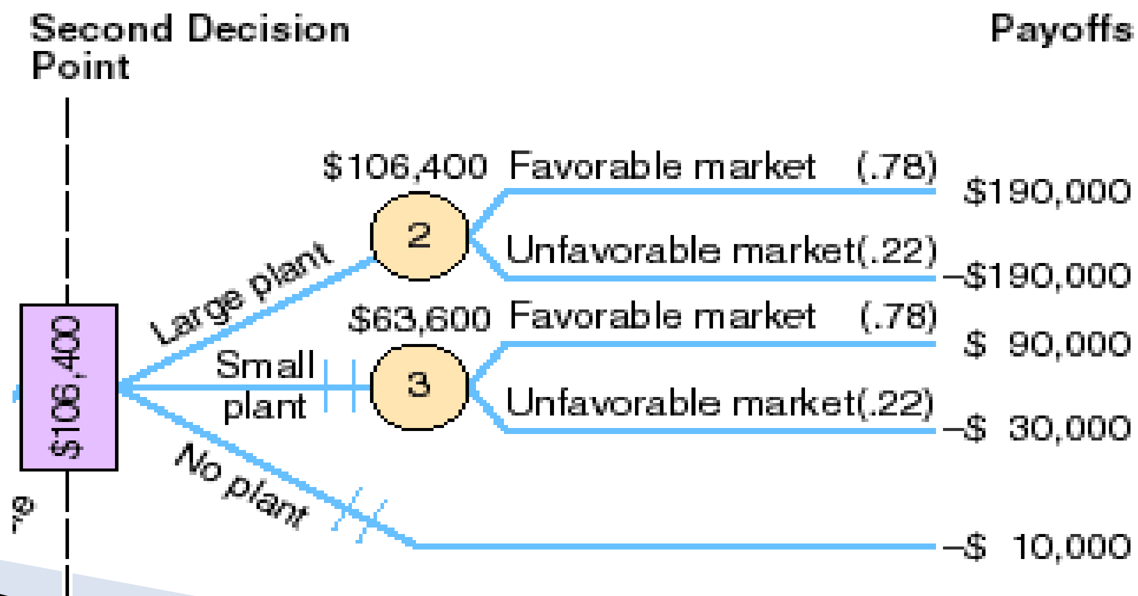
Decision Trees and EMV – *Example 1 – cont.*

- Given favorable survey results

- details of calculation

EMV(2) = (.78)($190,000) + (.22)(-$190,000) = $106,400
EMV(3) = (.78)($90,000) + (.22)(-$30,000) = $63,600

The EMV for no plant = -$10,000 so, if the survey results are favorable, build the large plant



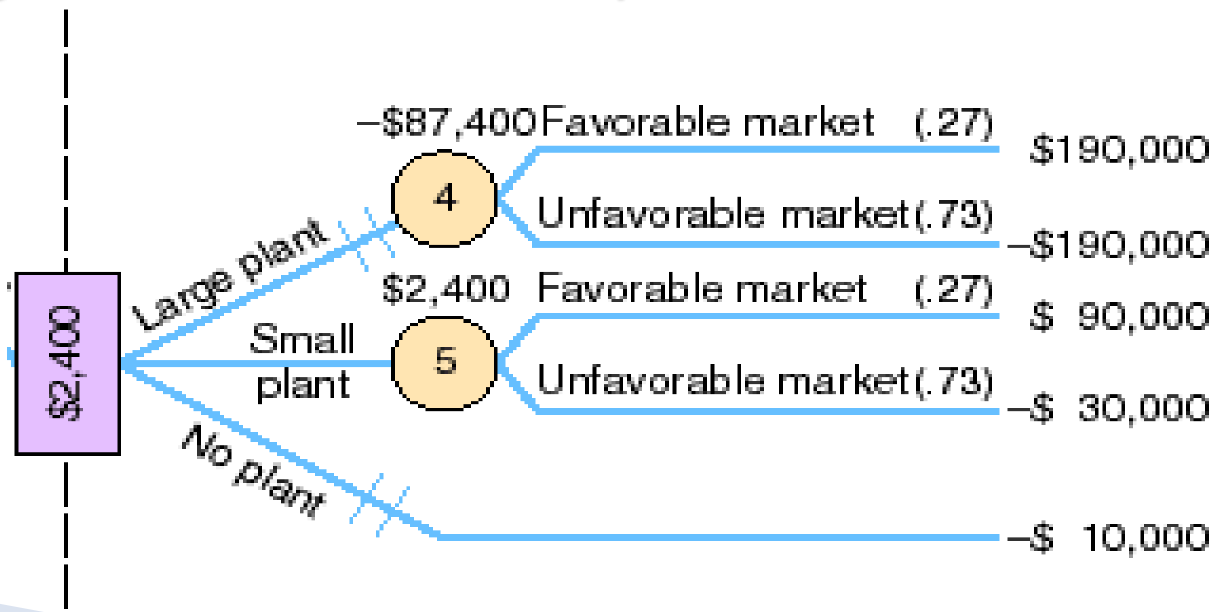
Decision Trees and EMV – *Example 1 – cont.*

- Given negative survey results

  - details of calculation

EMV(4) = (.27)($190,000) + (.73)(-$190,000) = -$87,400
EMV(5) = (.27)($90,000) + (.73)(-$30,000) = $2,400

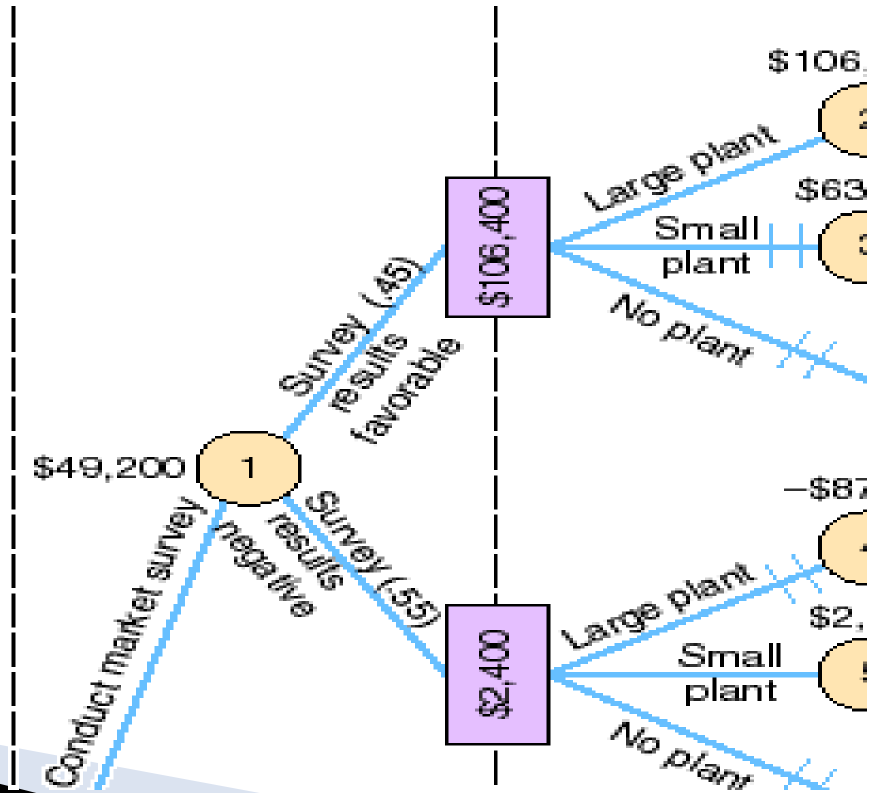
The EMV for no plant = -$10,000 so, if the survey results are negative, build the small plant



Decision Trees and EMV – *Example 1 – cont.*

- Compute the expected value of the market survey *- details of calculation*

EMV(1) = (.45)($106,400) + (.55)($2,400) = $49,200

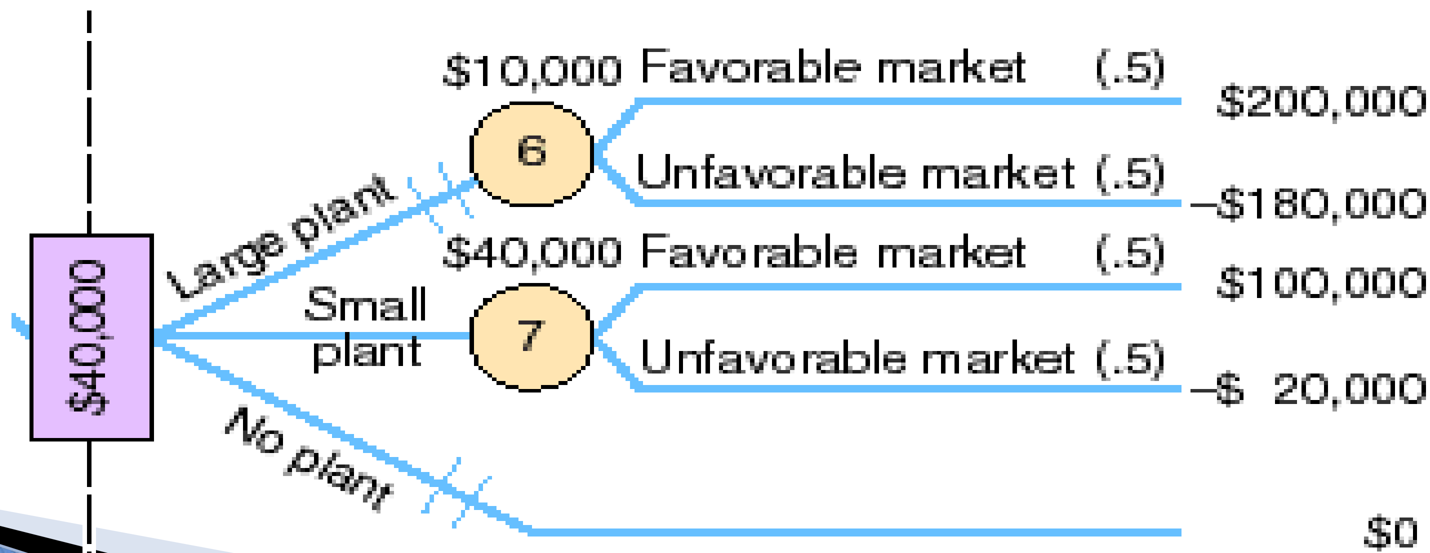


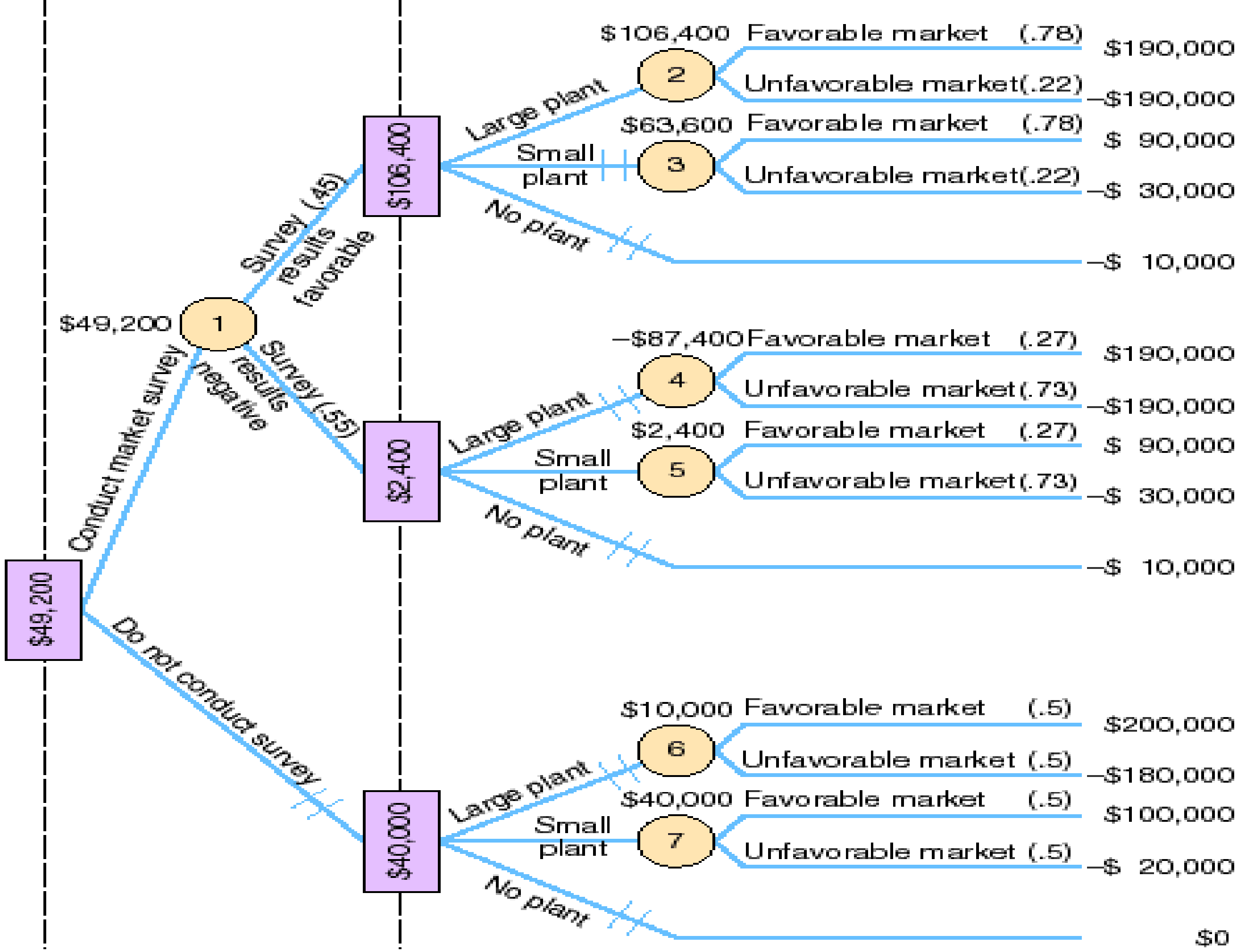
Decision Trees and EMV – *Example 1 – cont.*

- If the market survey is not conducted
  (we already calculated this as our first problem)

EMV(6) = (.5)($200,000) + (.5)(-$180,000) = $10,000
EMV(7) = (.5)($100,000) + (.5)(-$20,000) = $40,000

The EMV for no plant = $0 so, given no survey, build the small plant





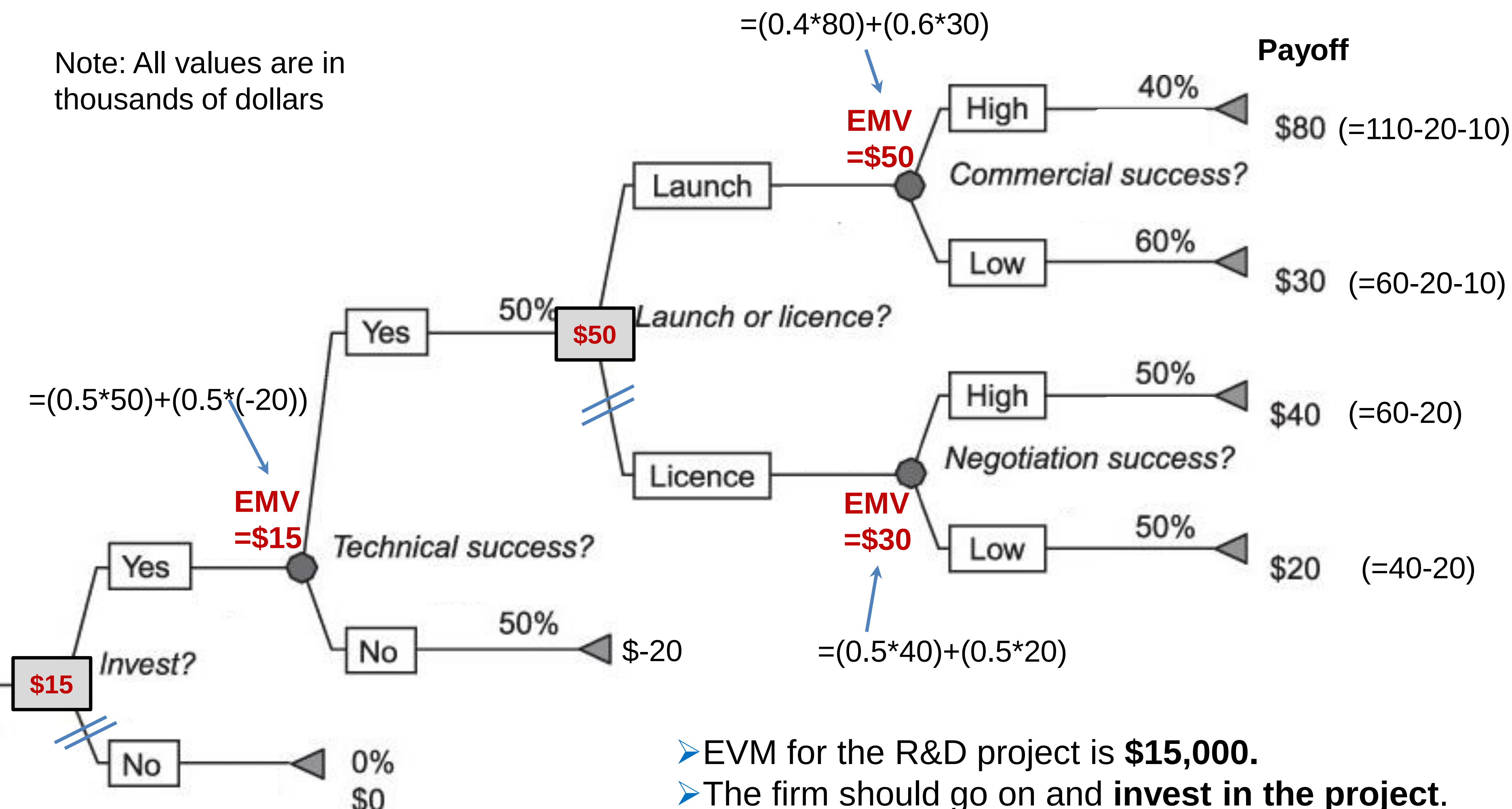
- EVM for the problem is $49,200.
- It Is recommended to conduct the market survey
- If the survey results are favorable, the large plant should be built.
- If the survey results are negative, the small plant should be built.
- If for some reason the market survey is not conducted, the small plant should be built.

Decision Trees and EMV – *Example 4*

- A firm considers an R&D project which requires an initial investment of $20,000. If it invests into this project there is a 50% probability of technical success of the project leading to a product. In case the product is developed the firm can either license the product or launch its own production. The licence negotiation is estimated to have around 50% chances of a high level of success resulting in $60,000 in benefits and 50% chance of a low level of success resulting in $40,000 in benefits. If the firm decides to launch its own production an additional investment of $10,000 would be required. There is a 40% probability of a high level of commercial success leading to $110,000 in benefits, while a low commercial success is estimated to bring only $60,000 in benefits.
- Should the firm invest into this R&D project?
- If it does invest, should it sell the license to some other company or should it launch its own production?
- Draw decision tree and calculate EVM for the project.

Decision Trees and EMV – *Example 4*

Note: All values are in thousands of dollars



- EVM for the R&D project is **$15,000.**
- The firm should go on and **invest in the project**.
- In case of the technical success of the project the firm should **launch its own production.**

Risk Response Planning

- After identifying and quantifying risks, you must decide how to respond to them
- Four main response strategies for **negative risks:**
  - *Risk avoidance*
    - Eliminate a specific threat by eliminating its causes
  - *Risk acceptance*
    - Accept the consequences should a risk event occur
  - *Risk transference*
    - Shift the consequences of a risk and responsibility for its management to a third party (e.g. insurance, warranty)
  - *Risk mitigation*
    - Reduce the impact of a risk event by reducing the probability of its occurrence.

Summary

- Project risk management is the art and science of identifying, analyzing, and responding to risk throughout the life of a project and in the best interests of meeting project objectives
- Main processes include:
  - Plan risk management
  - Identify risks
  - Perform qualitative risk analysis
  - Perform quantitative risk analysis
  - Plan risk responses
  - Monitor and control risks