

Risk and Decision Analytics

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Lecture 3

جامعة الجميع الذكية

تسعى لتكون الكيان الأول الذي يتبنى مبدأ المجتمع التعليمي
التعاوني ويقدم العلم مقابل العمل لتنمية وبناء المجتمعات.

PMG 621
Decision Policy



جامعة الجميع الذكية
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Chapter 1 introduces probability distributions and the expected value concept. We saw that expected value (EV) is the only unbiased predictor and the best single-value estimate for forecasting. Again, EV is the probability-weighted average of all possible outcomes represented in a probability distribution.

With an appropriate choice of a value measure, the expected value becomes a foundation for logical, consistent decisions under uncertainty. An example problem illustrates two tools for calculating expected value: Payoff table & decision tree.

Intuition Is a Poor Method

Because human intuition is typically so poor at processing probabilities and dealing with details, important evaluations under uncertainty will benefit from the decision analysis approach. We all rely daily upon our intuition, and the purpose here is not to replace intuition. Rather, the quantitative methods will bolster our intuition.

Many organizations continue using decision practices that are decades out of date. Partially responsible are misconceptions in project evaluation in many of the textbooks about capital-investment analysis. Most traditional decision criteria do not work well with uncertainty—which is most of the time. As with any discipline, it is important to understand the theory and to apply best practices. I hope this chapter will guide you in crafting or reaffirming a logical decision policy.

Decision Maker's Preferences

Decision analysts customarily refer to a decision maker (DM) when describing the person with this role in the decision-making process. In an organizational context, the DM acts-or at least should act-according to the organization's mission and objective(s). When appropriate, there may be multiple objectives, and typically these are aligned with different stake- holder group interests.

In addition to calculations with probabilities, the decision analysis approach needs a way to measure outcome value. Value is in the context of the organization's objective(s). Preferences are the dimensions of value. They are the DM'S attitudes toward different characteristics of decision problems based upon beliefs and values.

Most decision analysts find it convenient to segregate preferences into three categories: objective(s), time value, and risk attitude. We can deal with each preference separately, providing a more logical and consistent basis for evaluation analysis. We examine these three dimensions of decision policy in the following sections.

Attitude toward Different Objectives

What is the mission? What is the organization's reason for existing?
Creating wealth is the customary purpose of business. The usual driving objective is maximizing the monetary value of the enterprise (or total return to stockholders).

Other considerations that ultimately affect cash flow and enter the evaluation include:

Operating legally

Doing business in socially acceptable ways

- providing a quality product or service

- + creating and protecting jobs
- + contributing to the community
- + recognizing the interests of employees, suppliers, and customers

while not

- + trashing the environment
- + exploiting any group of people

Doing business with countries, companies, and people whom we like.

I cannot overemphasize the importance of being clear about the organization's mission and purpose. This is the basis for valuing the outcomes of decisions. Decision policy should specify how we measure "goodness" or progress toward the organization's objective. For example, providing great customer service is an important theme in many companies. Yet, is this an objective? Since stockholders own the business, most people--certainly most investors-agree that "maximizing share-holder value" is the logical and legitimate objective.

In my opinion, being a good corporate citizen is consistent with optimizing shareholder value. Let's continue with the customer-service example. Poor customer service destroys the brand. Also, excessive customer service would be at the expense of shareholders. Determining the right customer- service level is an optimization problem. Investments in health, safety, and the environment are other examples with a similar solution approach.

Enduring corporations have a core purpose beyond just making money: something to inspire the troops and customers [1]. Where creating monetary wealth is the most important objective, decision policy is often based upon money. At least, money is a convenient measurement unit. A good technique for recognizing nonmonetary considerations in the analysis is to translate them into money equivalents. Otherwise, multi-objective decisions are more difficult, because it is less clear how to measure value.

Attitude toward Time Value

When we measure the outcome in monetary units, the impact of a decision is the effect on the organization's future net cash flow. Most everyone prefers to receive money sooner rather than later. Conversely, we prefer to postpone payment obligations. We call this preference, "time value of money."

Present value (PV) discounting is the generally accepted method to recognize time preference for money. Discounting makes most sense in the context of money, but costs and benefits measured in nonmonetary units can be time-discounted as well.

The customary equation is:

$$PV = \frac{CF}{(1+i)^t} = CF(1+i)^{-t}$$

where

PV = present value at a reference time, typically the effective date of the next decision;

CF = a net cashflow amount, positive or negative, realized at a future time;

t = number of compounding periods. This is the time, usually in years, between the effective, or as-of, date, and when the future cashflow (CF) amount is realized; and

i = the PV discount(ing) rate, usually expressed as a rate per year. This is similar to an annual interest rate, hence the symbol, i.

This equation always works. CF is typically projected and discounted period by period, and t is the time from the as-of date to the middle of the projection period. We call this midperiod discounting. Beware that Microsoft Excel and functions in most other analysis tools typically assume-wrongly for most evaluations-that the t 's should be integers.

The discount rate, i , represents the DM'S attitude toward the time value of money. I recommend that a company choose i such that PV objectively measures increase to company value by doing the project, as viewed from an average stockholder's perspective.

Almost all companies use a fixed PV discount rate, i , in their decision policy. That is, the rate chosen applies to all future periods. However, it is appropriate to use different rates for different years, based on expectations about changing inflation and/or capital market conditions. If the value measure is something other than money, the discount rate rationale is murky. How would you represent time-value for outcomes measured in human lives? Or old growth trees? Analysts usually apply the same formula, though the discount rate reasoning is difficult.

EV PV is the value measure broadly recommended for widely held corporations seeking to maximize monetary value. This measure is so important that it has its own name: expected monetary value (EMV).

Cash flow Analysis Guidelines

PV and net present value (NPV or PV) are generally synonymous. CFs and PVs are usually net-of-investment expenditures, except when calculating a benefit/cost ratio. Many people involved with project evaluation make serious errors in PV calculations. Here are several guidelines for proper discounted cash flow (DCF) analysis.

Design the CF projection to be cash receipts net of investment and cash costs. We want to forecast the incremental CF effect on the company from doing the project (or whatever alternative is being considered). Often, we compare doing a project against a "do-nothing" or "current plan" alternative, set to zero value for reference. Be careful that overhead costs are legitimately incremental.

Set the PV discount rate to the company's marginal, after-tax cost of capital. This is necessary for objectively measuring incremental company value. A firm's chief financial officer should be able to provide this rate. Be careful that the discount rate does not include a build-up for project risk! Analysts often assume a risk premium in the discount rate, and this results in double risking when probabilities are applied. In decision analysis, we handle risks explicitly and separately with probabilities. ~Also, ensure that the discount rate is consistent with whether or not the forecast model incorporates inflation. In most cases, including financing is unnecessary because of the typical cost of capital reference for determining the discount rate.

Be careful about timing. Discount CFs to a single date, usually the next decision or investment point. Be sure your calculation tool properly recognizes the timing of CFs. Midperiod discounting is the most widely accepted timing approach, where a period's entire CF amount is assumed realized at the center of the respective forecast period.

Ignore sunk costs. Previous investment expenses or other prior CFs should be ignored for analyzing for today's decision. Do a "point-forward analysis." Recognize prior investments only when those amounts are part of future net CF calculations, such as the effects of contract terms and taxes.

(1) نموذج فترة الاسترداد البسيطة

Pay Back Period (PBP)

ويطلق عليه البعض اسم نموذج نقطة التعادل Break Even Model، وعن طريق هذا النموذج يتم احتساب الفترة الزمنية اللازمة لاسترداد مبلغ الاستثمار الأساسي المدفوع في المشروع، وبعدها يتم اختيار المشروع الذي له أقل فترة استرداد. ويتم حساب فترة الاسترداد باستخدام القانون الرياضي التالي:

$$\text{Pay Back Period} = \frac{\text{Initial Investment}}{\text{Periodic Cash Inflow}} \quad \dots\dots\dots 2 \rightarrow 1$$

حيث:

Pay Back Period : فترة الاسترداد البسيطة.
Initial Investment : مبلغ الاستثمار الأساسي.
Periodic Cash Inflow : التدفقات النقدية الواردة (الإيرادات).

مثال 2-2:

يبلغ الاستثمار الأساسي في أحد المشاريع 100 ألف دولار، ويتوقع له أن يحقق دفعات نقدية سنوية بقيمة 25 ألف دولار. احسب فترة الاسترداد البسيطة لهذا المشروع

(1) نموذج فترة الاسترداد البسيطة

Pay Back Period (PBP)

$$\text{Pay Back Period} = \frac{\text{Initial Investment}}{\text{Periodic Cash Inflow}}$$
$$= \frac{100}{25} = 4 \text{ years}$$

الجواب: فترة الاسترداد البسيطة للمشروع هي 4 سنوات.

خصائص (إيجابيات وسلبيات) نموذج فترة الاسترداد البسيطة:

- نموذج بسيط وسهل وشائع الاستخدام.
- نموذج يفترض أن التدفقات النقدية الواردة (CIF) معلومة.
- نموذج يفترض أن التدفقات النقدية الواردة (CIF) سوف تستمر لحين استرداد مبلغ الاستثمار الأساسي المدفوع.
- نموذج يتجاهل الدفعات النقدية الواردة (CIF) بعد فترة الاسترداد.
- نموذج يتجاهل الدفعات النقدية الخارجة (المبالغ المدفوعة) (COF) بعد دفع مبلغ الاستثمار الأساسي.
- نموذج يتجاهل القيمة الزمنية للنقود Time Value of Money.

(2) نموذج فترة الاسترداد بسعر الخصم

Discounted Pay Back Period

ويعالج هذا النموذج واحدة من أهم عيوب النموذج السابق، وذلك بأخذه للقيمة الزمنية للنقود بعين الاعتبار، عن طريق حساب قيمتها الحالية بإخضاعها لسعر الخصم، وذلك بإتباع الخطوات التالية:

• يتم حساب القيمة الحالية (PV) Present Value للتدفقات النقدية المستقبلية (FV) Future Value بحسوبة على أساس سعر الخصم (r) و بعدد فترات (n) وذلك باستخدام القانون الرياضي التالي:

$$PV = \frac{FV}{(1+r)^n} = FV \times \left[\frac{1}{(1+r)^n} \right] \dots\dots\dots 2 \rightarrow 2$$

ولتسهيل حل المعادلة نقوم ابتداء بحساب معامل الخصم Discount Index وهو جزء من المعادلة 2 → 2 ويعتمد على معرفة كل من (r) و (n) ويحسب بالقانون التالي:

$$PVIF_{(r,n)} = \left[\frac{1}{(1+r)^n} \right] \dots\dots\dots 2 \rightarrow 3$$

وعليه يمكن إعادة كتابة المعادلة 2 → 2 بالصيغة التالية:

$$PV = \frac{FV}{(1+r)^n} = FV \times \left[\frac{1}{(1+r)^n} \right] = FV \times PVIF_{(r,n)} \dots\dots\dots 2 \rightarrow 2$$

(2) نموذج فترة الاسترداد بسعر الخصم

Discounted Pay Back Period

ويتم حساب هذا المعامل إما باستخدام الآلة الحاسبة لحل المعادلة 3 → 2 أو عن طريق استخدام الجدول المالي الخاص باستخراج معامل القيمة الحالية للتدفقات النقدية (PVIF) Present Value index بعد تحديد كل من n, r . (الجدول مرفق في نهاية هذا الفصل).

- بعد احتساب معامل الخصم واحتساب القيمة الحالية (PV) للتدفقات النقدية المستقبلية المحسوبة على أساس سعر الخصم يتم استخراج فترة الاسترداد بنفس الطريقة المشروحة بنموذج فترة الاسترداد البسيطة.

مثال 2-3:

بالرجوع لنفس المثال السابق 2-2، حيث الاستثمار الأساسي يساوي 100 ألف دولار والتدفق النقدي السنوي يساوي 25 ألف دولار، ولكن مع الأخذ بعين الاعتبار أن سعر الخصم = 10%. وأن عمر المشروع = 6 سنوات. المطلوب: احسب فترة الاسترداد للمبلغ الأساسي المدفوع؟

الحل:

- نقوم أولاً باحتساب معامل الخصم (PVIF) باستخدام المعادلة 3 → 2 :

$$\text{معامل } PVIF_{(r,n)} = \left[\frac{1}{(1+r)^n} \right]$$

$$\frac{1}{(1+0.1)^1} = \frac{1}{1.1} = 0.909$$

إذن معامل الخصم للسنة الأولى =

(2) نموذج فترة الاسترداد بسعر الخصم

Discounted Pay Back Period

$$\frac{1}{(1+0.1)^2} = \frac{1}{1.21} = 0.826 \quad \text{معامل الخصم للسنة الثانية} =$$

$$\frac{1}{(1+0.1)^3} = \frac{1}{1.331} = 0.751 \quad \text{معامل الخصم للسنة الثالثة} =$$

وهكذا، تجد بقية النتائج في جدول الحل 2-3.

- نقوم ثانياً باحتساب القيمة الحالية للتدفقات النقدية المستقبلية (PV) باستخدام المعادلة 2 → 2 على النحو التالي:

$$PV = FV \times \left[\frac{1}{(1+r)^n} \right] = FV \times PVIF_{(r,n)}$$

وباستخدام هذه المعادلة يكون:

القيمة الحالية (PV) للدفعة النقدية الواردة في نهاية السنة الأولى =

$$25 \times 0.909 = 22.725 \text{ Thousand \$}$$

القيمة الحالية (PV) للدفعة الواردة في نهاية السنة الثانية =

$$25 \times 0.826 = 20.65 \text{ Thousand \$}$$

القيمة الحالية (PV) للدفعة الواردة في نهاية السنة الثالثة =

$$25 \times 0.751 = 18.775 \text{ Thousand \$}$$

وهكذا تجد بقية النتائج في جدول الحل 2-3.

جداول سعر الخصم

Discounted Rate

جدول 2 - 10

معامل القيمة الحالية لدينار واحد عند سعر خصم محدد ولفترة زمنية محددة $PVIF_{r,n}$

%11	%10	%9	%8	%7	%6	%5	%4	%3	%2	%1	$r \downarrow$ $n \downarrow$
0.901	0.909	0.917	0.926	0.935	0.943	0.952	0.962	0.971	0.980	0.990	1
0.812	0.826	0.842	0.857	0.873	0.890	0.907	0.925	0.943	0.961	0.980	2
0.731	0.751	0.772	0.794	0.816	0.840	0.864	0.889	0.915	0.942	0.971	3
0.659	0.683	0.708	0.735	0.763	0.792	0.823	0.855	0.888	0.924	0.961	4
0.593	0.621	0.650	0.681	0.713	0.747	0.784	0.822	0.863	0.906	0.951	5
0.535	0.564	0.596	0.630	0.666	0.705	0.746	0.790	0.837	0.888	0.942	6
0.482	0.513	0.547	0.583	0.623	0.665	0.711	0.760	0.813	0.871	0.933	7
0.434	0.467	0.502	0.540	0.582	0.627	0.677	0.731	0.789	0.853	0.923	8
0.391	0.424	0.460	0.500	0.544	0.592	0.645	0.703	0.766	0.837	0.914	9
0.352	0.386	0.422	0.463	0.508	0.558	0.614	0.676	0.744	0.820	0.905	10
0.317	0.350	0.388	0.429	0.475	0.527	0.585	0.650	0.722	0.804	0.896	11
0.286	0.319	0.356	0.397	0.444	0.497	0.557	0.625	0.701	0.789	0.887	12
0.258	0.290	0.326	0.368	0.415	0.469	0.530	0.601	0.681	0.773	0.879	13
0.232	0.263	0.299	0.340	0.388	0.442	0.505	0.577	0.661	0.758	0.870	14
0.209	0.239	0.275	0.315	0.362	0.417	0.481	0.555	0.642	0.743	0.861	15
0.188	0.218	0.252	0.292	0.339	0.394	0.458	0.534	0.623	0.728	0.853	16
0.170	0.198	0.231	0.270	0.317	0.371	0.436	0.513	0.605	0.714	0.844	17
0.153	0.180	0.212	0.250	0.296	0.350	0.416	0.494	0.587	0.700	0.836	18
0.138	0.164	0.194	0.232	0.277	0.331	0.396	0.475	0.570	0.686	0.828	19
0.124	0.149	0.178	0.215	0.258	0.312	0.377	0.456	0.554	0.673	0.820	20
0.112	0.135	0.164	0.199	0.242	0.294	0.359	0.439	0.538	0.660	0.811	21
0.101	0.123	0.150	0.184	0.226	0.278	0.342	0.422	0.522	0.647	0.803	22
0.091	0.112	0.138	0.170	0.211	0.262	0.326	0.406	0.507	0.634	0.795	23
0.082	0.102	0.126	0.158	0.197	0.247	0.310	0.390	0.492	0.622	0.788	24
0.074	0.092	0.116	0.146	0.184	0.233	0.295	0.375	0.478	0.610	0.780	25
0.044	0.057	0.075	0.099	0.131	0.174	0.231	0.308	0.412	0.552	0.742	30
0.026	0.036	0.049	0.068	0.094	0.130	0.181	0.253	0.355	0.500	0.706	35
0.009	0.014	0.021	0.031	0.048	0.073	0.111	0.171	0.264	0.410	0.639	45
0.005	0.009	0.013	0.021	0.034	0.054	0.087	0.141	0.228	0.372	0.608	50

(2) نموذج فترة الاسترداد بسعر الخصم

Discounted Pay Back Period

جدول 3-2
حل المثال 3-2

الفترة الزمنية (السنة) n	التدفق النقدي لكل ألف \$ في نهاية السنة (FV) or CIF	سعر الخصم r	معامل الخصم $PVIF_{(r,n)}$	القيمة الحالية للتدفق النقدي السنوي ألف \$ PV	مجموع التدفقات النقدية ألف \$ $\sum_{i=1}^n PV$
1	25	%10	0.909	22.725	22.725
2	25	%10	0.826	20.650	43.375
3	25	%10	0.751	18.775	62.150
4	25	%10	0.683	17.075	79.225
5	25	%10	0.621	15.525	94.750
6	25	%10	0.564	14.100	108.850

يتم حساب باقي مبلغ الاستثمار (دولار 3.72)

- ولحساب فترة الاسترداد بسعر الخصم نقوم بأخذ مجموع التدفقات النقدية التراكمية $\sum_{i=1}^n PV$ حتى نصل إلى قيمة الاستثمار الأساسي وهو 100 ألف دولار، وهذا المبلغ كما هو واضح في الجدول يقع بين السنة الخامسة (المجموع = 94.75 ألف دولار) وبين السنة السادسة (المجموع = 108.85 ألف دولار).
- ولعرفة الفترة الزمنية بالضبط نقوم بطرح التدفق التراكمي $\sum_{i=1}^n PV$ للسنة الخامسة من مبلغ الاستثمار

$$100 - 94.750 = 5.250 \text{ Thousand \$}$$

$$\frac{5.250}{14.100} = 0.372$$

بمعدل فترة استرداد = 5 + 0.372 = 5.372 سنة

لحساب فترة استرداد راس المال من الجدول

(راس المال - مجموع التدفقات النقدية لنفس السنة التي وقف عندها) وتعتبر السنة الخامسة
هنا

تقسيم /

(مجموع التدفقات النقدية للسنة التالية - مجموع التدفقات النقدية لنفس السنة التي وقف عندها)

(2) نموذج فترة الاسترداد بسعر الخصم Discounted Pay Back Period

ثم نقوم بقسمة هذا المبلغ على التدفق المخصص للسنة اللاحقة 14.100 ألف دولار لمعرفة في أي جزء من السنة السادسة يتم استرداد المبلغ بالضبط

$$\frac{5.250}{14.100} = 0.372$$

إذن فترة الاسترداد مع سعر الخصم = 5.372 سنة ويلاحظ هنا أن إخضاع التدفقات النقدية الواردة إلى القيمة الزمنية للنقود أطال من فترة استرداد مبلغ الاستثمار الأساسي.

(3) نموذج صافي القيمة الحالية للتدفقات النقدية المستقبلية Net Present Value (NPV)

وباستخدام هذا النموذج يتم إتباع الخطوات التالية:

- يكون العمر الافتراضي للمشروع (أو الفترة الزمنية التي نرغب في دراستها) معلومة وهي n .
- نقوم باحتساب القيمة الحالية (PV) للتدفقات النقدية المستقبلية بسعر الخصم، تماماً كما ورد في النموذج السابق.
- نقوم بجمع محصلة القيمة الحالية للتدفقات النقدية المستقبلية $\left(\sum_{i=1}^n PV\right)$ لعدد الفترات الزمنية (السنوات) يساوي (n) .

نموذج صافي القيمة الحالية للتدفقات النقدية المستقبلية

Net Present Value (NPV)

- بعدها يتم طرح مبلغ الاستثمار الأساسي من مجموع القيمة الحالية للتدفقات المستقبلية، والناتج يسمى صافي القيمة الحالية (NPV) Net Present Value

$$NPV = \sum_{i=1}^n PV - \text{Initial Investment} \dots\dots\dots 2 \rightarrow 4$$

وتكون النتيجة واحد من ثلاث حالات:

- 1- إما أن تكون NPV سالبة (-)، وهذا يعني أن هذا المشروع سيحقق خسارة بقيمة (NPV) في الفترة الزمنية التي تمت دراستها.
- 2- أو أن تكون NPV تساوي صفراً، وهذا يعني أن المشروع سيحقق نقطة التعادل لهذه الفترة أي لا ربح ولا خسارة.
- 3- أو أن تكون NPV موجبة (+)، وهذا يعني أن المشروع سيحقق ربحاً بقيمة (NPV).

وعليه فإن عملية اختيار المشروع تتم على النحو التالي:

- (+) إذا كان المشروع فردياً، فإننا نقوم باختيار المشروع إذا كانت له NPV موجبة، لأن ذلك يعني أن المشروع سيحقق ربحاً.
- (-) إذا كان اختيار مشروع من بين مجموع مشاريع فإننا نختار المشروع الذي له أعلى NPV، لأنه يكون أكثرها قدرة على تحقيق ربح لنفس الفترة.

نموذج صافي القيمة الحالية للتدفقات النقدية المستقبلية

Net Present Value (NPV)

مثال 2-4:

بالرجوع إلى نفس المثال السابق 2-3، ولنفس الفترة الزمنية ويساوي 6 سنوات، احسب صافي القيمة الحالية للتدفقات النقدية (NPV) وقم بتقرير هل تختار هذا المشروع للتنفيذ أم لا؟

الحل:

1- نقوم باستخراج محصلة القيمة الحالية $\left(\sum_{i=1}^n PV \right)$ ، تماماً كما في المثال السابق 2-3. وبالبالغة لمجموع التدفقات في السنوات الستة = 108.85 ألف دولار.

2- نقوم باحتساب صافي القيمة الحالية للتدفقات النقدية المستقبلية (NPV) وذلك عن طريق طرح مبلغ الاستثمار الأساسي من مجموع القيمة الحالية للتدفقات النقدية المستقبلية $\left(\sum_{i=1}^n PV \right)$

$$NPV = \sum_{i=1}^n PV - \text{Initial Investment}$$

أي مجموع التدفقات

$$NPV = 108.85 - 100 = \boxed{8.85 \text{ Thousand \$}} \rightarrow (+)$$

✓ يعني مربح. ∴ المشروع يعتبر ناجح

إذن NPV تساوي 8.85 ألف دولار.

القرار: نعم يتم اختيار هذا المشروع للتنفيذ، وذلك لأن قيمة NPV موجبة، وتساوي 8.85 ألف دولار وهذا يعني أنه مشروع مربح.

Attitude toward Risk

Risk attitude, or risk preference, is a fascinating aspect of decision analysis. Unaided intuition, for most people, leads us to make inconsistent tradeoffs between value and risk. That is, most people, unknowingly, make choices that are inconsistent with their long-term objectives. We do better in project evaluations, decisions, and negotiations by understanding the concept of risk preference. This is the purpose of risk policy.

The uninitiated typically exhibit excessive conservatism. For example, consider the manager of a large project who foregoes a chance to invest \$1 million to gain a 50 percent chance at saving \$10 million in project PV cost. That is, there are equal chances between a \$1 million loss and a \$9 million PVnet gain. This behavior may seem rational if the manager or project has a modest budget.

"Risk \$1 million with a 90 percent chance of failure?!" A more proper perspective, however, is to consider decision outcomes relative to the size of the entire organization's capital. For the example, the EMV for this decision is:

$$\begin{aligned}\text{EMV} &= -\$1 \text{ million} + [.5 (\$10 \text{ million}) + .5 (\$0)] \\ &= .5 (-\$1 \text{ million}) + .5 (+\$9 \text{ million}) \\ &= \$4 \text{ million.}\end{aligned}$$

For our example, a risk-neutral decision maker would be indifferent between having \$4 million cash in hand or having this project opportunity. Risk-neutral means being objective about money; that is, the scale of the outcomes does not matter. This means being an EMV decision maker. The EMV decision criterion is widely used in decision analysis, either as a decision criterion by itself or as a reference to the "objective" value.

How much risk aversion is appropriate for a corporation? The ideal perspective, though perhaps impractical, is to compare the possible project outcomes to the collective net worth of the stockholders. For the second term, one approach is to assess a typical stockholder's net worth and multiply this times the number of stockholders. Very risky projects would have little effect on individual investors. For large, widely held companies, a nearly risk-neutral decision policy is perhaps best. Even for conservative individuals, most persons should be nearly risk-neutral for modest day decisions.

Upon realizing the implications of conservative selections, most people begin to make future decisions more objectively. An investment like the earlier example will reduce the project's cost by \$4 million on average. This is clearly a good decision in a portfolio of many similarly sized decisions. When the project's value-or, better, the company's value-is large in comparison to the outcomes of a particular decision, the project manager generally will be better off using a neutral attitude toward risk when evaluating alternatives.

However, if one does want to have a conservative risk policy as a part of the decision policy, there is a straightforward way to do this. We determine a utility function, unique to the DM or organization, that relates "value" (i.e., utility) to wealth. It defines how the DM feels about money. This function also portrays a DM'S risk policy. The utility function transformation provides a guide in how to make tradeoffs between objective value and risk.

In calculations, we translate outcome value (usually PV) into utility units. The usual methods apply for calculating expected (value) utility. Then, the expected utility decision rule is to choose the alternative with the highest expected utility (EU). The next chapter details this topic.

Decision Policy Summary

Consistent decisions in an organization require a clear decision policy. Setting the guideline is straightforward, yet most organizations fail to do this. The result is sub-optimal decision making across the organization. Some parts of the organization are rejecting opportunities that would be approved elsewhere.

Most companies use DCF analysis for project evaluations. Dollars or other currency units measure value. PV discounting reflects attitude about the time value of money. If desired, a utility function expresses a conservative risk policy. Many people may have never seen or heard of the technique. Instead, they subjectively make tradeoffs between risk and value. And, typically, people do this poorly. Fortunately, adjusting for risk aversion is not important for most decisions. If the outcomes are small in comparison to project value, then risk aversion should have little effect on decision making. For most purposes, EMV adequately measures value.

Crane Size Decision

The problem-solving approach in this example is typical, and illustrates use of the EMV decision rule. In this example, the decision is what Sue Crane to order for a specific task. We will solve this using two different presentation and calculation methods: a payoff table and a decision tree.

The project manager is planning Activity 15, which requires use of a crane. Table 3.1 shows the crane-use alternatives and possible outcomes, valued in activity Completion Days. A Medium Crane and a Large Crane are available by rental. The medium-sized crane is adequate in performing Activity 15. A large crane, however, would accomplish the activity faster.

The decision pending is: Which Size Crane is the best alternative? If the project goes according to the baseline plan, Activity 15 is not on the metical path ("not critical") and does not delay the overall completion time. (Critical path is discussed in Chapter 9 and Chapter 14.) A conventional project analysis sees no benefit of greater crane capacity on the project completion time. In fact, the Large Crane is inferior because of its higher cost.

However, a stochastic (probabilistic) project model shows the potential for Activity 15 (A15) to be on the experienced critical path. Suppose that the probability that A15 will be critical is .30 (30 percent, the criticality index) with the Medium Crane. That is, there is a .70 chance that A15 will not be critical. Table 3.1 represents best judgments about completion days, regardless of whether A15 is critical.

Time to Complete	Medium Crane		Large Crane	
	Probability	Days	Probability	Days
Quick	0.3	16	0.3	12
Average	0.5	18	0.5	14
Slow	0.2	23	0.2	18

Table: 3.1 Delay Days Given Activity 15 Are Critical

Table 3.2: Payoff Table for Crane Size Selection

Scenario		Medium Crane		Large Crane	
Time to Complete	Probability	Total Cost	Probability $\times$ Cost	Total Cost	Probability $\times$ Cost
Not Critical and Quick	$.7 \times .3$	\$34.0	\$7.14	\$39.0	\$8.19
Not Critical and Average	$.7 \times .5$	\$37.0	\$12.95	\$43.0	\$15.05
Not Critical and Slow	$.7 \times .2$	\$44.5	\$6.23	\$51.0	\$7.14
Critical and Quick	$.3 \times .3$	\$306.0	\$27.54	\$243.0	\$21.87
Critical and Average	$.3 \times .5$	\$343.0	\$78.99	\$281.0	\$42.15
Critical and Slow	$.3 \times .2$	\$435.5	\$26.13	\$357.0	\$21.42
Expected Value Cost			\$131.44		115.82

Amounts are in \$thousands

- Payoff tables are sometimes an excellent way to present a simple decision situation. Most people use computer spreadsheets for the layout and calculations.

Decision Trees

Decision tree analysis is a standard calculation method in decision analysis. Decision trees can accommodate more complex problems than payoff tables. Trees are often non-symmetric and have subsequent decision points, which are difficult features to represent in a table. The tree diagram is the decision model and serves as a template for calculating expected values. Decision trees are flexible in expressing the logic of a complex decision. Chapter 5 and Chapter 6 feature decision tree analysis. Squares represent decision points, and circles represent chance events.

Figure 3.2 shows a decision tree analysis for the Crane Size problem. We can solve small problems easily without special software. Decision trees can quickly become enormous (hundreds or thousands of branches), and decision tree software is immensely helpful. An example decision tree program is DATA (Decision Analysis by TreeAge), and Figure 3.3 is a screen showing the solved tree.

Costs in \$thousands (\$k)

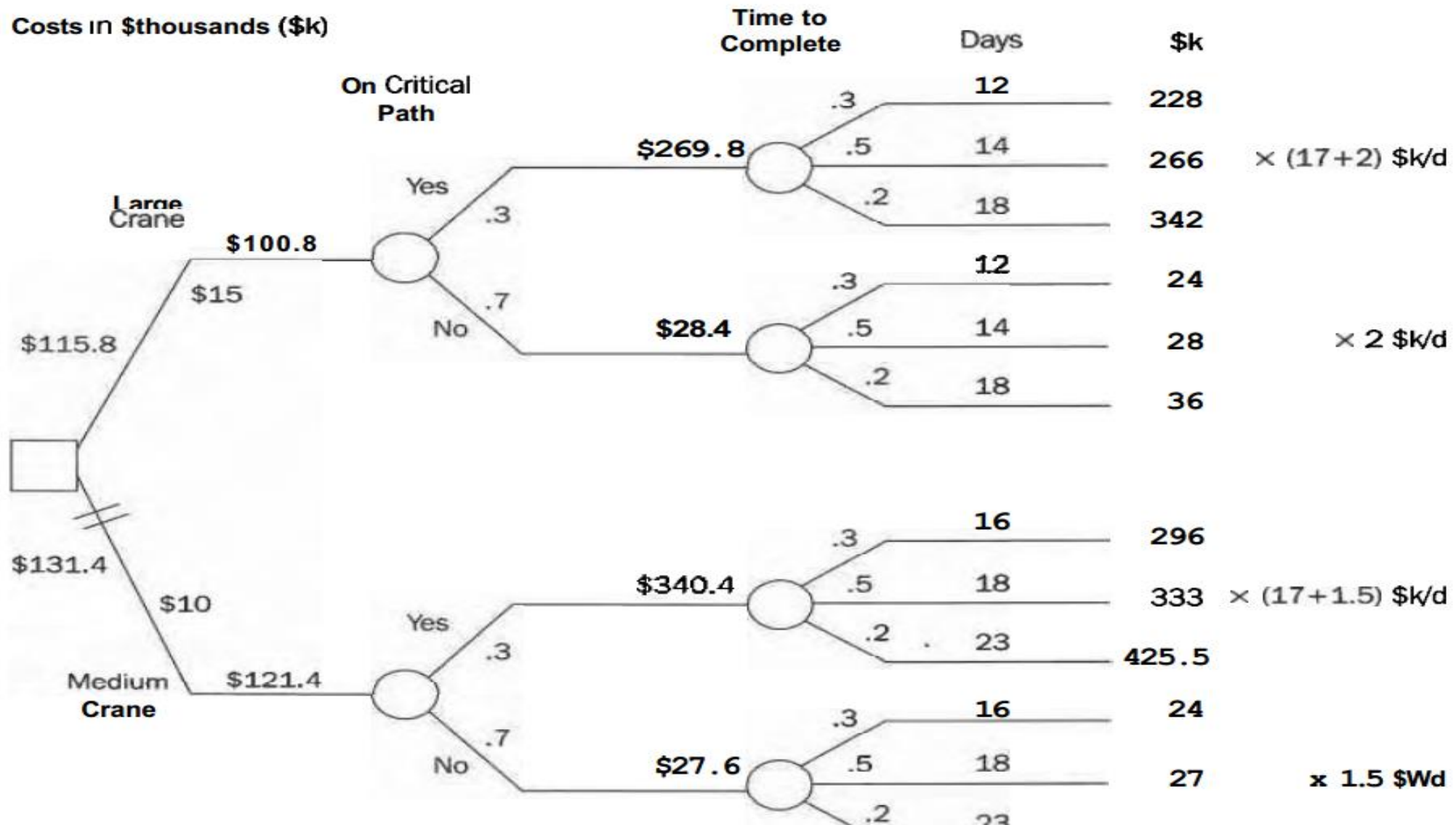


Figure 3.2 decision tree analysis

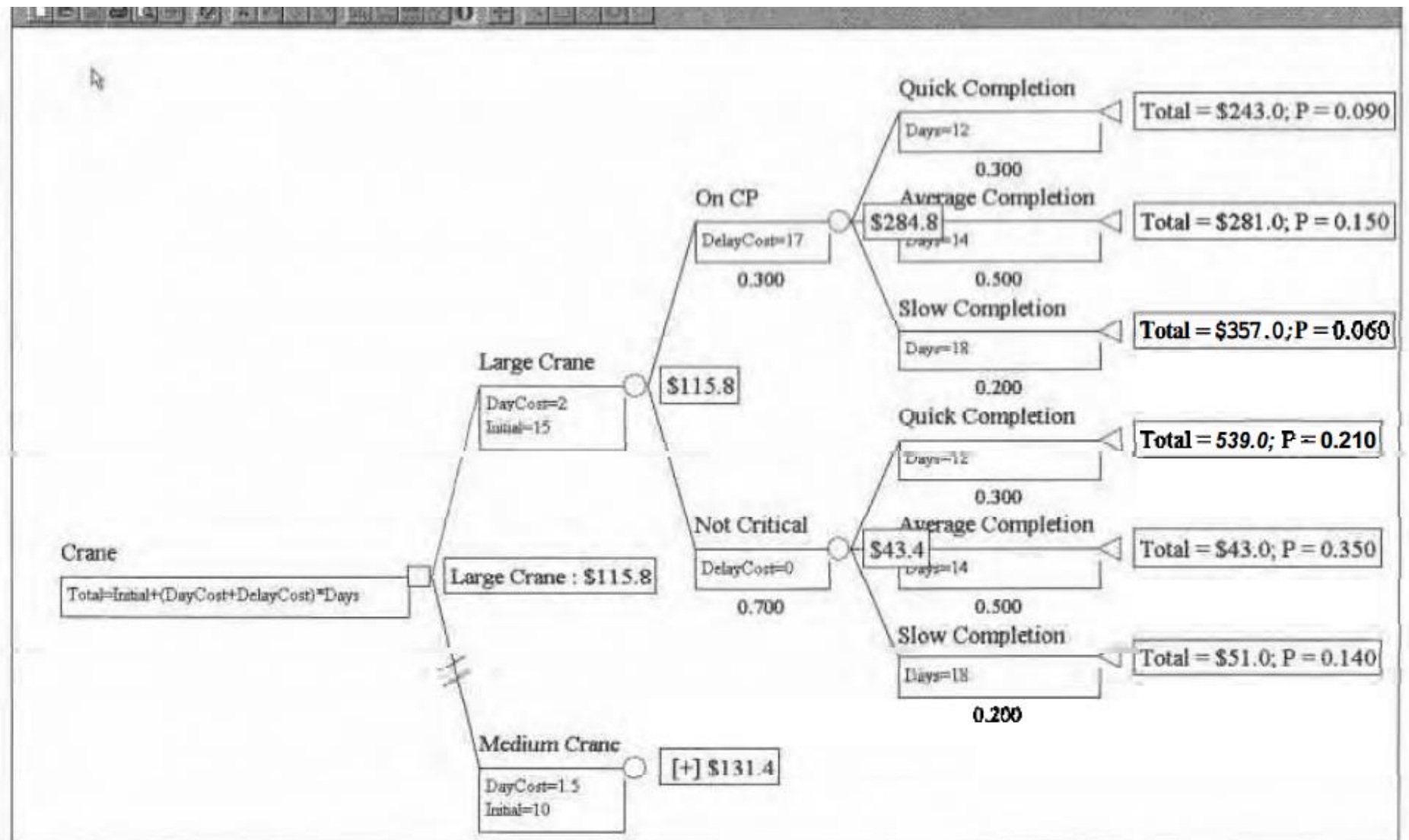


Figure 3.3

Decision Tree Solution with DATA

Methods Summary

We have now seen two decision model formats: a payoff table and a decision tree. The payoff table works adequately in simple decision models involving a single decision point, several alternatives, and several discrete outcomes. Usually, the chance events in these tables apply symmetrically to every alternative. Decision trees are better able to represent sequences of chance events and subsequent decision points. A problem's structure is often different for each alternative, and decision trees handle this easily.

Recourse:

RISK and DECISION ANALYSIS in Projects

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Chapter 3