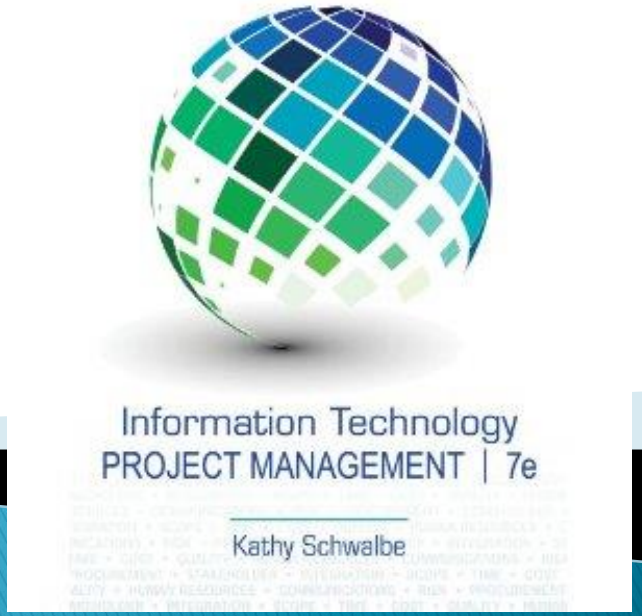
Chapter 7: Project Cost Management

Information Technology Project Management, Seventh Edition



Note: See the text itself for full citations.

The Importance of Project Cost Management

- IT projects have a poor track record for meeting budget goals
- The CHAOS studies found the average cost **overrun** (the additional percentage or dollar amount by which actual costs exceed estimates) ranged from 180 percent in 1994 to 43 percent in 2010
- A 2011 Harvard Business Review study reported an average cost overrun of 27 percent. The most important finding was the discovery of a large number of gigantic overages or “black swans”

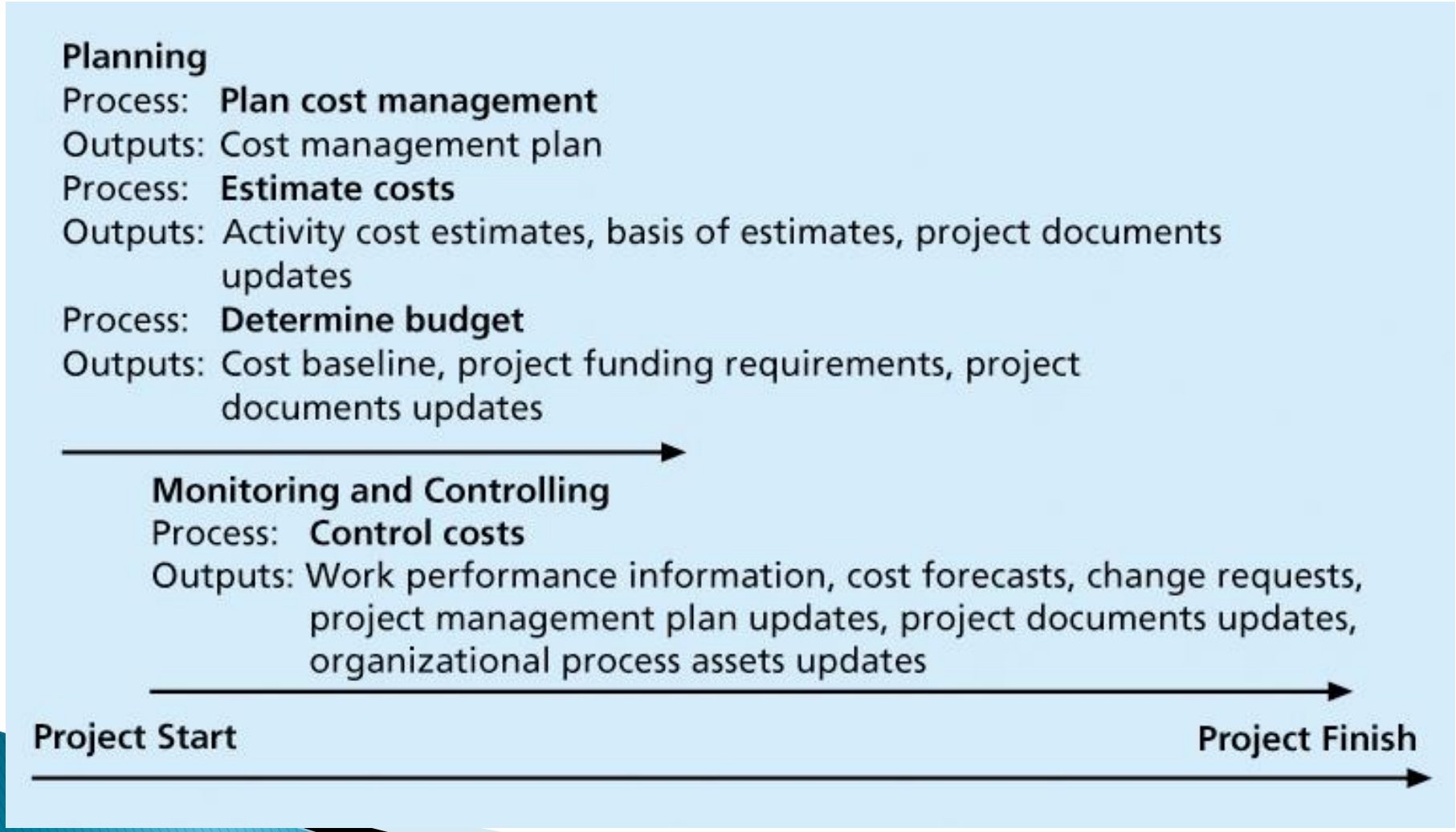
What is Cost and Project Cost Management?

- **Cost** is a resource sacrificed or foregone to achieve a specific objective or something given up in exchange
- Costs are usually measured in monetary units like dollars
- **Project cost management** includes the processes required to ensure that the project is completed within an approved budget

Project Cost Management Processes

- **Planning cost management** :determining the policies, procedures, and documentation that will be used for planning, executing, and controlling project cost.
- **Estimating costs:** developing an approximation or estimate of the costs of the resources needed to complete a project
- **Determining the budget:** allocating the overall cost estimate to individual work items to establish a baseline for measuring performance
- **Controlling costs:** controlling changes to the project budget

Figure 7-1. Project Cost Management Summary



Basic Principles of Cost Management

- Most members of an executive board better understand and are more interested in financial terms than IT terms , so IT project managers must speak their language
  - **Profits** are revenues minus expenditures
  - **Profit margin** is the ratio of revenues to profits
  - **Life cycle costing** considers the total cost of ownership, or development plus support costs, for a project
  - **Cash flow analysis** determines the estimated annual costs and benefits for a project and the resulting annual cash flow

Table 7-1. Cost of Downtime for IT Applications

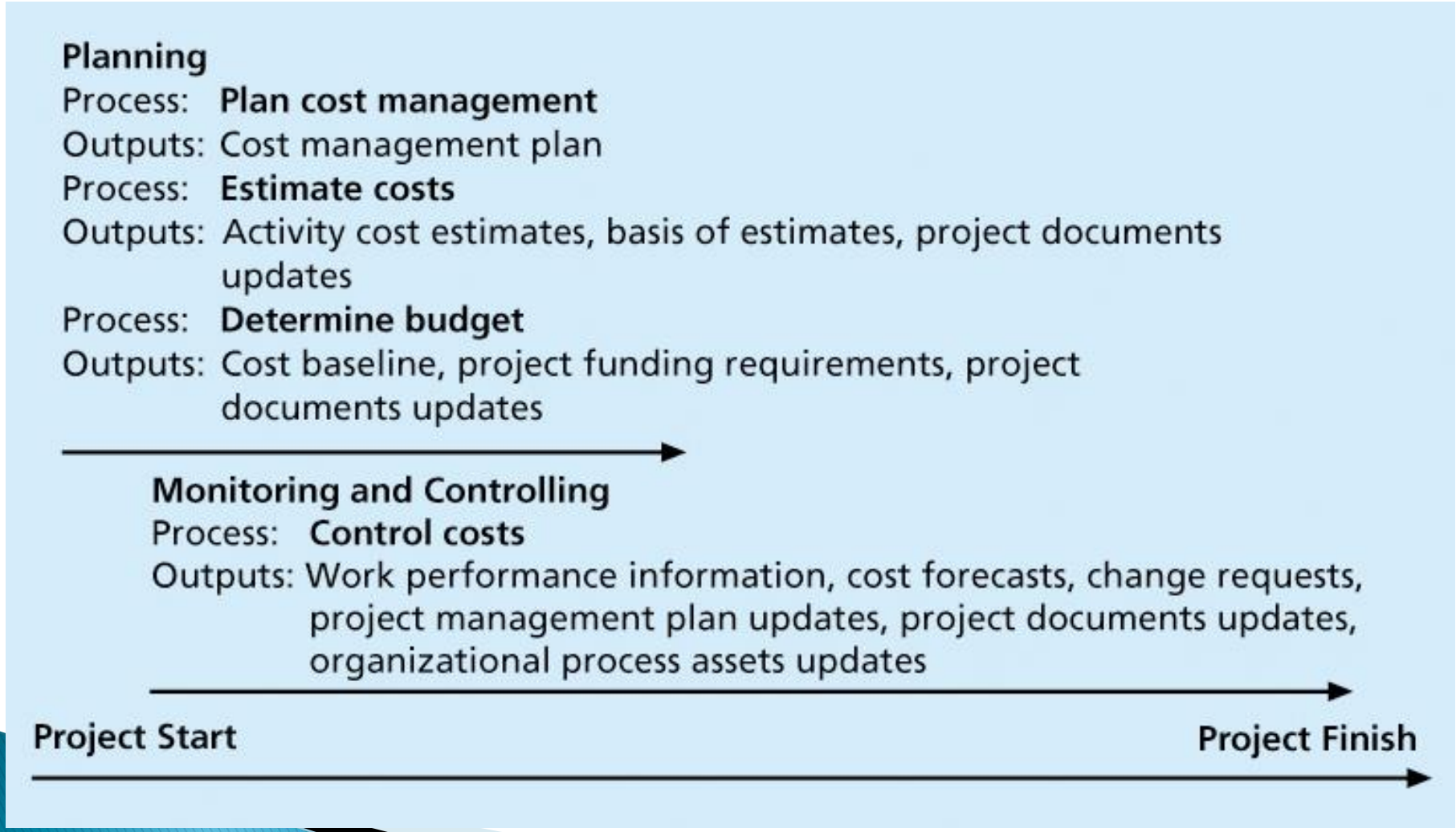
Type of IT Application	Cost/Minute
Securities trading	$73,000
Enterprise Requirements Planning (ERP)	$14,800
Order processing	$13,300
Electronic commerce	$12,600
Supply chain	$11,500
Point of sale (POS)	$ 4,700
Automatic teller machine (ATM)	$ 3,600
E-mail	$ 1,900

Source: The Standish Group International, “Trends in IT Value,” www.standishgroup.com (2008).

Types of Costs and Benefits

- **Tangible costs** or **benefits** are those costs or benefits that an organization can easily measure in dollars
- **Intangible costs** or **benefits** are costs or benefits that are difficult to measure in monetary terms
- **Direct costs** are costs that can be directly related to producing the products and services of the project
- **Indirect costs** are costs that are not directly related to the products or services of the project, but are indirectly related to performing the project
- **Sunk cost** is money that has been spent in the past; when deciding what projects to invest in or continue, you should *not* include sunk costs

Figure 7-1. Project Cost Management Summary



Planning Cost Management

- The project team uses expert judgment, analytical techniques, and meetings to develop the cost management plan
- A cost management plan includes:
  - Level of accuracy and units of measure
  - Organizational procedure links
  - Control thresholds
  - Rules of performance measurement
  - Reporting formats
  - Process descriptions

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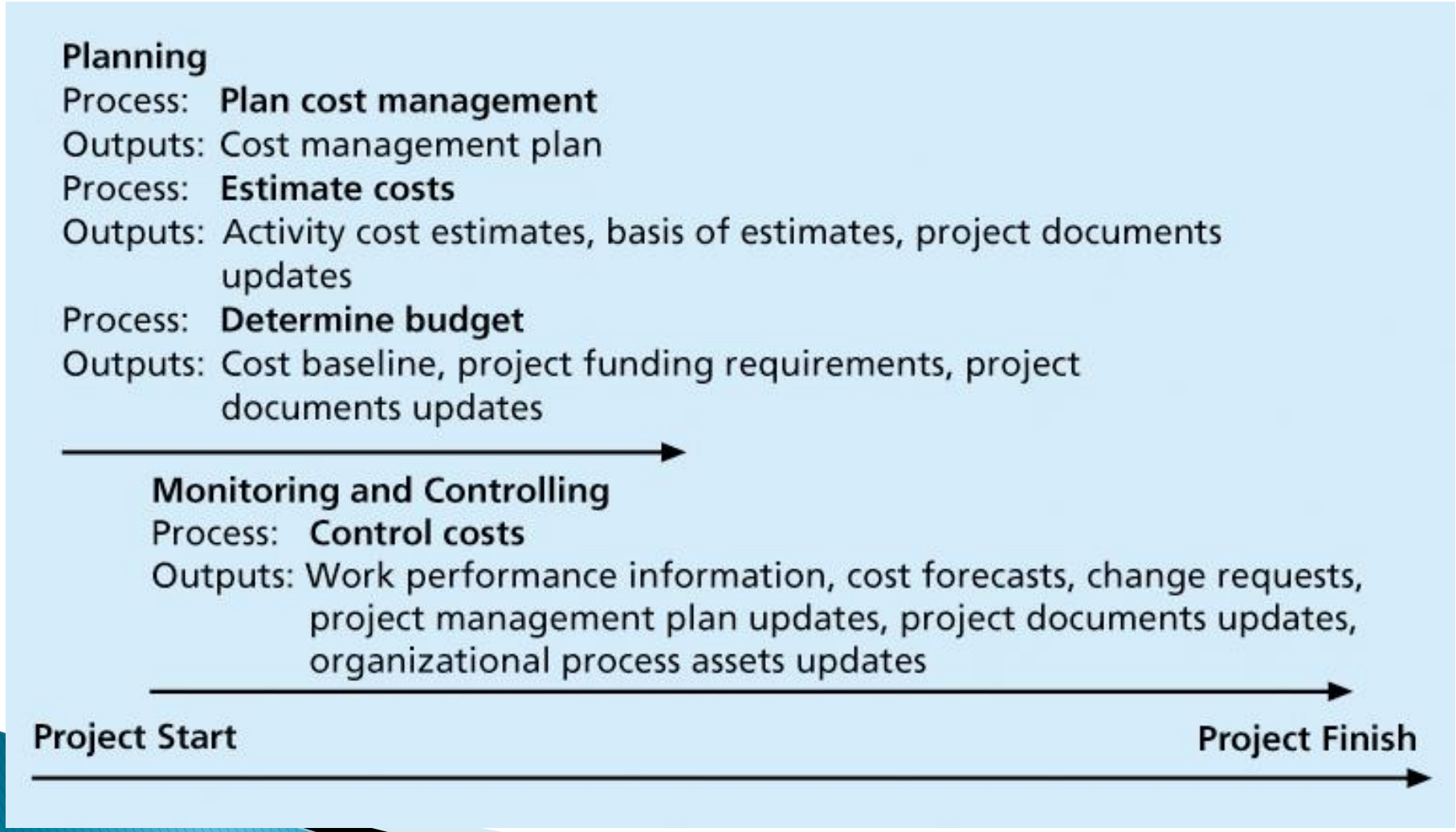


Estimating Costs

- Project managers must take cost estimates seriously if they want to complete projects within budget constraints
- It's important to know the types of cost estimates, how to prepare cost estimates, and typical problems associated with IT cost estimates

Table 7-2. Types of Cost Estimates

Type of Estimate	When Done	Why Done	How Accurate
Rough Order of Magnitude (ROM)	Very early in the project life cycle, often 3–5 years before project completion	Provides estimate of cost for selection decisions	–50% to +100%
Budgetary	Early, 1–2 years out	Puts dollars in the budget plans	–10% to +25%
Definitive	Later in the project, less than 1 year out	Provides details for purchases, estimates actual costs	–5% to +10%

More on Cost Estimates

- The number and type of cost estimates vary by application area.
  - The Association for the Advancement of Cost Engineering International identifies five types of cost estimates for construction projects:
    - order of magnitude, conceptual, preliminary, definitive, and control
- Estimates are usually done at various stages of a project and should become more accurate as time progresses
- A large percentage of total project costs are often labor costs

Table 7-3. Maximum FTE by Department by Year

Department	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Information systems	24	31	35	13	13	116
Marketing systems	3	3	3	3	3	15
Reservations	12	29	33	9	7	90
Contractors	2	3	1	0	0	6
Totals	41	66	72	25	23	227

Cost Estimation Tools and Techniques

- Basic tools and techniques for cost estimates:
  - **Analogous** or **top-down estimates:** use the actual cost of a previous, similar project as the basis for estimating the cost of the current project
  - **Bottom-up estimates:** involve estimating individual work items or activities and summing them to get a project total
  - **Parametric modeling** uses project characteristics (parameters) in a mathematical model to estimate project costs

Typical Problems with IT Cost Estimates

- Estimates are done too quickly
- People lack estimating experience
- Human beings are biased toward underestimation
- Management desires accuracy

Sample Cost Estimate

- See pages 284-289 for a detailed example of creating a cost estimate for the Surveyor Pro project described in the opening case
- Before creating an estimate, know what it will be used for, gather as much information as possible, and clarify the ground rules and assumptions for the estimate
- If possible, estimate costs by major WBS categories
- Create a cost model to make it easy to make changes to and document the estimate

Figure 7-2. Surveyor Pro Project Cost Estimate

Surveyor Pro Project Cost Estimate Created October 5

	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	WBS Level 2 Totals	% of Total
WBS Items					
1. Project Management				**$306,300**	**20%**
Project manager	960	$100	$96,000		
Project team members	1920	$75	$144,000		
Contractors (10% of software development and testing)			$66,300		
2. Hardware				**$76,000**	**5%**
2.1 Handheld devices	100	$600	$60,000		
2.2 Servers	4	$4,000	$16,000		
3. Software				**$614,000**	**40%**
3.1 Licensed software	100	$200	$20,000		
3.2 Software development*			$594,000		
4. Testing (10% of total hardware and software costs)			$69,000	**$69,000**	**5%**
5. Training and Support				**$202,400**	**13%**
Trainee cost	100	$500	$50,000		
Travel cost	12	$700	$8,400		
Project team members	1920	$75	$144,000		
6. Reserves (20% of total estimate)			$253,540	**$253,540**	**17%**
Total project cost estimate				**$1,521,240**	

*See software development estimate.

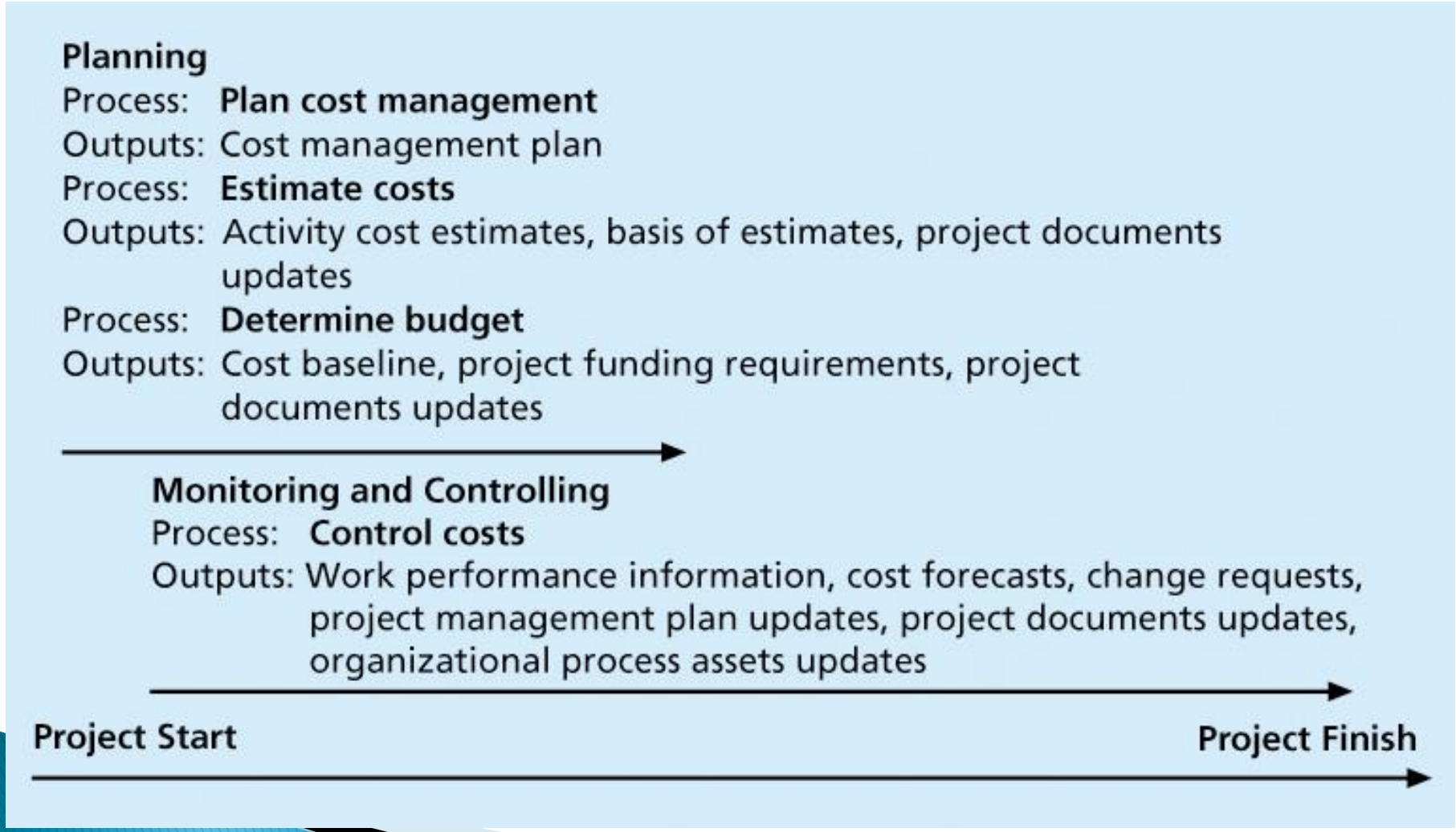
Figure 7-3. Surveyor Pro Software Development Estimate

Surveyor Pro Software Development Estimate Created October 5

1. Labor Estimate	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	Calculations
Contractor labor estimate	3000	$150	$450,000	3000 * 150
Project team member estimate	1920	$75	$144,000	1920 * 75
Total labor estimate			**$594,000**	Sum above two values
2. Function point estimate**	Quantity	Conversion Factor	Function Points	**Calculations**
External inputs	10	4	40	10 * 4
External interface files	3	7	21	3 * 7
External outputs	4	5	20	4 * 5
External queries	6	4	24	6 * 4
Logical internal tables	7	10	70	7 * 10
Total function points			**175**	Sum above function point values
Java 2 languange equivalency value			46	Assumed value from reference
Source lines of code (SLOC) estimate			8,050	175 * 46
Productivity×KSLOC^Penalty (in months)			29.28	3.13 * 8.05^1.072 (see reference)
Total labor hours (160 hours/month)			4,684.65	29.28 * 160
Cost/labor hour ($120/hour)			$120	Assumed value from budget expert
Total function point estimate			**$562,158**	4684.65 * 120

**Approach based on paper by William Roetzheim, "Estimating Software Costs," Cost Xpert Group, Inc. (2003) using the COCOMO II default linear productivity factor (3.13) and penalty factor (1.072).

Figure 7-1. Project Cost Management Summary



Determining the Budget

- Cost budgeting involves allocating the project cost estimate to individual work items over time
- The WBS is a required input to the cost budgeting process since it defines the work items
- Important goal is to produce a **cost baseline**
  - a time-phased budget that project managers use to measure and monitor cost performance

Figure 7-4. Surveyor Pro Project Cost Baseline

Surveyor Pro Project Cost Baseline Created October 10*

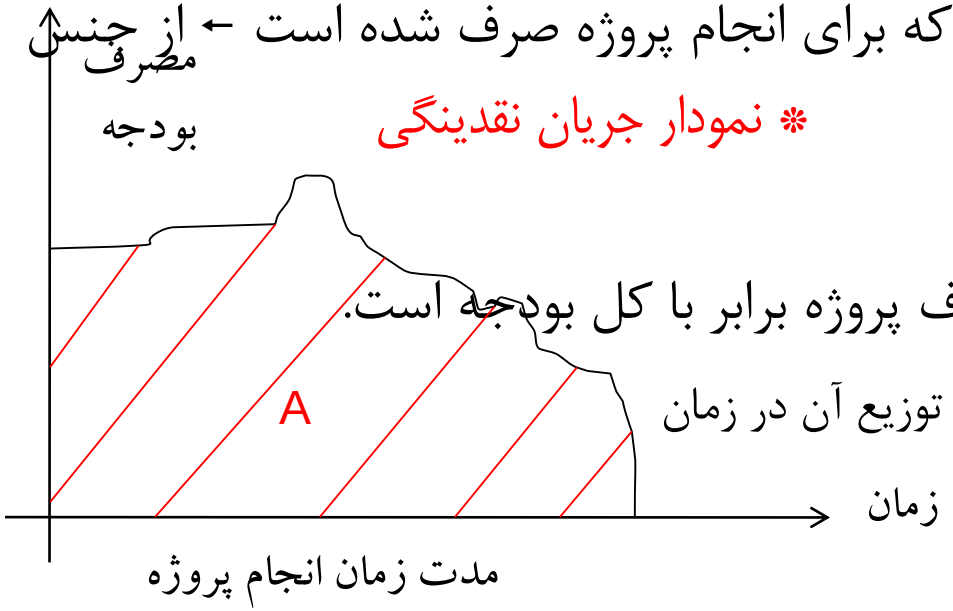
WBS Items	1	2	3	4	5	6	7	8	9	10	11	12	Totals
1. Project Management													
1.1 Project manager	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	96,000
1.2 Project team members	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
1.3 Contractors		6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	66,300
2. Hardware													
2.1 Handheld devices				30,000	30,000								60,000
2.2 Servers				8,000	8,000								16,000
3. Software													
3.1 Licensed software				10,000	10,000								20,000
3.2 Software development		60,000	60,000	80,000	127,000	127,000	90,000	50,000					594,000
4. Testing			6,000	8,000	12,000	15,000	15,000	13,000					69,000
5. Training and Support													
5.1 Trainee cost									50,000				50,000
5.2 Travel cost									8,400				8,400
5.3 Project team members							24,000	24,000	24,000	24,000	24,000	24,000	144,000
6. Reserves				10,000	10,000	30,000	30,000	60,000	40,000	40,000	30,000	3,540	253,540
Totals	20,000	86,027	92,027	172,027	223,027	198,027	185,027	173,027	148,427	90,027	80,027	53,567	1,521,240

*See the lecture slides for this chapter on the companion Web site for a larger view of this and other figures in this chapter. Numbers are rounded, so some totals appear to be off.

تفاوت مفهوم بودجه و هزینه

- بودجه:
  - عبارتست حجم منابع مالی که برای انجام پروژه پیش‌بینی شود ← از جنس پیش‌بینی
- هزینه:
  - عبارتست از حجم منابع مالی که برای انجام پروژه صرف شده است ← از جنس رویداد واقع شده
- نمودار جریان نقدینگی
  - سطح زیر منحنی نمودار مصرف پروژه برابر با کل بودجه است.
  - پیش‌بینی نحوه تقسیم کل بودجه و توزیع آن در زمان

* نمودار جریان نقدینگی



انواع هزینه در پروژه

- بطور کلی در هر پروژه ۲ نوع هزینه وجود دارد:
  - ۱) هزینه‌های ثابت :Fixed costs
    - در تمام طول دورهٔ عمر پروژه نرخشان ثابت است.
    - هزینه تامین جا و مکان دفتر، پرسنل اداری، ملزومات اداری، ...
  - ۲) هزینه‌های متغیر :Variable costs
    - شامل کلیه هزینه مرتبط با انجام فعالیت نظیر دستمزد نیروی انسانی، مواد و ملزومات و ...
    - هزینه‌هایی که با طول مدت زمان تغییر می‌کند.

حالت‌های مختلف مصرف بودجه در فعالیت‌های پروژه

- **مصرف در ابتدای شروع فعالیت**

S ↓_____

  - فرض می‌شود که کل منبع یا بودجه مورد نیاز فعالیت در ابتدای شروع آن مصرف می‌شود.

- **مصرف با نرخ ثابت در طول انجام فعالیت(Portrated)**
  - فرض می‌شود که بودجه یا منبع مورد نیاز فعالیت در طی مدت انجام آن با یک نرخ ثابت معرف می‌شود.
  - اگر فعالیت A، T_A واحد زمانی طول بکشد و B_A واحد بودجه نخواهد در هر واحد زمانی $\frac{B_A}{T_A}$ واحد بودجه مصرف می‌شود.

_____↓ E

- **مصرف در انتهای فعالیت**
  - فرض می‌شود که کل بودجه مورد نیاز فعالیت (یا منبع آن) در انتهای مدت انجام فعالیت مصرف می‌گردد.
  - هر فعالیت متناسب با میزان منابع مورد نیازش نیازش به بودجه دارد. جمع بودجهٔ فعالیتها نمی‌توانند از بودجهٔ کل پروژه بیشتر باشد.

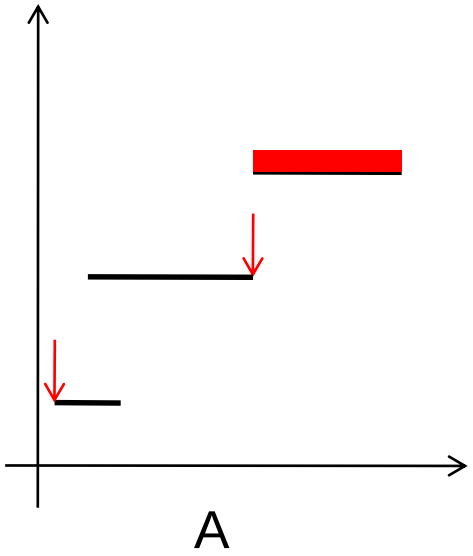
وابستگی نحوه مصرف بودجه در فعالیت به نحوه مصرف منابع

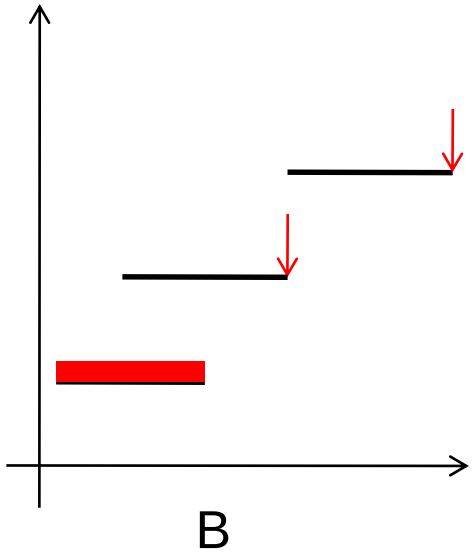
- نکته: عوامل اصلی در تعیین جریان نقدینگی پروژه
  - ۱) نحوه مصرف نقدینگی (بودجه) در هر یک از فعالیت‌ها
  - ۲) زمان‌بندی انجام فعالیت‌ها
  - ۳) مقدار بودجه مورد نیاز برای انجام هر فعالیت
- نکته: در هر فعالیت، نحوه مصرف بودجه به موارد زیر وابسته است
  - ۱) نحوه تامین منابع انسانی ـ نوع بکارگیری منابع انسانی مثلاً: پیمانکار یا نیروی تمام وقت و ...
  - ۲) نحوه تامین منابع تجهیزاتی ـ نوع بکارگیری منابع تجهیزاتی به صورت ساعتی یا پیمانکاری
  - ۳) نحوه تامین مواد و ملزومات(JIT یا Inventory cont.)
    - معمولاً با نرخ ثابت در طول مدت است اما گاهی از ابتدا تهیه شده از بودجه پروژه جدا می‌شود.

امکان ترکیبی شدن نحوه مصرف بودجه در فعالیت

- نکته:
  - در هر پروژه فعالیت‌های مختلف می‌توانند دارای الگوهای متفاوت تامین بودجه باشند.
- نکته:
  - ترکیب‌های متفاوت روش‌های تامین نقدینگی (بودجه) برای فعالیت‌های یک پروژه می‌تواند موجب ایجاد الگوهای متفاوت جریان نقدینگی برای کل پروژه شود.

امکان ترکیبی شدن نحوه مصرف بودجه در فعالیت





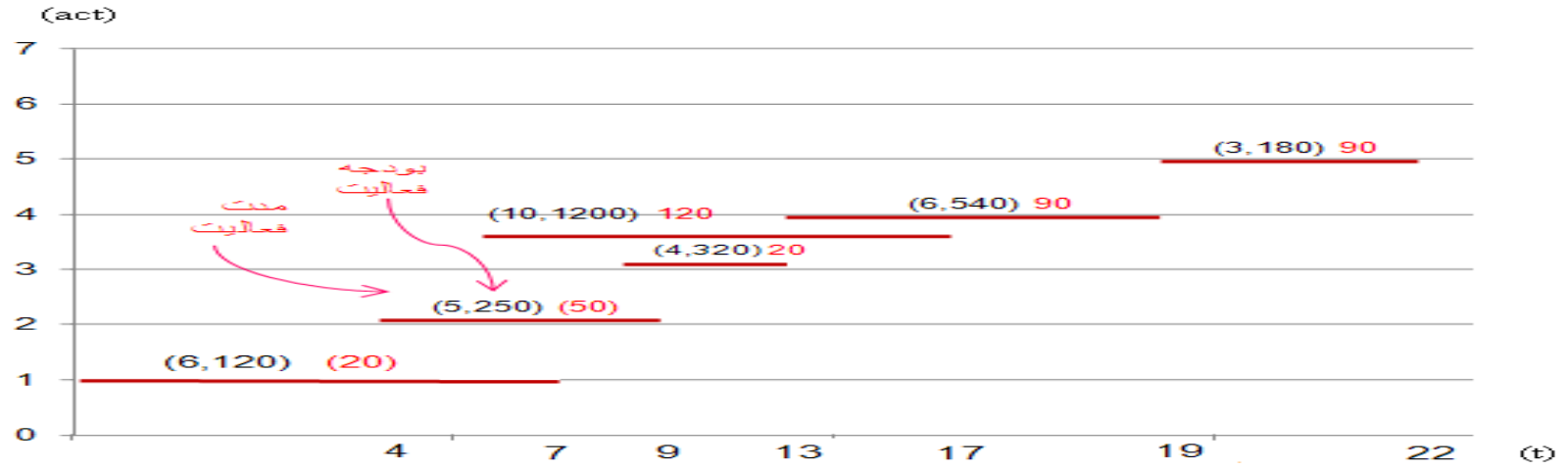
جریان نقدینگی A = جریان نقدینگی B

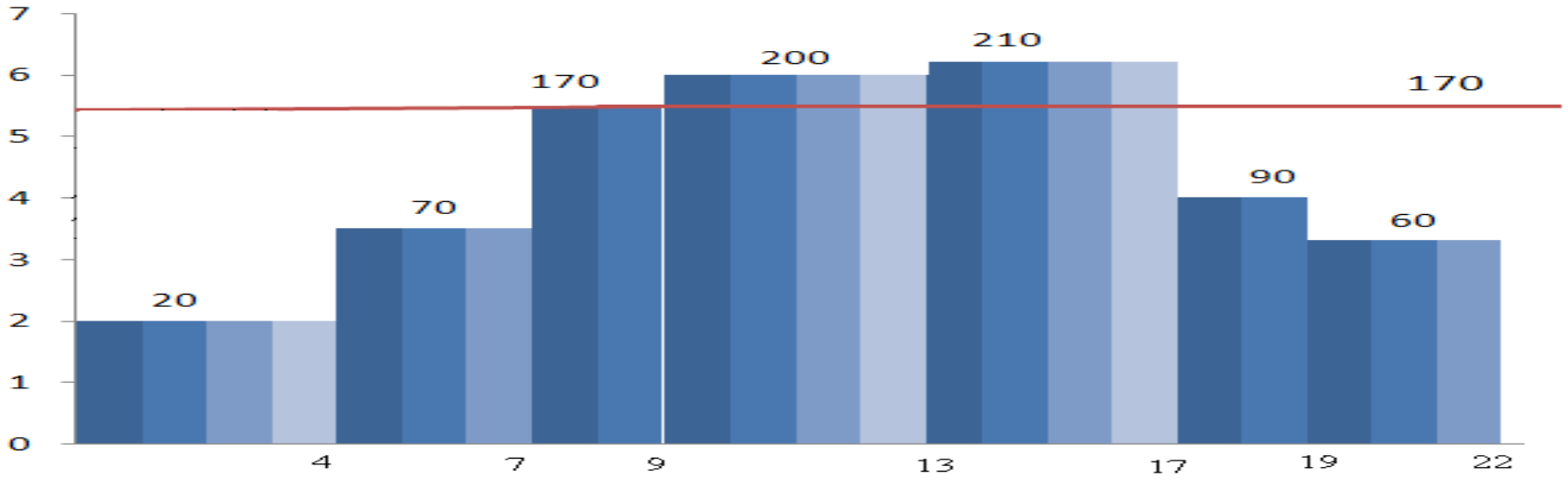
زمانبندی A = زمانبندی B

فرآیند محاسبه جریان نقدینگی پروژه

- فرض:
  - نمودار زمان بندی انجام فعالیت‌ها و مقدار کل بودجه پروژه و کل بودجه مورد نیاز برای هر فعالیت در اختیار می‌باشد.
  - در غیر اینصورت امکان محاسبه وجود ندارد.
- ۱) تعیین الگوی تغذیه بودجه به هر فعالیت پروژه
- ۲) تعیین مقاطع زمانی تغییر حالت در پروژه در طول مدت زمان انجام آن
  - معیار تشخیص تغییر حالت: شروع یا پایان فعالیت پروژه
- ۳) محاسبه مقدار بودجه لازم برای هر فعالیت در هر مقطع زمانی حاصل از مرحله قبل
- ۴) تجمیع مقدار بودجه فعالیت‌های هر مقطع زمانی
- ۵) تصویرسازی بودجه مورد نیاز در هر مقطع زمانی

فرآیند محاسبه جریان نقدینگی پروژه





فرآیند محاسبه جریان نقدینگی پروژه

- **سئوال:**
  - **چنانچه کارفرما اعلام کند که طی مدت زمان انجام پروژه، نمی‌تواند بیش از ۱۶۵ واحد بودجه را تامین نماید، روند انجام پروژه به چه صورت خواهد بود؟**
- **جواب:**
  - در دو مقطع زمانی اول با اضافه بودجه مواجه خواهیم شد.
  - در مقطع سوم سر به سر است.
  - در مقطع ۴ و ۵ با کمبود بودجه رو به رو خواهیم شد، که می‌توان آن را از ذخیره بودجه مقاطع ۱ و ۲ آنرا جبران نمود.
  - چون کمبودها با اضافه بودجه‌های مقاطع قبلی قابل جبران بوده، پس پروژه در زمان پیش‌بینی شده قابل اجرا است.

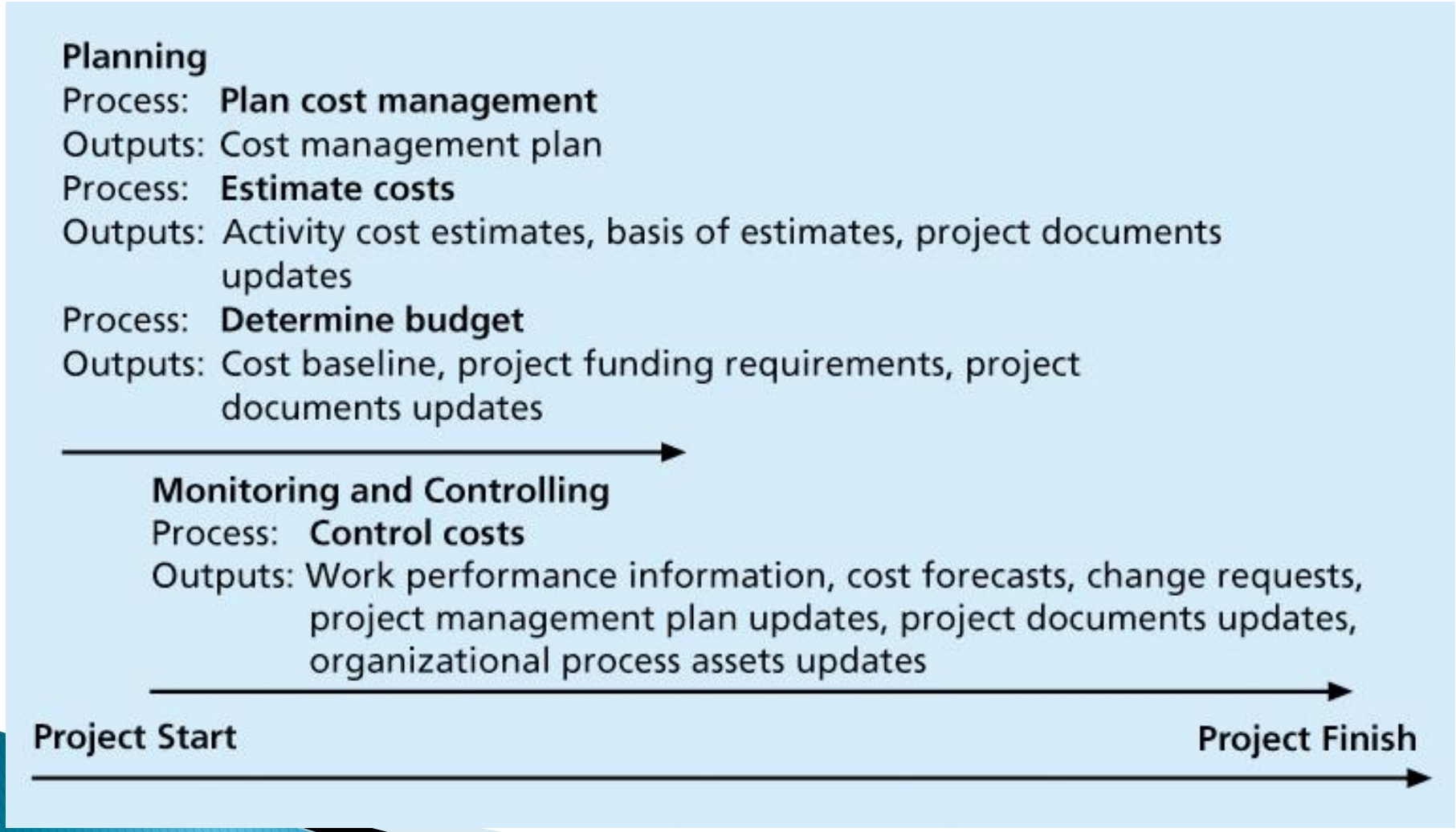
تاثیر تفاوت بین روند نیاز به نقدینگی و تامین بودجه

- **نکته:** چنانچه روند تامین بودجه پروژه با نمودار جریان نقدینگی بدست آمده متفاوت باشد، اضافه بودجه‌ها را در قبل از هر مقطع کمبود بودجه با یکدیگر مقایسه می‌نمائیم.
  - چنانچه جمع کمبودها بودجه کوچکتر از جمع اضافه بودجه‌های مقاطع قبلی باشد، روند تامین بودجه پیش‌بینی شده را می‌توان مبنای کار قرار داد.
  - چنانچه مجموع کمبود بودجه ها بزرگتر از مجموع اضافه بودجه‌های مقاطع قبلی باشد، آنگاه:
    - عمل تسطیح منابع را باید برای فعالیت‌های همزمان در مقاطع کمبود بودجه انجام داد.
    - روند تامین بودجه را تصحیح نمود.

اهمیت جریان نقدینگی در تدوین قرارداد انجام پروژه

- جریان نقدینگی پروژه (محاسبه شده) باید مبنای نحوه و زمان‌های پرداخت از سوی متولی پروژه به مجری پروژه باشد. ← مدیریت پروژه قدرت مانور برای حداکثر انطباق با شرایط کارفرما را براساس نمودار جریان نقدینگی خواهد داشت.
- باید نحوه و زمانهای پرداخت منطبق بر جریان نقدینگی محاسبه شده باشد وگرنه دچار مشکل می‌شویم.
- جریان نقدینگی آنچه است که باید پیش آید تا در پروژه مشکلی پیش نیاید.
- به هر نسبت که تنوع الگوهای مصرف بودجه تغییر کند، نمودار جریان نقدینگی پیچیده‌تر شده و الگوی تغذیه باید متناسب با آن باشد.

Figure 7-1. Project Cost Management Summary



Controlling Costs

- Project cost control includes
  - Monitoring cost performance
  - Ensuring that only appropriate project changes are included in a revised cost baseline
  - Informing project stakeholders of authorized changes to the project that will affect costs
- Many organizations around the globe have problems with cost control

Earned Value Management (EVM)

- **EVM** is a project performance measurement technique that integrates scope, time, and cost data
- Given a **baseline** (original plan plus approved changes), you can determine how well the project is meeting its goals
- You must enter actual information periodically to use EVM
- More and more organizations around the world are using EVM to help control project costs

Earned Value Management Terms

- The **planned value (PV),** formerly called the budgeted cost of work scheduled (BCWS), also called the budget, is that portion of the approved total cost estimate planned to be spent on an activity during a given period
- **Actual cost (AC),** formerly called actual cost of work performed (ACWP), is the total of direct and indirect costs incurred in accomplishing work on an activity during a given period
- The **earned value (EV),** formerly called the budgeted cost of work performed (BCWP), is an estimate of the value of the physical work actually completed
- EV is based on the original planned costs for the project or activity and the rate at which the team is completing work on the project or activity to date

Rate of Performance

- **Rate of performance (RP)** is the ratio of actual work completed to the percentage of work planned to have been completed at any given time during the life of the project or activity
- Brenda Taylor, Senior Project Manager in South Africa, suggests this term and approach for estimating earned value
- For example, suppose the server installation was halfway completed by the end of week 1. The rate of performance would be 50% because by the end of week 1, the planned schedule reflects that the task should be 100 percent complete and only 50 percent of that work has been completed

Table 7-4. Earned Value Calculations for One Activity After Week One

Activity	Week 1
Earned Value (EV)	5,000
Planned Value (PV)	10,000
Actual Cost (AC)	15,000
Cost Variance (CV)	–10,000
Schedule Variance (SV)	–5,000
Cost Performance Index (CPI)	33%
Schedule Performance Index (SPI)	50%

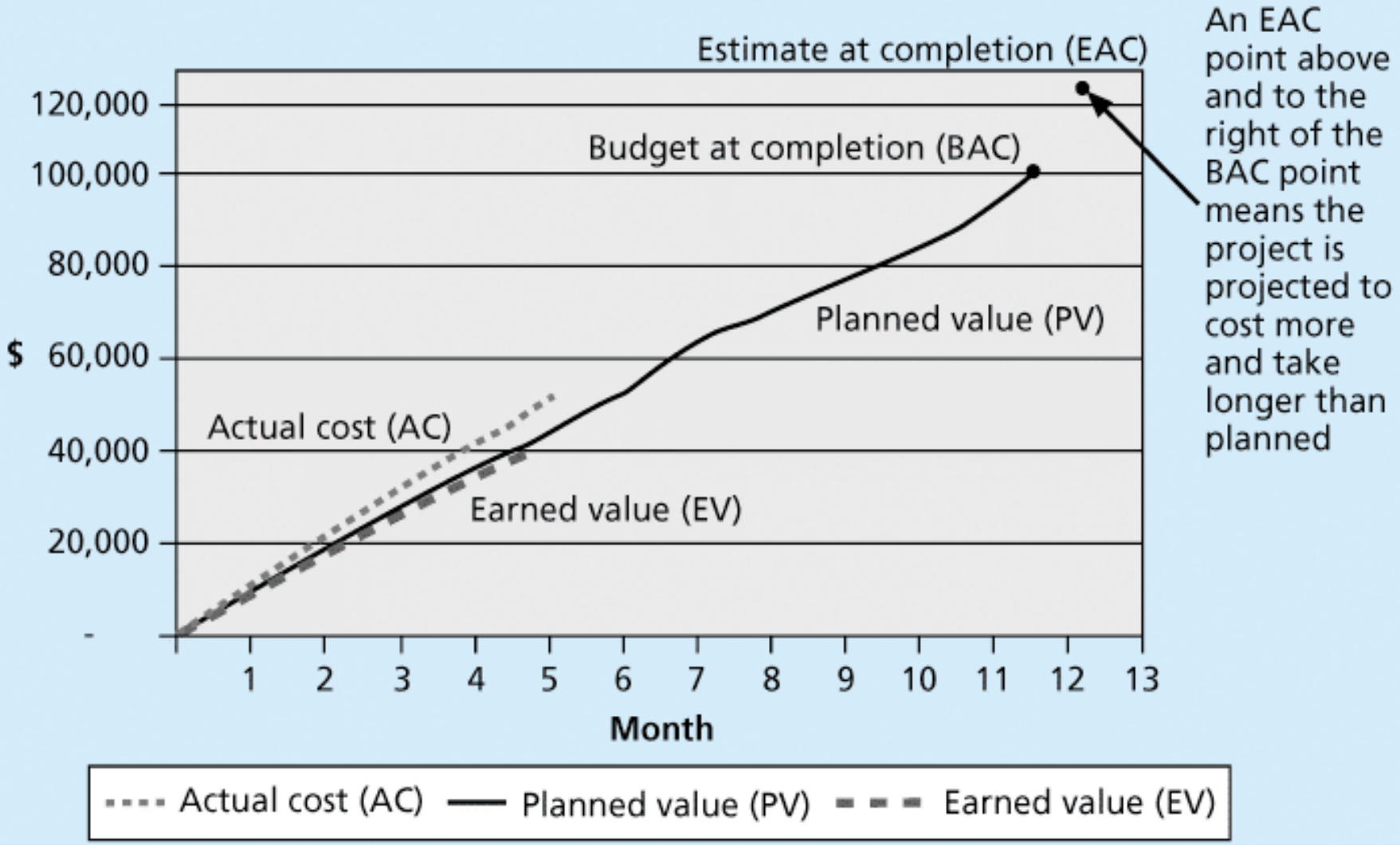
Table 7-5. Earned Value Formulas

Term	Formula
Earned value (EV)	EV = PV to date * RP
Cost variance (CV)	CV = EV – AC
Schedule variance (SV)	SV = EV – PV
Cost performance index (CPI)	CPI = EV/AC
Schedule performance index (SPI)	SPI = EV/PV
Estimate at completion (EAC)	EAC = BAC/CPI
Estimated time to complete	Original time estimate/SPI

Rules of Thumb for Earned Value Numbers

- Negative numbers for cost and schedule variance indicate problems in those areas
- CPI and SPI less than 100% indicate problems
- Problems mean the project is costing more than planned (over budget) or taking longer than planned (behind schedule)
- The CPI can be used to calculate the **estimate at completion** (EAC)—
  - an estimate of what it will cost to complete the project based on performance to date.
  - The **budget at completion** (BAC) is the original total budget for the project

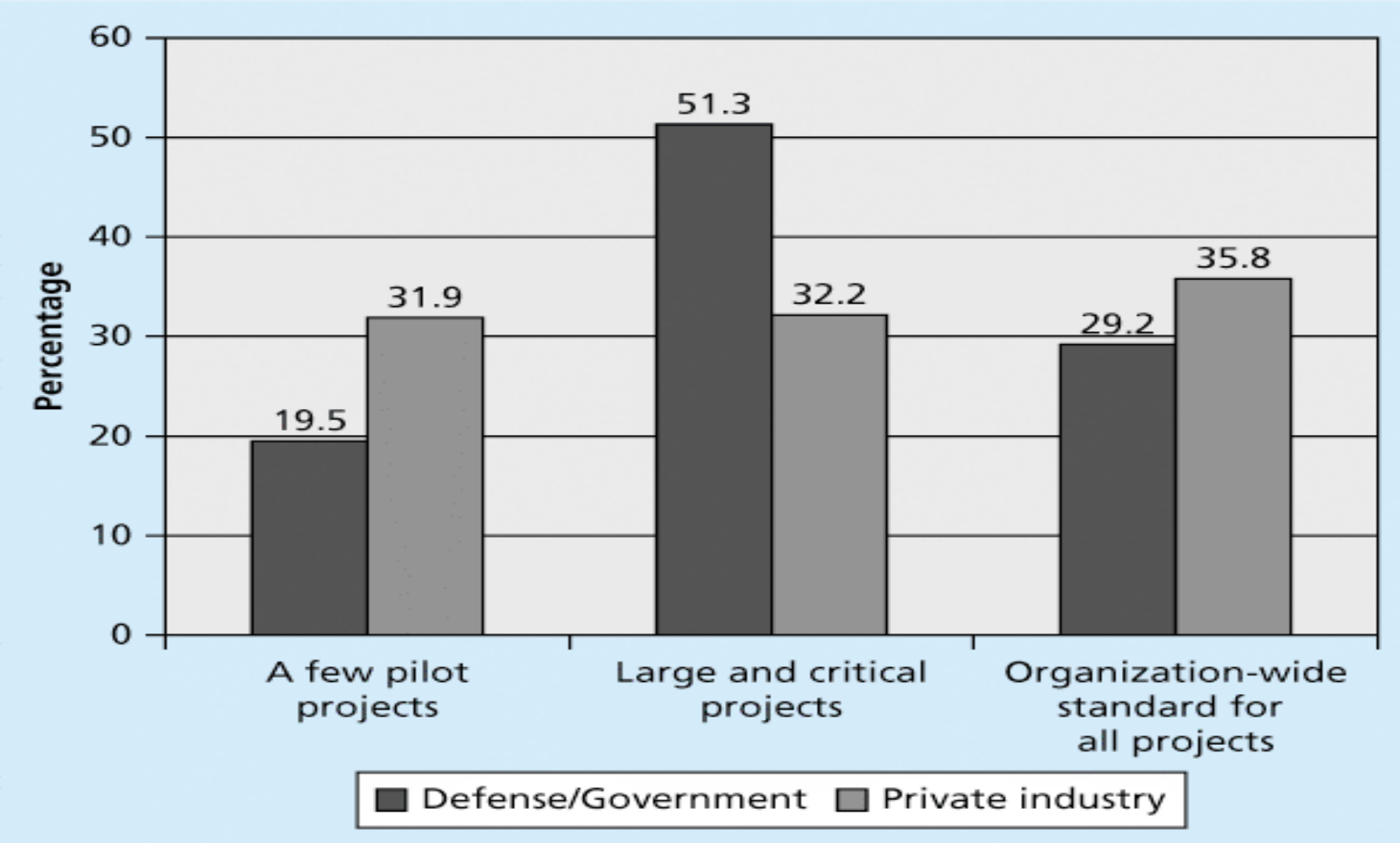
Figure 7-5. Earned Value Chart for Project after Five Months



Earned Value Calculations for a One-Year Project After Five Months

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**Activity**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**PV**	**% Complete**	**EV**
2	Plan and staff project	4,000	4,000											8,000	100	8,000
3	Analyze requirements		6,000	6,000										12,000	100	12,000
4	Develop ERDs			4,000	4,000									8,000	100	8,000
5	Design database tables				6,000	4,000								10,000	100	10,000
6	Design forms, reports, and queries					8,000	4,000							12,000	50	6,000
7	Construct working prototype						10,000							10,000	-	-
8	Test/evaluate prototype						2,000	6,000						8,000	-	-
9	Incorporate user feedback							4,000	6,000	4,000				14,000	-	-
10	Test system									4,000	4,000	2,000		10,000	-	-
11	Document system											3,000	1,000	4,000	-	-
12	Train users												4,000	4,000	-	-
13	Monthly Planned Value (PV)	4,000	10,000	10,000	10,000	12,000	16,000	10,000	6,000	8,000	4,000	5,000	5,000	100,000		44,000
14	Cumulative Planned Value (PV)	4,000	14,000	24,000	34,000	46,000	62,000	72,000	78,000	86,000	90,000	95,000	100,000			
15	Monthly Actual Cost (AC)	4,000	11,000	11,000	12,000	15,000										
16	Cumulative Actual Cost (AC)	4,000	15,000	26,000	38,000	53,000										
17	Monthly Earned Value (EV)	4,000	10,000	10,000	10,000	10,000										
18	Cumulative Earned Value (EV)	4,000	14,000	24,000	34,000	44,000										
19	Project EV as of May 31	44,000														
20	Project PV as of May 31	46,000														
21	Project AC as of May 31	$ 53,000														
22	**CV=EV-AC**	**$ (9,000)**														
23	**SV=EV-PV**	**$ (2,000)**														
24	**CPI=EV/AC**	**83%**														
25	**SPI=EV/PV**	**96%**														
26	**Estimate at Completion (EAC)**	**$120,455**	(original plan of $100,000 divided by CPI of 83%)													
27	**Estimated time to complete**	**12.55**	(original plan of 12 months divided by SPI of 96%)													

Figure 7-6. Earned Value Usage



Using Software to Assist in Cost Management

- Spreadsheets are a common tool for resource planning, cost estimating, cost budgeting, and cost control
- Many companies use more sophisticated and centralized financial applications software for cost information
- Project management software has many cost-related features, especially enterprise PM software
- Portfolio management software can help reduce costs

Chapter Summary

- Project cost management is a traditionally weak area of IT projects, and project managers must work to improve their ability to deliver projects within approved budgets
- Main processes include
  - Plan cost management
  - Estimate costs
  - Determine the budget
  - Control costs