



Week 4

Pre-Project Planning (2)

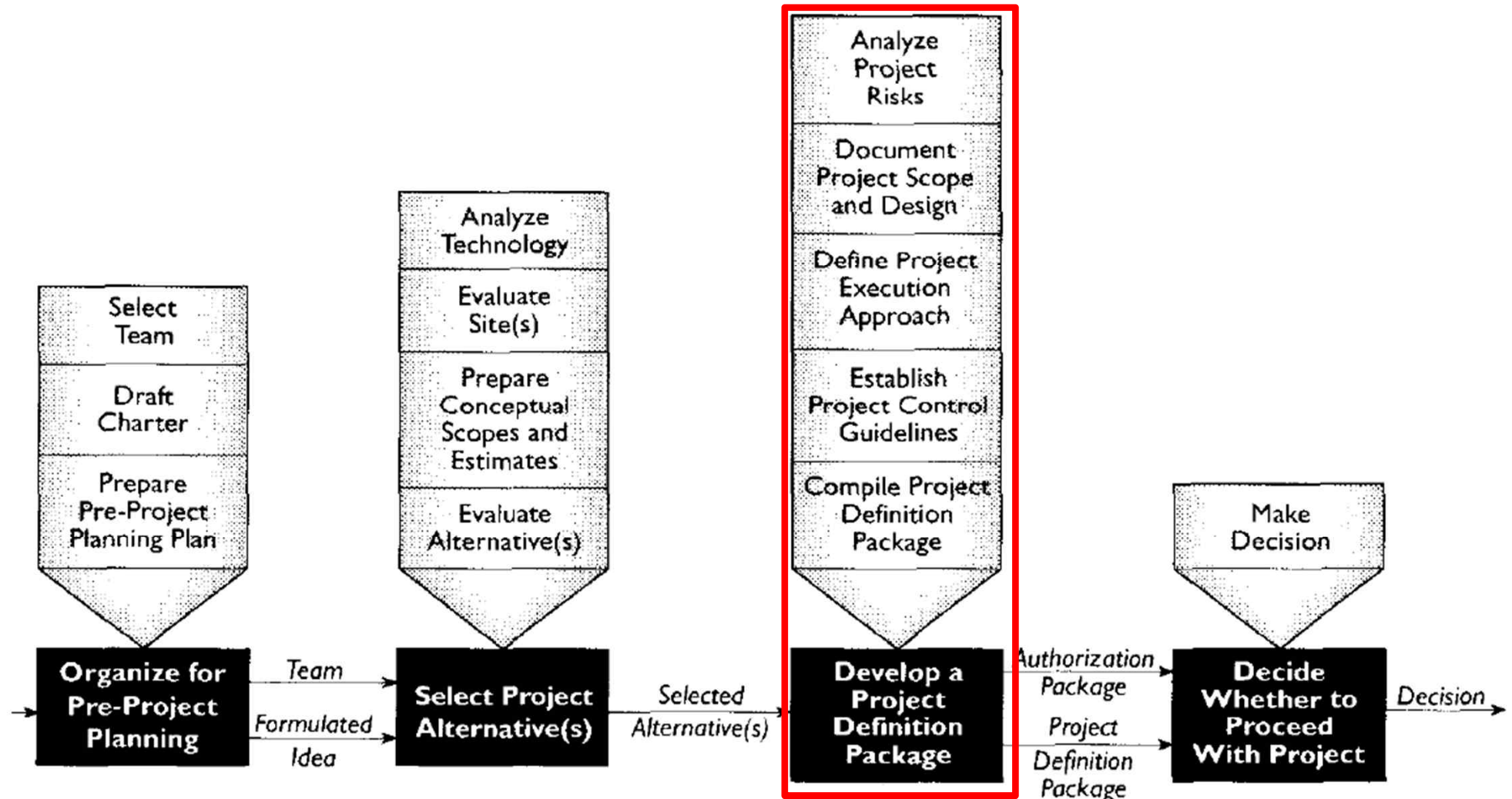
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(3) Develop a Project Definition Package



(3) Develop a Project Definition Package

- **Analyze Project Risks**

- Uncertainties produce severe losses
- Identify, measure and manage project risks on cost, schedule, and technical performance
- Mostly subjective and qualitative
 - Experience of key project personnel
 - Input from stakeholders is critical.
- Financial, business, technology, regulatory, operational, environmental, permitting + construction-related risks

(3) Develop a Project Definition Package

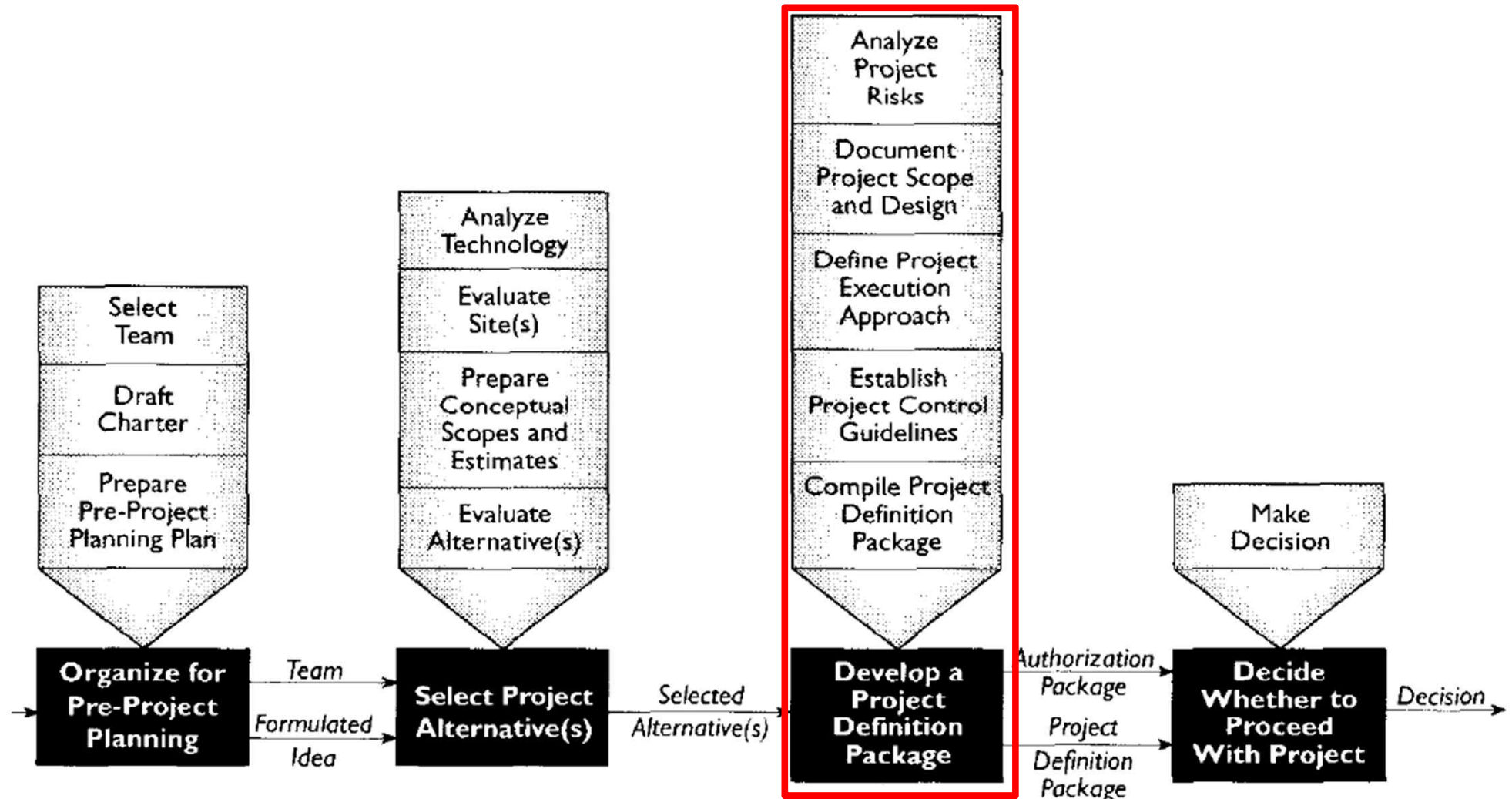
- **Two critical risk considerations:**
 - Which risks may produce severe losses?
 - Which risks may occur frequently?
- **Key things**
 - Capture risk issues in a risk matrix or “risk register”
 - Begin as early as possible
 - Develop mitigation strategies
 - Accept, shift through contract, design solutions, apply contingency \$ or plans, or insure
 - Track over time

Example – Analyze Project Risks

- What would be possible risks?

RISK	WEIGHT			SCORE
	Type	Severe loss (50%)	Frequency (50%)	
1. Market consideration	Business	10	10	10
2. Building code/regulation impact	Regulatory	5	5	5
3. General construction costs	Project	10	20	15
4. Cost and availability of raw material and feedstock	Project	15	10	12.5
5. Capital cost	Business	5	5	5
6. Environmental concerns	Environ.	5	10	7.5
7. Distribution networks	Business	15	10	12.5
8. Uncertainty in process and technology capabilities	Technology	20	5	12.5
9. Labors	Project	10	20	15
10. Weather conditions	Project	5	5	5
<i>TOTAL WEIGHT</i>		100	100	100

(3) Develop a Project Definition Package



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- **Document Project Scope and Design**

- All key elements of the scope should be identified and addressed in as much detail
- Fundamentals of scope development affecting design planning and decision making
 - Project definition
 - Statement of key technical and physical attributes
 - General building requirements
 - Building features required to support operations
 - Integration requirements
 - Procedures necessary for renovating an existing facility to accommodate the new operations
 - Process design basis
 - Design characteristics necessary to support the new process

(3) Develop a Project Definition Package

- **Document Project Scope and Design**
 - Fundamentals of scope development (cont'd)
 - Utility design basis
 - Design characteristics of the utilities necessary to support the new process
 - Control system design basis
 - Design characteristics of the controls necessary to support the new process
 - Equipment list and data sheets
 - Electrical, piping and instrumentation schematics
 - General site information

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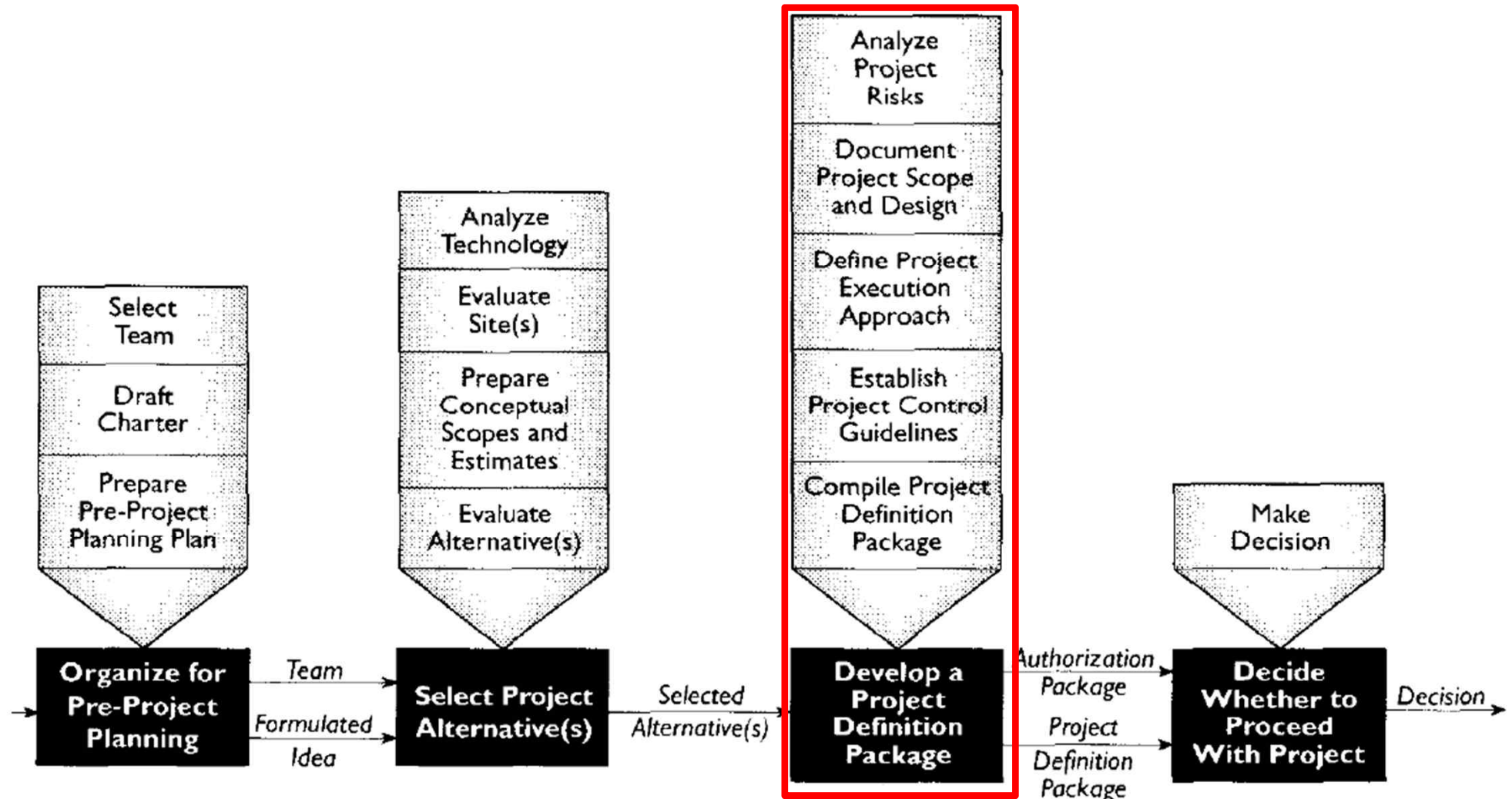
- **Document Project Scope and Design**
 - Critical considerations for scope control
 - Minimize non-income producing investments
 - e.g., Unnecessary upgrades
 - Complex scope items
 - e.g., Complex control systems
 - Equipment cost multipliers
 - e.g., Non-standard equipment items
 - Expensive materials of construction
 - e.g., Exotic finishes
 - Management of changes

Example – Document Scope and Design

- Best: 100, Worst: 500
- Find improvement opportunities and monitoring

SCOPE ELEMENT	RANK	WEIGHT	SCORE (1: Good to 5: Poor)	TOTAL
Project goals, overall, and definition phase	15	15	1	15
Technology/Site alternatives considerations	14	10	1	10
Detailed scope of work	13	10	1	10
Detailed cost estimate	12	10	4	40
Detailed project cost structure	11	10	4	40
Approved P&IDs (Piping and Instrumentation Diagram)	10	7	3	21
Transportation networks	9	7	1	7
Community/Environmental impacts	8	7	1	7
HAZOP reviews (Hazard and Operability)	7	5	3	15
Equipment lists	6	5	3	15
Utilities requirements	5	5	1	5
Process review for risk management concepts	4	3	2	6
Detailed division of responsibilities matrix	3	2	1	2
Engineer contractor selection and needed contracts	2	2	3	6
Identification of standards and specifications to be used	1	2	4	8
<i>TOTAL WEIGHT</i>		100		207

(3) Develop a Project Definition Package



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- **Define Project Execution Approach**

- All tasks are identified and carried out in a timely manner even in the early stages of project development
- Define who, how, and when
- Available resources affects approach
- Project schedule
 - What will be included?
- Design implementation plan
 - What questions must be answered when deciding design approach?

(3) Develop a Project Definition Package

- **Define Project Execution Approach**
 - Contracting and procurement plan
 - Potential options?
 - Permitting and compliance plan
 - Who assumes the risk?
 - Materials management / procurement plan
 - Who purchases major equipment?
 - Who assumes the risk?
 - Safety process
 - May cut across all stages of the execution
 - Cost/Schedule controls
 - Covered in next section
 - Staffing plan
 - Who is responsible at each stage of execution?
 - Who assumes the risk at each stage?

Example – Define Execution Approach

- Project Schedule

	Tasks	Duration (Month)	Start date	Finish date
1	Pre-project planning	3	01/01/2007	03/31/2007
2	Authorization to proceed	1	04/01/2007	04/30/2007
3	Engineering	16	05/01/2007	08/31/2008
4	Permit application and approval	19	06/01/2007	12/31/2009
5	Procurement and construction strategy	1	05/01/2007	05/31/2007
6	Long-lead items procurement	14	06/01/2007	07/31/2008
7	Bidding	3	03/31/2007	05/31/2007
8	Award construction contracts	3	06/01/2007	08/31/2007
9	Construction	19	08/01/2007	02/28/2009
10	Commissioning and start up	1	03/01/2009	04/30/2009
11	Product testing and stabilization	2	05/01/2009	06/30/2009
	(Product ready for commercial delivery)			

- Contracting

**EPCC: Engineering, Procurement, Construction Contractor*

	Facilities	Contracting strategy	Alternative strategy
1	Process unit	Design/Build	CM with EPCC (CM at Risk)
2	Power plant	Design/Build	CM with EPCC
3	Admin. building	Design/Build (Contractors)	Design/Bid/Build

Example – Define Execution Approach

- Design

	Facilities	Designer
1	Process unit	A/E with PMC
2	Power plant	A/E with PMC
3	Admin. building	A/E
Project Management Consultant (PMC)		
<i>Additional design studies</i> - Geotechnical investigation - Special foundation requirements for admin. building - Transportation/Public distribution network studies		

- Permitting

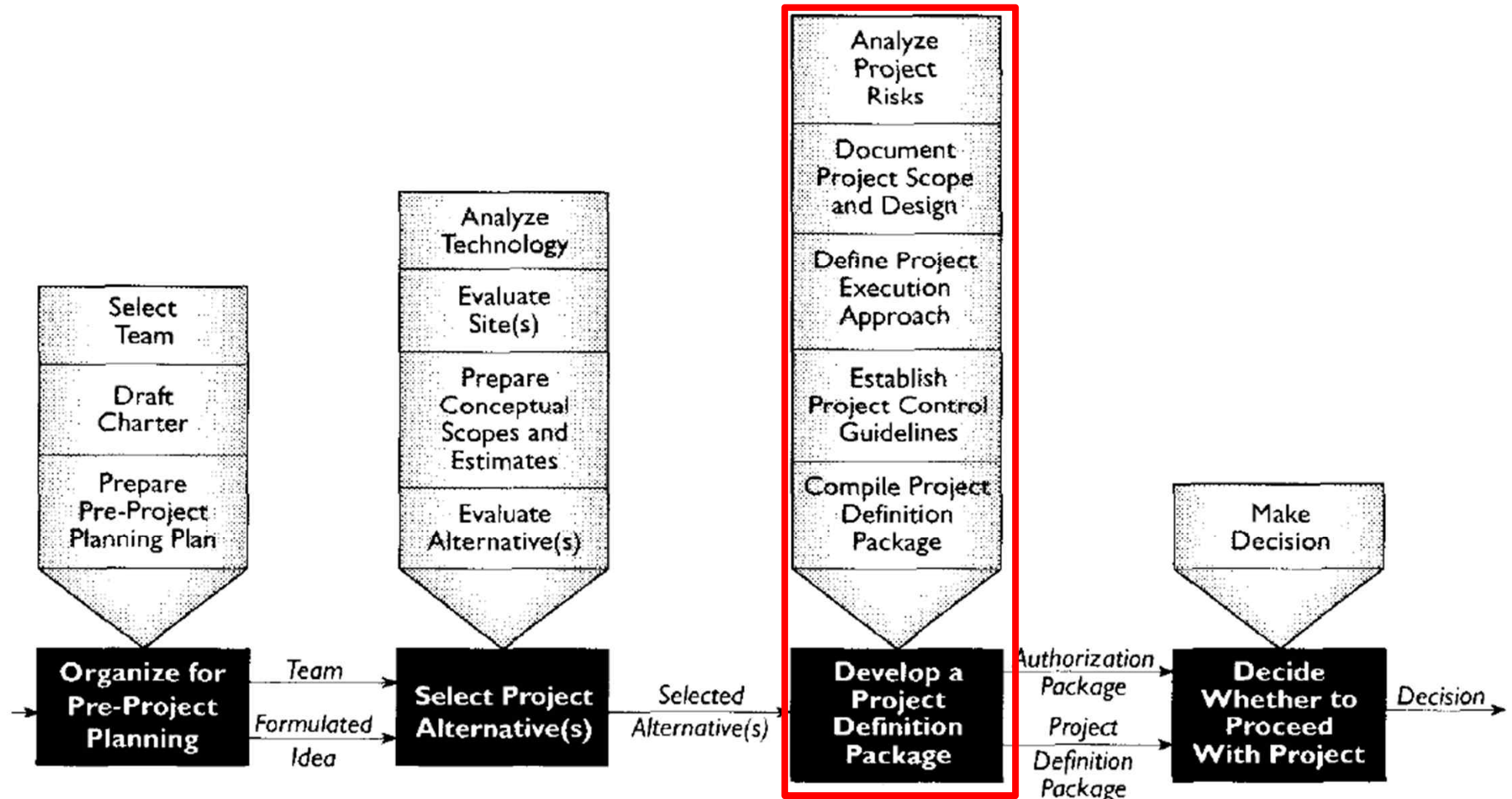
	Permit	Start	End	Responsibility
1	Construction permit	09/01/2007	06/15/2007	Owner*
2	Process permit	04/15/2007	05/15/2007	Owner*
	Permit	Start	End	Responsibility
3	Construction safety permit	08/15/2007	09/15/2007	Contractor
4	Operation safety permit	05/01/2008	12/31/2008	Owner*
* Assisted by PMC				

Example – Define Execution Approach

- **Materials**

- Long-lead items
 - Extrusion processing equipment, Gas compressor, Gas turbine, High pressure pump
- Who will purchase
 - All items will be purchased by the owner.
- How do the long-lead items impact the schedule?
 - They are on the critical path schedule. (Any delay on this leads to delay of the entire project.)
 - Associated facilities' construction schedule has to be matched to ensure minimum time expenditure in housing of the equipment after receipt.

(3) Develop a Project Definition Package



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- **Establish Project Control Guidelines**
 - Compare actual performance to planned performance and take action to correct poor performance when necessary
 - Control time and money
 - Status reporting and change management
 - These will be discussed in detail through the semester

Example – Establish Control Guidelines

- **Preliminary Budget**

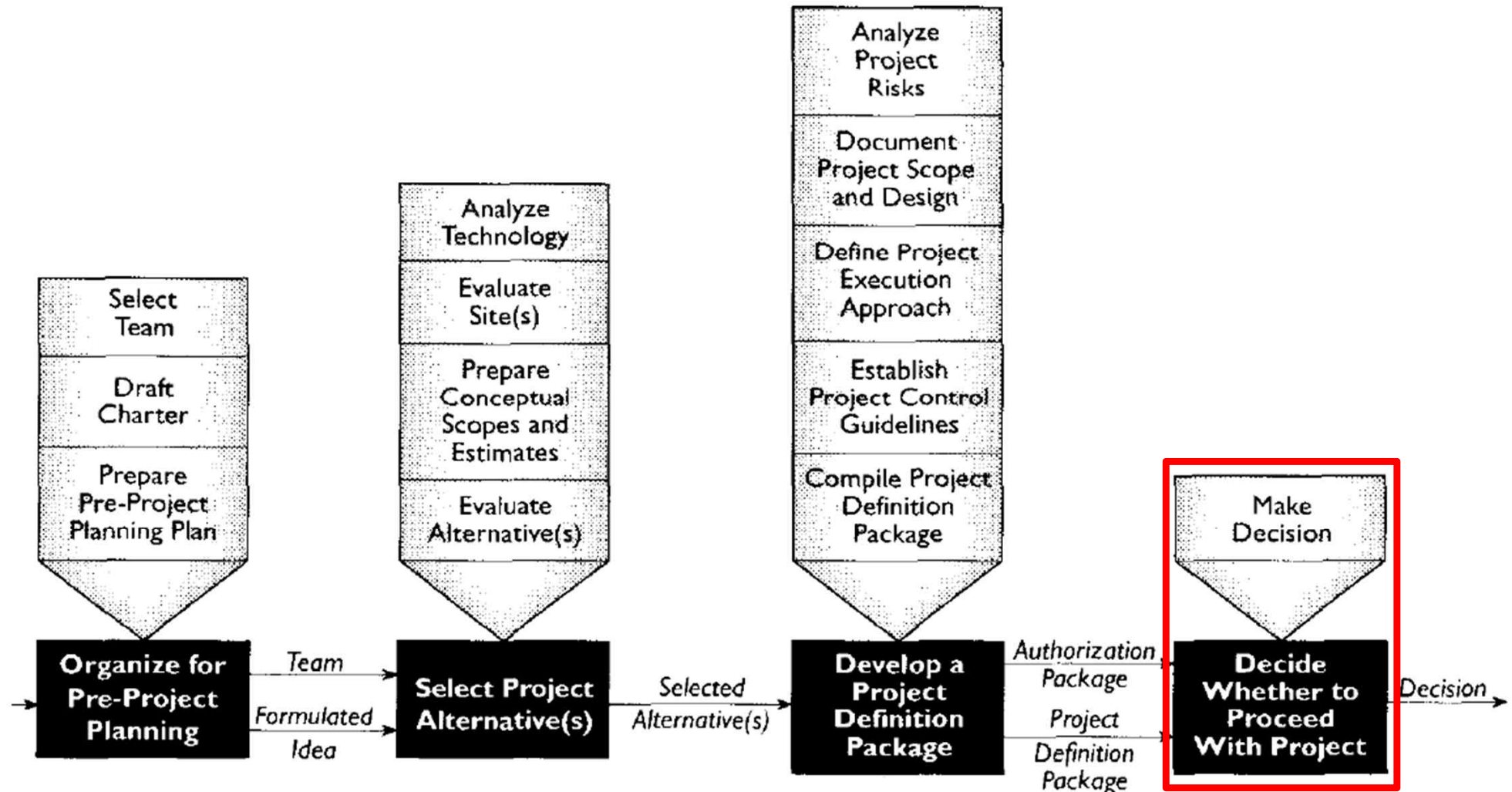
	Tasks	Budget (Total \$93 million)	
		%	\$ (million)
1	Pre-project planning	5	8
2	Engineering	10	16
3	Procurement	20	32
4	Construction, Commissioning, & Start up	65	104
	TOTAL	100	160

- **Status reporting items**

(3) Develop a Project Definition Package

- **Compile Project Definition Package**
 - Project Definition Package (PDP)
 - Package prepared for *execution* (a detailed roadmap)
 - All previous data including project objectives, alternatives, risk analysis, cost estimate, future obligations
 - Project Authorization Package (PAP)
 - Executive summary for project authorization approval
 - Package prepared for *decision makers*

(4) Make Decision



(4) Make Decision

- **Make Decision**
 - Project must align with the business needs and the objectives
 - Requires commitment to plan
- **What information will the CEO & CFO use?**
 - Business needs
 - Risk
 - Execution approach
 - Decision time – is everyone committed?
 - Lack of consistent views

Measuring PPP (PDRI)

- **Project Definition Rating Index (PDRI)**
 - Simple, easy-to-use tool for measuring the degree of scope development
 - 3 sections, 15 Categories, 70 Elements
 - Section I: Basis of project decision
 - Section II: Basis of design
 - Section III: Execution approach
 - How does the PDRI work?
 - Rate each of the 70 elements to obtain a project definition score of up to 1,000 points
 - Lower score = Better scope definition

Measuring PPP (PDRI)

- **Project Definition Rating Index (PDRI)**
 - How was it developed?
 - By G. Edward Gibson
 - CII Research Team 39 at the University of Texas, Austin
 - Used scope development package from 14 companies
 - Brainstorming, affinity diagramming
 - Workshop of project managers and estimators

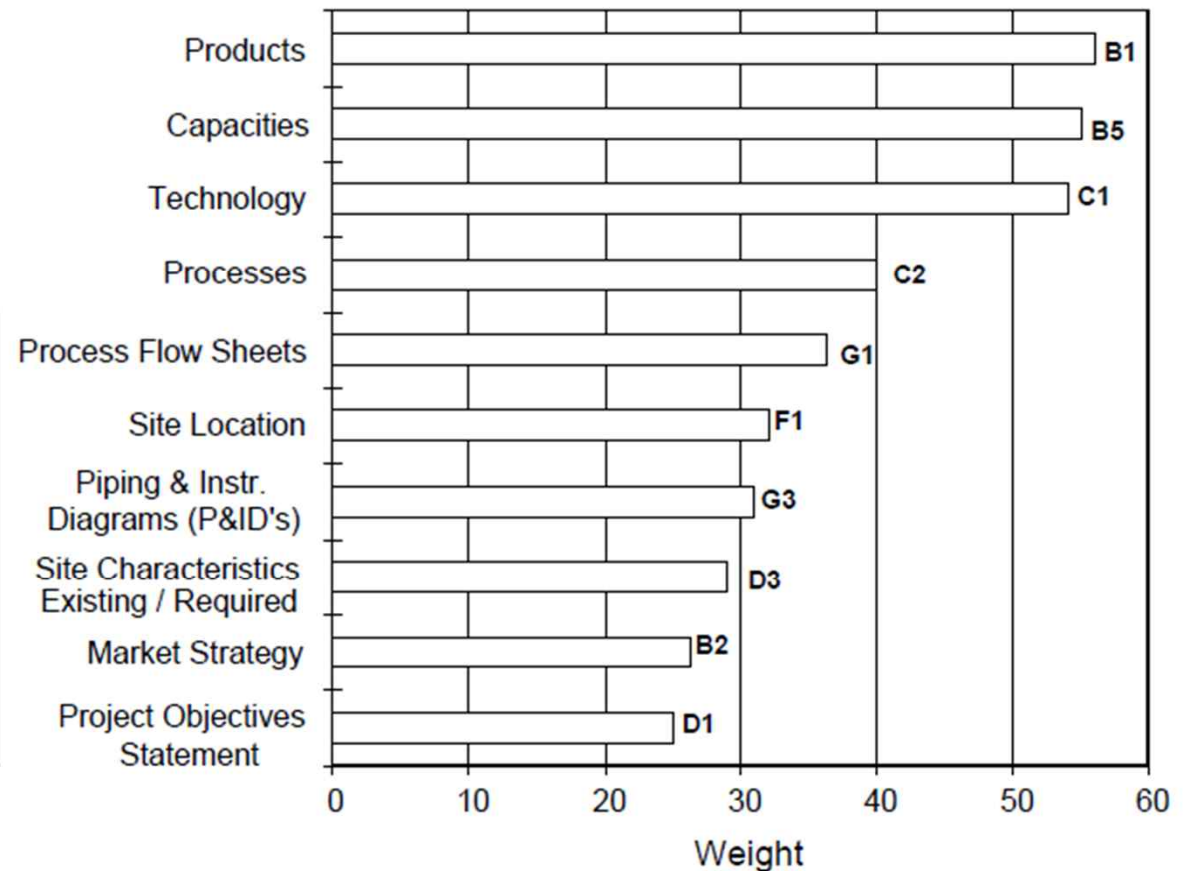


Measuring PPP (PDRI)

- **Project Definition Rating Index (PDRI)**
 - All 70 elements not equally important (different weights)
 - 54 project managers and estimators from 31 companies
 - Top 10 Elements:

Projects With PDRI Scores Above and Below 200

Performance	PDRI Score		△
	< 200	> 200	
Cost	-5%	+14%	19%
Schedule	-1%	+12%	13%
Change Orders	+2%	+8%	6%
	(N=20)	(N=20)	



Measuring PPP (PDRI)

- **Benefits**
 - Checklist
 - Standardized scope definition terminology
 - Risk assessment
 - Monitor progress
 - Communication and promotes alignment
 - Reconcile differences
 - Training tool
 - Benchmarking tool

Measuring PPP (PDRI)

- **Instructions for Scoring (Start Empty & Transfer)**
 - STEP 1: Review Assessment Sheet
 - Review Appendix C (element descriptions) before scoring
 - STEP 2: Gather project information needed to make decision
 - STEP 3: Choose a level of scope definition
 - Discuss with team members whether the element has no deficiencies, some deficiencies, is incomplete, or is not applicable
 - Document on Action List

Definition Levels

0 = Not Applicable

1 = Complete Definition

2 = Minor Deficiencies

3 = Some Deficiencies

4 = Major Deficiencies

5 = Incomplete or Poor Definition

Measuring PPP (PDRI)

- Action List justifies how you completed the definition for the elements
- “Actions” are identified only for those elements that are not completely defined (definition levels 2 – 5)

Project Assessment Session Action Items, June 22, 200x						
(Sorted in order of PDRI element)						
Item #	PDRI Element(s)	Level of Definition	PDRI Element Score	Item Description	Date Completed	Responsible
1	A2	2	3	Resolve recycle maintenance philosophy issues	July 1, 200x	John Ramos
2	B4	1	1	Issue affordability/feasibility report to the team	July 1, 200x	Jake Blinn
3	B5	1	2	Confirm distribution for finished product	July 1, 200x	Sue Howard
4	F2	2	4	Complete soil testing for duct work	July 15, 200x	Jose Garcia
5	F4	1	1	Monitor all open permits	Ongoing	Jake Blinn
6	G9	3	9	Waste gas, water treatment, HVAC, and misc. balance of plant mechanical equipment list	July 31, 200x	Tina Towne
				<i>And so on.....</i>		

Measuring PPP (PDRI)

- **Instructions for Scoring**
 - STEP 4: Select element score
 - Place an “X” in the box on the unweighted score sheet (Appendix A) that represents your chosen definition level
 - Transfer the score on the weighted score sheet (Appendix B) and write the numeric score to the “Score” column
 - STEP 5: Add element scores to get category and total PDRI score ([Example](#))

Measuring PPP (PDRI)

- **Instructions for Scoring**

- STEP 6: Score analysis

- The maximum score possible is 1000 (poor) and the minimum is 70 (good)
 - A total PDRI score of 200 or less improves a project's chances of successful performance
 - Hence, each category should strive for a category score that is 20% or less of the maximum category score
 - Take actions for low-level definition elements and continuously monitor to achieve a project goal



Week 4

Decision and Risk Analysis

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Decision and Risk Analysis

- **What is decision and risk analysis?**
 - *Formal method* for understanding & *modeling* a decision environment
 - Method for making “more aware” decisions
 - Approach for minimizing *expected losses* or maximizing *expected gains*

Decision and Risk Analysis

- **Decisions can be difficult**
 - *Many options* from which to choose
 - Decisions linked to *other* decisions
 - *Many* factors to consider
 - Some factors have *uncertainties*
 - *Multiple & competing* objectives or criteria
 - DM's *value* system
 - Often in public view

Decision and Risk Analysis

- **Examples of difficult decisions**
 - Project selection/priorities
 - Quantify project's economic risks
 - Project location selection
 - Use corridor A or B for the new freeway?
 - Technology selection
 - Operations, maintenance, construction
 - Segmental or conventional bridge construction technology?

Decision and Risk Analysis

- **Examples of difficult decisions (Cont'd)**
 - Selection of project strategies
 - e.g., J-V, design-build, incentives, performance spec, ...
 - Owner's in-house engineering staff or a design consultant
 - Break up a very large project into multiple contracts?
 - Project timing
 - Start date? Duration? Sequence?
 - Shut down a “problem job” and replace the contractor?
 - Use extreme amounts of overtime or two shifts to catch up on project schedule?
 - Quantify benefit/cost of insurance

Decision and Risk Analysis

- **Decisions inappropriate to analyze**
 - *Easy* decisions
 - the answer is obvious
 - *Dominated* decisions
 - one option is always more advantages than any other
 - *Trivial* decisions
 - not much to lose or gain
- **Good decision?**
 - It's *logically consistent* with...
 - *Values* brought to the process
 - *Assumptions* made
 - *Information available & used*

Decision and Risk Analysis

- **5 Fundamental Elements of Decision**
 - Outcomes, decision criteria, & objective functions
 - Variables that drive decisions
 - Any associated *data*?
 - Sequence of decision(s) & events
 - Alternatives for each decision
 - Decision-maker's value system

Objective Functions

- Previous exercises weighted different decision criteria and scored different alternatives to find the best option.
- *What would be a more strategic, structured way for criteria and weights setting and scoring?*
 - Become the basis for decision making
 - Explain what we are trying to achieve better
 - Need to be more objective-driven
- **Objective functions** (formula-based decision support)
 - Outcomes + Decision Criteria
 - Outcomes: What are the consequences of decisions and related events? (advantages and disadvantages)
 - Decision criteria: What are the measures of goodness or preference?

Objective Functions

- **Ideal objective functions**
 - Definable, or determinable with a formula
 - Measured on a scale, preferably absolute
 - Reflective of all major objectives
 - Often multi-dimensional and computed as a composite of several variables
 - Understandable to non-experts
 - *Transparency* is good

Objective Functions – Example (1)

- Examples for objective function for modularization/preassembly GO/NO GO

Modularization/Preassembly:
(Off-site manufacturing)
Remote construction of portion
of project for beneficial reasons



Objective Functions – Example (1)

- **Modularization/Preassembly Go/No Go**
- **Possible Objective Function:**
 - Potential Total Value to Owner =
 - (1) Potential Project Net Savings +
 - (2) Potential Gross Revenue from Early Completion & Sales

where, *Potential Project Net Savings* =

Direct labor savings + Savings from reduced project duration + Scaffolding savings

– Additional engineering cost – Additional material cost

– Additional transport cost – Additional indirect cost

– Additional rework cost

Objective Functions – Example (2)

- **Son-La dam construction in Vietnam: Go/No Go**
 - Vietnam is experiencing a more rapid rise in demand for electricity than economic growth.
 - Vietnam's energy demand heavily relies on coal fired generating plant
 - Vietnam government is deciding whether or not to do the great hydro expansion.
 - Son-La Dam will be the biggest project in this hydro expansion

Objective Functions – Example (2)

- **Son-La dam construction in Vietnam: Go/No Go**

Normal Water Level	265 m
Dam Height	177 m
Volume of Reservoir	25.4 billion m ³
Surface of Reservoir	440 km ²
Installment Capacity	3,600 MW
Energy Production	14,124 GWh/year
Project Estimated Cost	\$2.3 billion
Project Life Cycle	100 years

Objective Functions – Example (2)

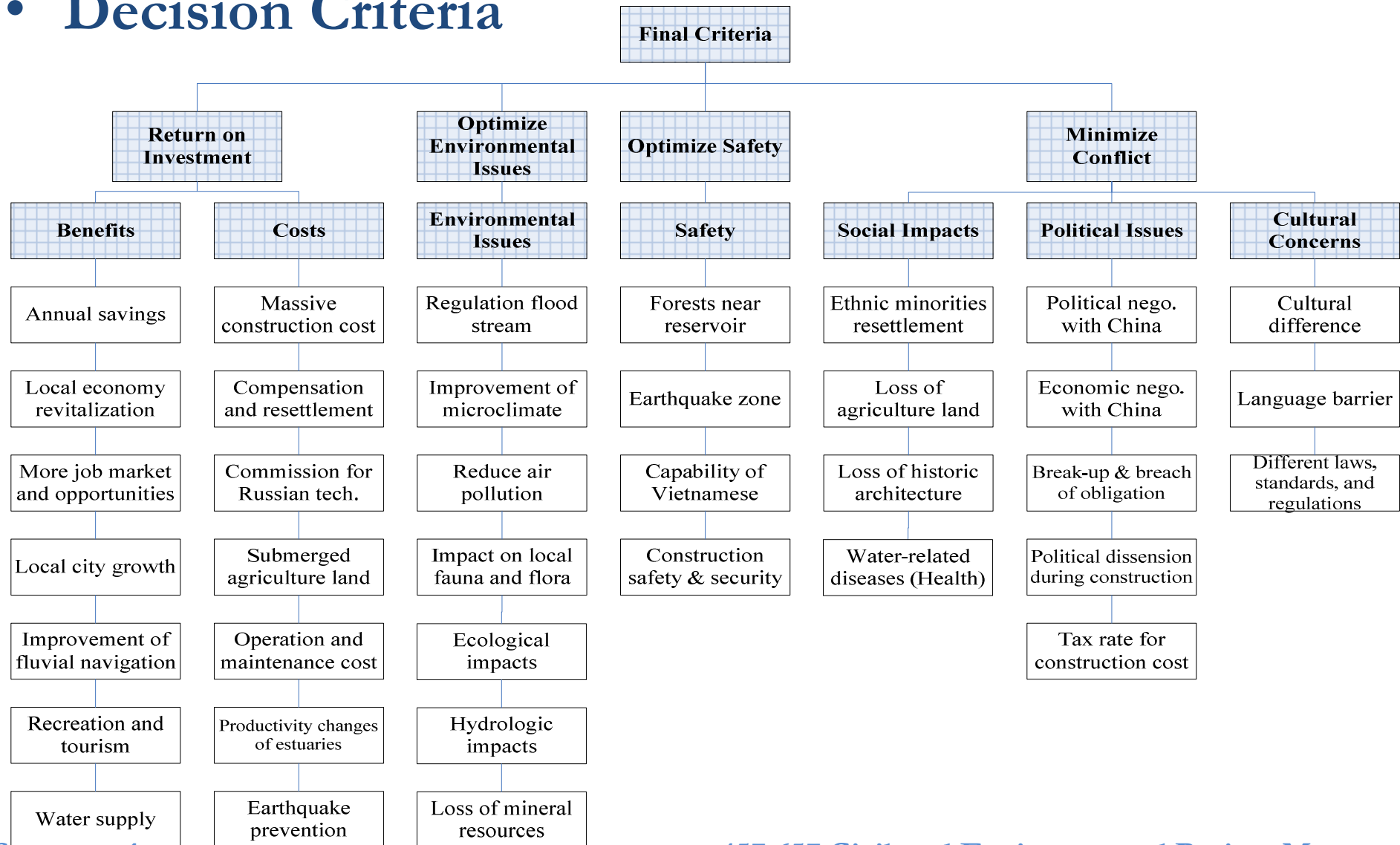
- Positive Impacts

Objective Functions – Example (2)

- Negative Impacts

Objective Functions – Example (2)

- Decision Criteria



Objective Functions – Example (2)

- **Weighting Four Major Criteria**
 - Analytic Hierarchy Process (AHP) method
 - Compare the major categories in pair-wise fashion, ranking each pair on a scale of 1 to 5 according to the criteria:
 - 1: The two factors contribute equally
 - 2: One factor is slightly favored over the other
 - 3: One factor is moderately favored over the other
 - 4: One factor is strongly favored over the other
 - 5: One factor dominates

Objective Functions – Example (2)

- **Weighting Four Major Criteria**
 - Analytic Hierarchy Process (AHP) method

A	B	Return on Investment	Optimize Safety	Minimize Conflicts	Optimize Environment
Return on Investment		1 (contribute equally)	2 (A slightly favored over B)	2	3 (moderately favored)
Optimize Safety		0.5	1	1.2	2
Minimize Conflicts		0.5	0.83	1	2
Optimize Environment		0.33	0.5	0.5	1
Sum		2.33	4.3	4.7	8

Objective Functions – Example (2)

- **Normalized Weighting Four Major Criteria**
 - Analytic Hierarchy Process (AHP) method

	Return on Investment	Optimize Safety	Minimize Conflicts	Optimize Environment	Row Sum	Average
Return on Investment	0.43 (1/2.33)	0.47	0.43	0.38	1.69	0.42
Optimize Safety	0.21 (0.5/2.33)	0.23	0.26	0.25	0.95	0.24
Minimize Conflicts	0.21 (0.5/2.33)	0.19	0.21	0.25	0.86	0.22
Optimize Environment	0.14 (0.33/2.33)	0.12	0.11	0.13	0.49	0.12
Sum	1	1	1	1	4	1

Objective Function

$$= 0.42 * \text{Return on Investment} + 0.24 * \text{Optimize Safety} \\ + 0.22 * \text{Minimize Conflicts} + 0.12 * \text{Optimize Environmental Issues}$$

Group Assignment Exercise

The U.S. Navy plans to design and construct two new recruit barracks to replace the old ones built between the years of 1958 and 1966, located at Naval Station Great Lakes, Illinois. This movement is a part of the RTC RECAP project, transforming Boot Camp from a deficient, facility-centric base into a state-of-the-art, training-centric environment. The entire project includes the development of the complete infrastructure (roads, sidewalks, utilities, storm drainage, elevated water tank, railroad underpass, landscaping, etc.) for a 48-acre parcel of land, adjacent to the existing RTC campus. Additional incidental related work must also be considered to provide a complete and useable facility. Each barrack will measure 16,700 square meters and will provide open bay housing for 1,100 recruits, classrooms, and advanced food service and dining facility. The total estimate cost is approximately \$80 million including two barrack (each \$30 million) facilities and green land development.

Group Assignment Exercise

- PDRI for risk assessment, *What would be possible risks?*
 - [Example of risk register](#)
- Conceptual estimate and impact of risk issues
 - Conceptual estimate
 - The total estimate cost is approximated \$80 million, including \$60 million for two barrack facilities and \$20 million for green land development such as site earthmoving work, road construction, building water and power supply facilities, etc. Former experience shows one barrack facility with the same size costs \$30 million. Although the cost of land development may vary depending on the actual work quantity, it is our best estimated based on the current information.

Group Assignment Exercise

- **Conceptual estimate and impact of risk issues**
 - Risk analysis
 - Regarding PDRI building sections, ten high risk issues that have the potential impacts on cost have been identified. These issues are addressed in risk management register. Among the ten high risk issues, the following three rank top three:
 - Designing problems: Valve, mechanical, and galley equipment access
 - Severe winter work condition
 - Construction safety

Group Assignment Exercise

Risk analysis (Cont'd)

First, considering this is a public work, construction safety is the primary concern of all stakeholders. The consequence of safety problem is critical. No one serving for the government wants to make problems resulting from safety such as incidents and delay of work. The potential cost due to this issue have a large range depending on the specific problems occurred. Insurance should be purchased for worker compensation.

Secondly, based on the characteristics of this project and past experience, it is found that valve, mechanical, and galley equipment access play an important role in our facility. Designing problems of changing them, therefore, have heavy impacts on the schedule as well as the cost of the whole project.

Group Assignment Exercise

Risk analysis (Cont'd)

Typically the cost of valve, mechanical, and galley equipment access is approximately 20-30 percent of the total cost. With thorough consideration, the cost impact caused by this could be limited to 5 percent of the total cost (i.e., \$4 million).

Finally, although severe winter work condition is very normal in Chicago, unexpected severe weather may be encountered, resulting to work delay in large scale. This has to be carefully studied and monitored during construction. The impact of this issues is also restricted to about 5 percent the total cost (i.e., \$4 million), considering possible 1 month or less project delay among the total 18-month project duration.