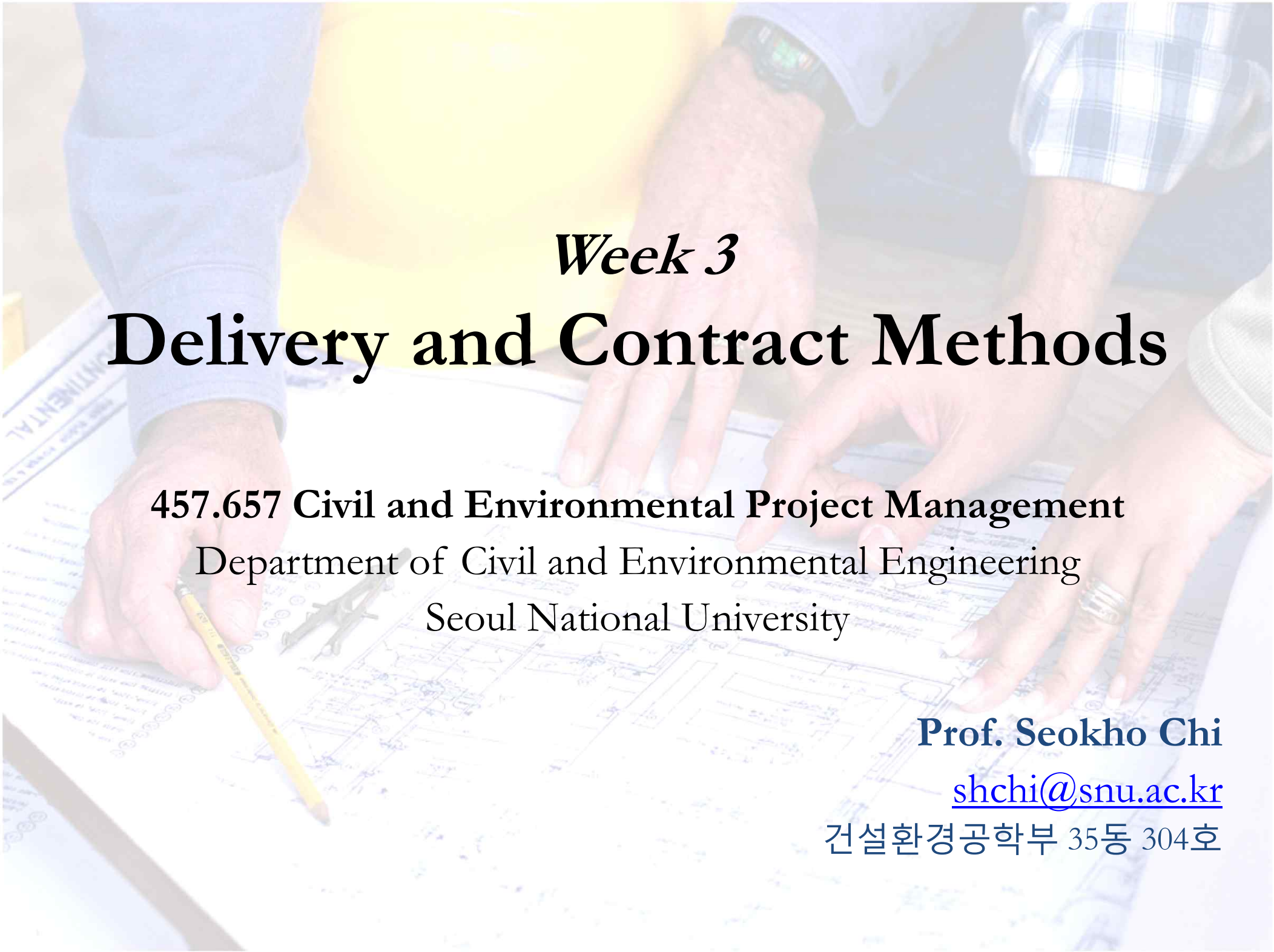

Week 3

Delivery and Contract Methods

457.657 Civil and Environmental Project Management

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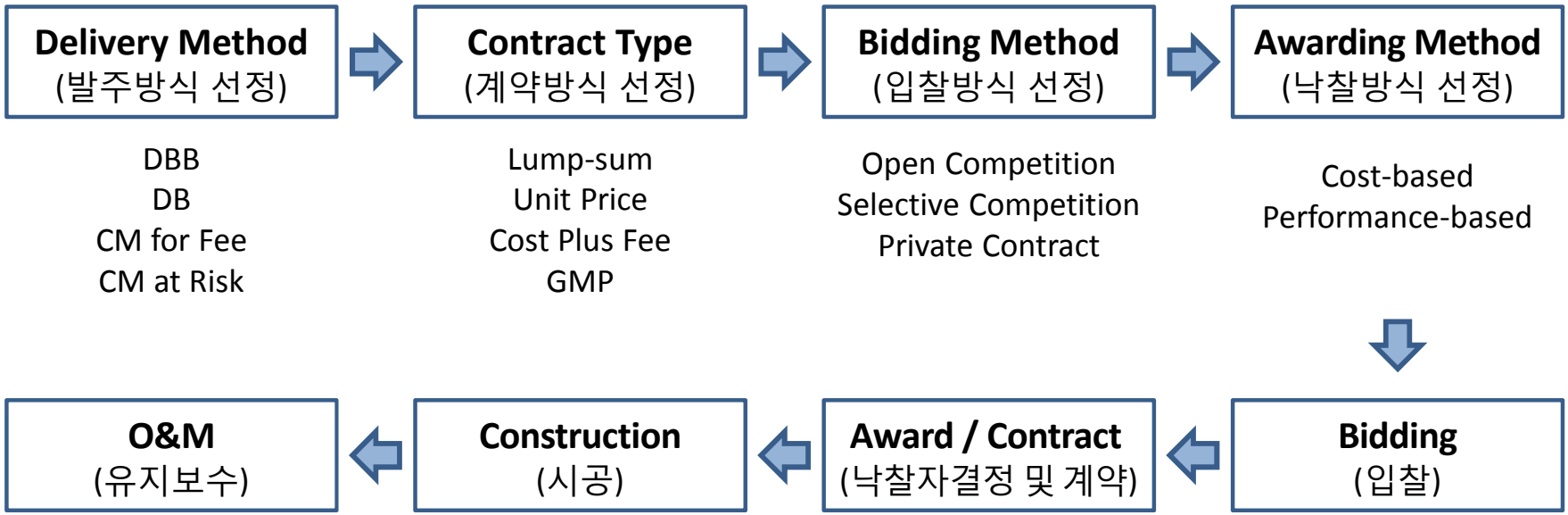
Construction Project Delivery



Delivery Method (발주방식)

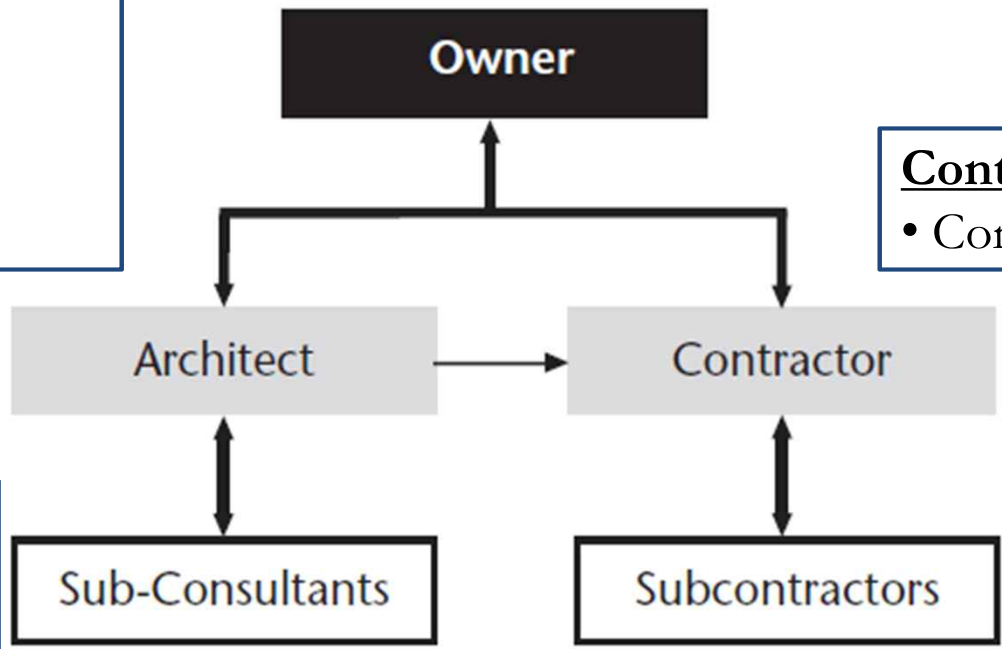
- **How to organize roles of each participant and deliver the project (management model)**

- **Design-Bid-Build**
  - Traditional project delivery method
- **Design-Build (Turnkey)**
- **Construction Management**

**Construction Documentation: Final design phase, Finalizing all drawings and specifications for building systems, site utilities, and construction components*

Design-Bid-Build (설계시공분리방식)

Contract for
- Feasibility studies
- Design
- Construction Documentation



Contract for
- Construction

Engineer
- Civil
- Environmental
- Structural
- Mechanical
- Electrical

Specialty Contractor
- Plumbing
- Electrical
- Roofing
- Plastering
- Others

No direct, formal relationship exists between the designer and the builder
Communicate only through the owner

Design-Bid-Build

- Advantages

Design-Bid-Build

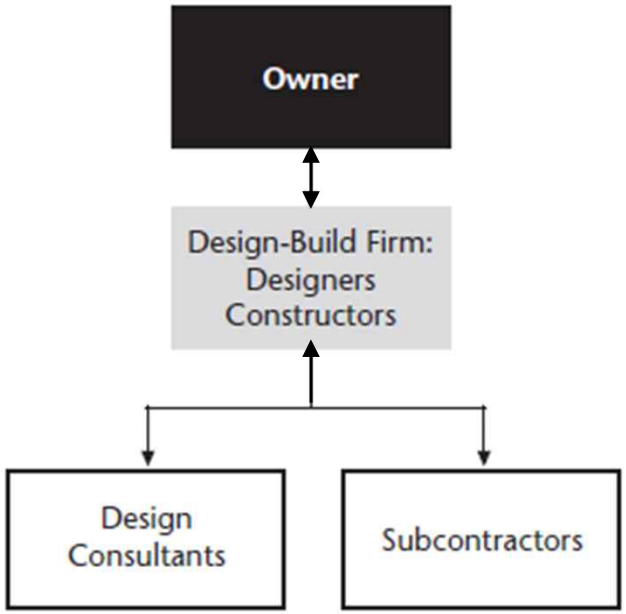
- Disadvantages

Design-Build (Turnkey, 설계시공통합방식)

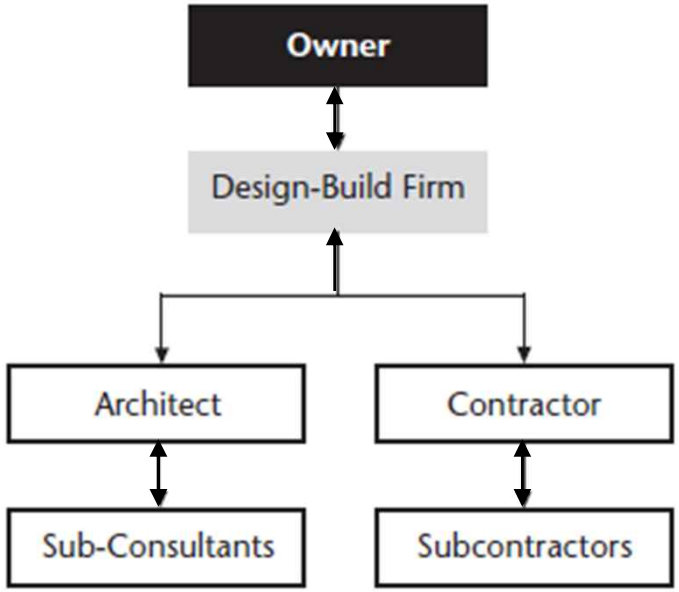
- **Designer and contractor are either from the same firm or joint venture (consortium)**

- **Single-source procurement for the owner**
  - A design-build firm provides both design and construction
  - Creates a non-adversarial relationship between designers and constructors
  - Three major types of arrangements

Design-Build

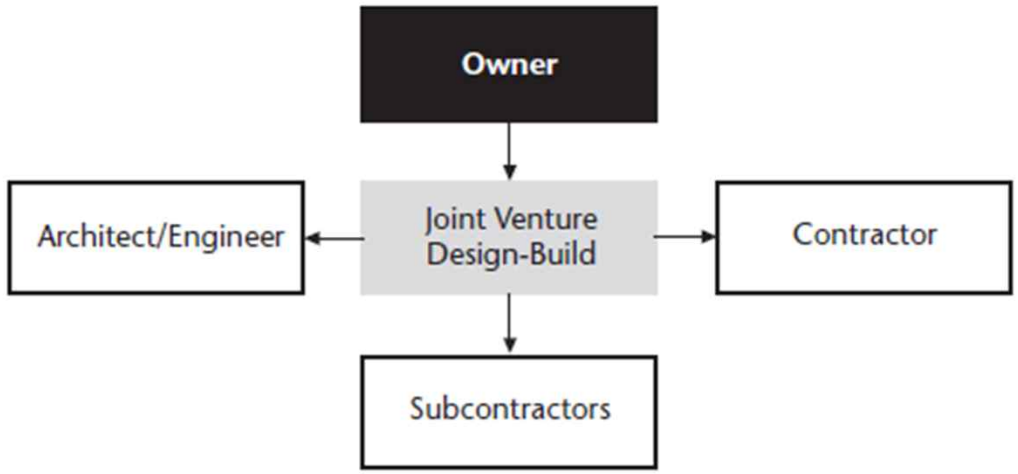


Includes and directly controls designers and constructers by Large design-build firm



Contracts out design and construction works by Developer firms

Design-Build



Joint-venture for
financing, resource, and
risk management

Design-Build

- Advantages

Design-Build

- Disadvantages

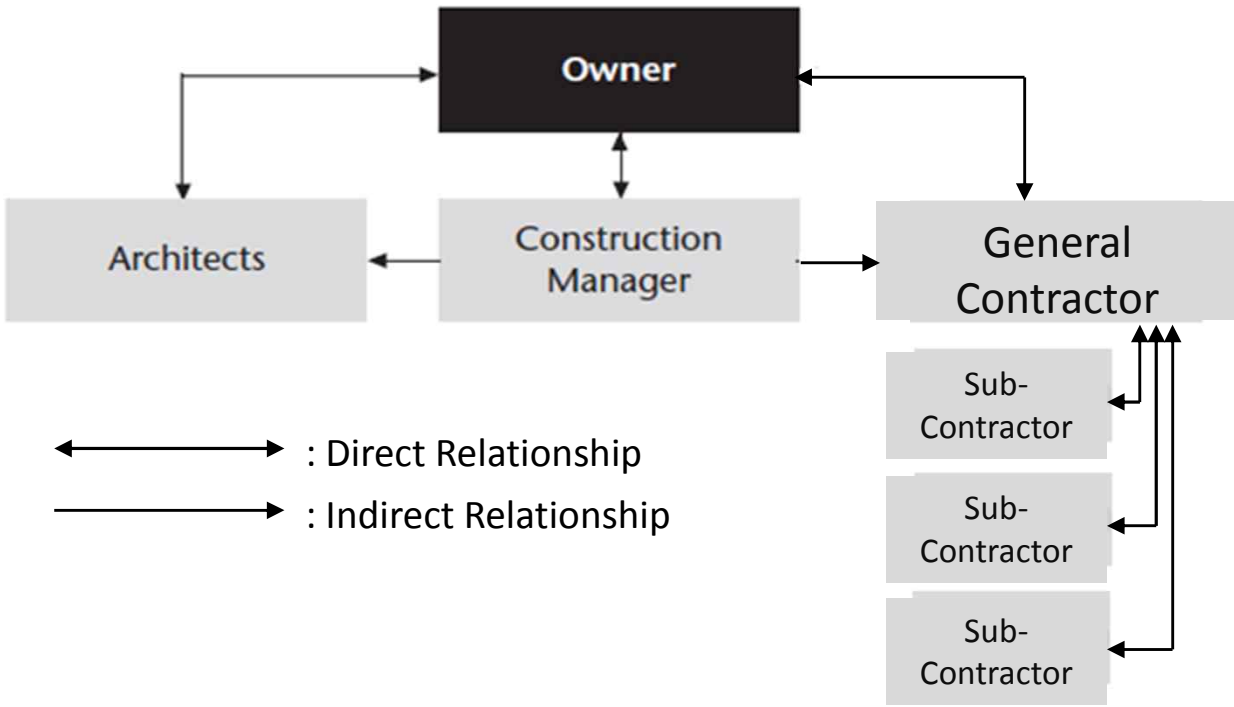
Construction Management (관리방식)

- **Applies contractor-based management systems early in the project**

- **CM delivery methods**
  - Agency CM (CM for Fee, 용역형 CM)
  - CM at Risk (도급형 CM)

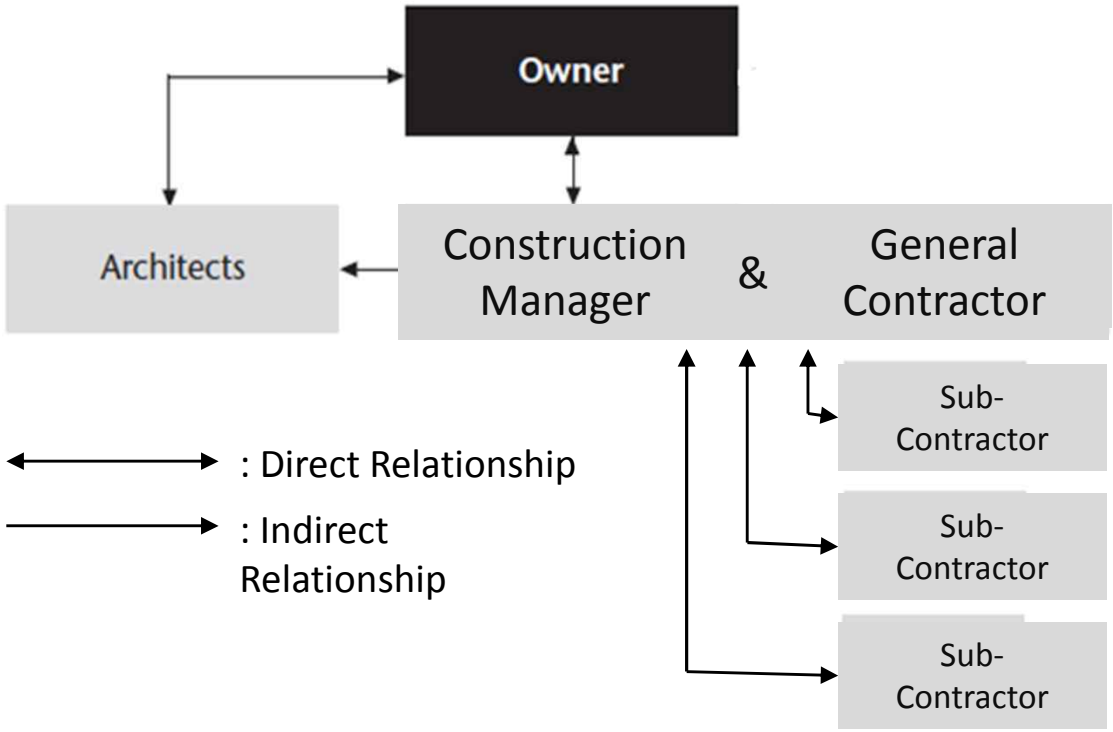
Agency CM

- **Agency CM (CM for Fee)**
  - CM as an owner's agent managing both A/E & GC
  - CM brings management tools
  - Best for an owner who has little or no CM expertise
  - e.g., 5%



CM at Risk

- **CM at Risk**
  - CM is involved in project planning, design, and construction of the project
  - CM provides the owner a maximum price for the project, considering the project's initial scope.



CM Project Delivery

- **Advantages**
  - Input of construction processes during design by CM
  - Good communication is established early among the owner, designer, and construction professional and continues through the completion of the project.
  - The implementation of changes is not as difficult as in the traditional method because of close communication.
  - Reduce the project duration

CM Project Delivery

- **Disadvantages**
  - If any of the players become inflexible, uncooperative or uncommunicative, the advantages can quickly become disadvantages.
  - This arrangement requires high owner involvement and more sophisticated owner.

Comparison

Description		Design-Bid-Build	Construction Management	Design-Build	Remarks
Level of familiarity		+			Less uncertainty about contractual relationships among participants and their roles
Open market competition		++	+		Best economic efficiency
Fixed final cost prior to construction		++	+	-	Low financial risk
Contractor involvement		-	+	+	Benefits from constructability analyses and value engineering
Non-linear process		-	+	+	Less possibility to redesign or cancel the project after the design is complete
Can be fast-tracked		-	++	++	Time reduction; cost savings; less influenced by interest expenses, indirect cost expenses, and inflation
Relationship among participants		-	+	++	Easy accommodation for changes
Respond to unforseen conditions		-	+	++	Easy accommodation for changes
Check and balance		++	+	-	Less possibility of fraud
Contractual simplicity		+	-	++	Simple communication line
Less owner involvement		+	-	++	Less organizational cost for the owner
Candidate Projects	Characteristics	• Fixed budget • Uncomplicated • Have been built before • Time is not a significant driver	• HIgh level of management	• Time constraints • Complex	
	Example	Road pavings, single-family homes, warehouses, fast-food restaurants, public projects	Commercial buildings, large projects	Oil refineries, power plants, manufacturing plants	

Contract Type

- **Specify how to compensate/pay the contractor for work completed**

- **Contract type**
  - Lump sum (총액계약)
  - Unit price (단가계약)
  - Cost plus fee (실비정산계약)
  - Guaranteed maximum price (최대비용 보증계약)

Lump-Sum (Single Fixed Price)

- **A fixed lump-sum price by the contractor**
  - Based on detailed plans and specifications
  - Owner knows the final cost before construction
  - Can be adjusted by the owner's change orders
- **Most common method working well with D-B-B**

- **Contingency**
  - Additional money or time added into a budget or schedule to allow for changes stemming from conditions different from what were originally assumed.
  - For scope changes, unforeseen conditions, design errors, etc.

Unit Price

- **Characteristic**
  - A fixed lump-sum price based on the quantities provided by the owner for the major components of the project
  - Contractor overhead, profit and other project expenses must be included within the unit prices

			Bidder 1		Bidder 2	
Work Items	Unit	Estimated Quantity	Unit Price	Bid Amount	Unit Price	Bid Amount
Soil Excavation	CY	10,000	5.50	55,000	2.00	20,000
Rock Excavation	CY	3,000	25.00	75,000	25.00	75,000
6" Pipe	LF	600	17.00	10,200	18.00	10,800
Crushed Stone Fill	CY	4,000	21.00	84,000	20.00	80,000
Fill Material	CY	6,000	14.00	84,000	20.00	120,000
Top Soil 4" Deep	SY	400	5.00	2,000	6.00	2,400
TOTAL				$310.200		$308.200

Bidder 2 wins the job with the $308,200 total price.

Cost Plus a Fee

- **Characteristics**
  - Contractors work on the project and get reimbursed by the owner for costs, plus additional agreed-upon fees
  - Usually used when the scope of work is difficult to define
  - No fixed price
  - Working well with both CM and D-B
- **Cost and Fee**
  - Cost: Labor, material, equipment, subcontracts, and on-site overhead
  - Fee: Indirect overhead and profit (benefit/cost sharing) (e.g., Cost plus 5%)

GMP

- **Guaranteed maximum price (GMP)**
  - Hybrid of the lump-sum and cost plus
  - A guaranteed maximum price by the contractor
    - Contractor is reimbursed at cost with an agreed-upon fee up to the GMP (e.g., $100M)
    - Beyond the GMP, contractor is responsible for covering any additional costs (e.g., if actual = $110M, 100% cost)
    - Incentive clause specifies that contractor will receive additional profit for bringing the project under the GMP. (e.g., if actual = $90M, 60% incentive)

Bidding Method

- **Open competition** (일반/공개 경쟁입찰)
  - Bidding opens to general companies
- **Selective competition** (지명/제한 경쟁입찰)
  - Bidding opens to selected companies only
- **Private contract** (수의계약)
  - Owner selects one company

Awarding Method

- **Cost-based** (최저가낙찰제)
  - Award to the company proposed the lowest project cost
  - Pre-qualification during bidding is important

- **Performance-based** (적격심사제)
  - Consider technical skills and quality performance as well as cost

Week 3

Pre-Project Planning (1)

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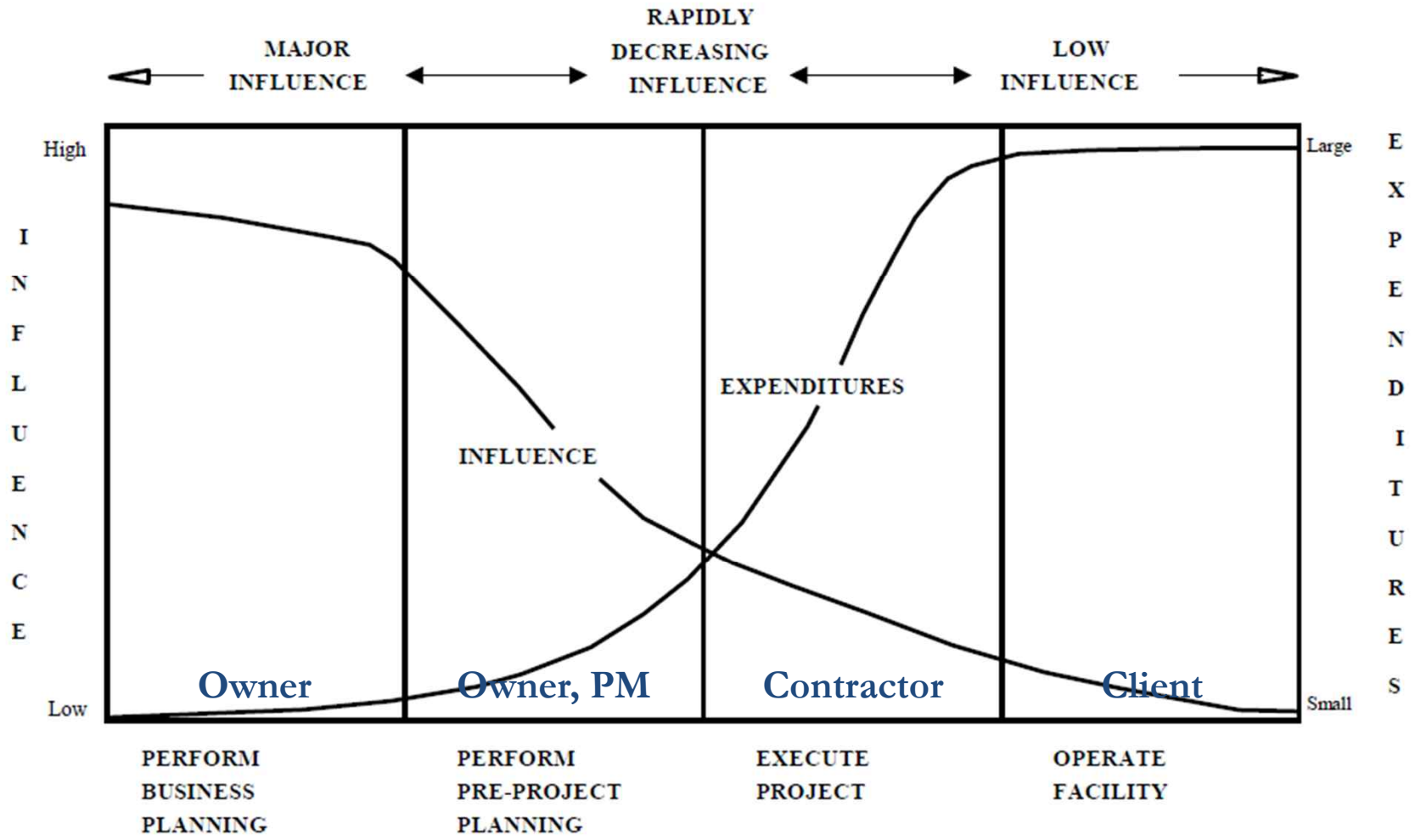
Pre-Project Planning (PMBOK Chapter 4 and Chapter 5)

- **"Process for developing sufficient strategy information with which owners can address risk and decide to commit resources to maximize the chance for a successful project."**

- **Simply,**
  - Performing the right project
  - Scoping the right "things" for a good design basis
  - Setting the stage for successful execution

Cost-Influence Diagram



"Influence" reflects a company's ability to affect the outcome of a project.
It is much easier to influence during the early project stages, when expenditures are relatively lower.

Pre-Project Planning

- **Key Beliefs**
  - Early PPP plays an essential role in producing high quality projects.
- **When PPP effort is:**

Cost

Effort	Avg.	Std. Dev.
High	-4%	7%
Medium	-2%	10%
Low	+16%	45%

Schedule

Effort	Avg.	Std. Dev.
High	-13%	17%
Medium	+8%	24%
Low	+26%	44%

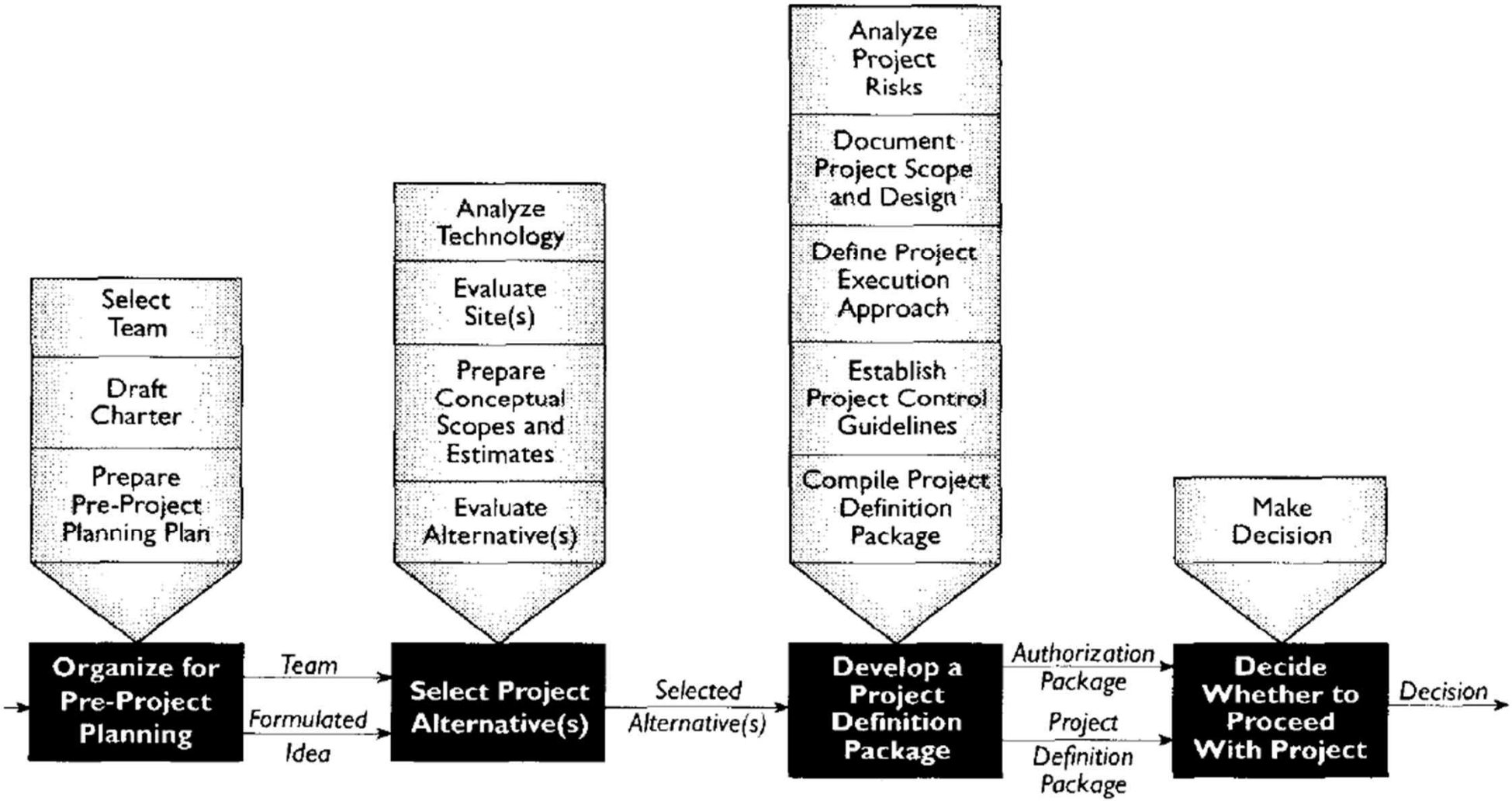
Scope Changes

Effort	Avg.	Std. Dev.
High	3%	3%
Medium	2%	3%
Low	11%	13%

Pre-Project Planning

- Reasons for Poor Early Planning

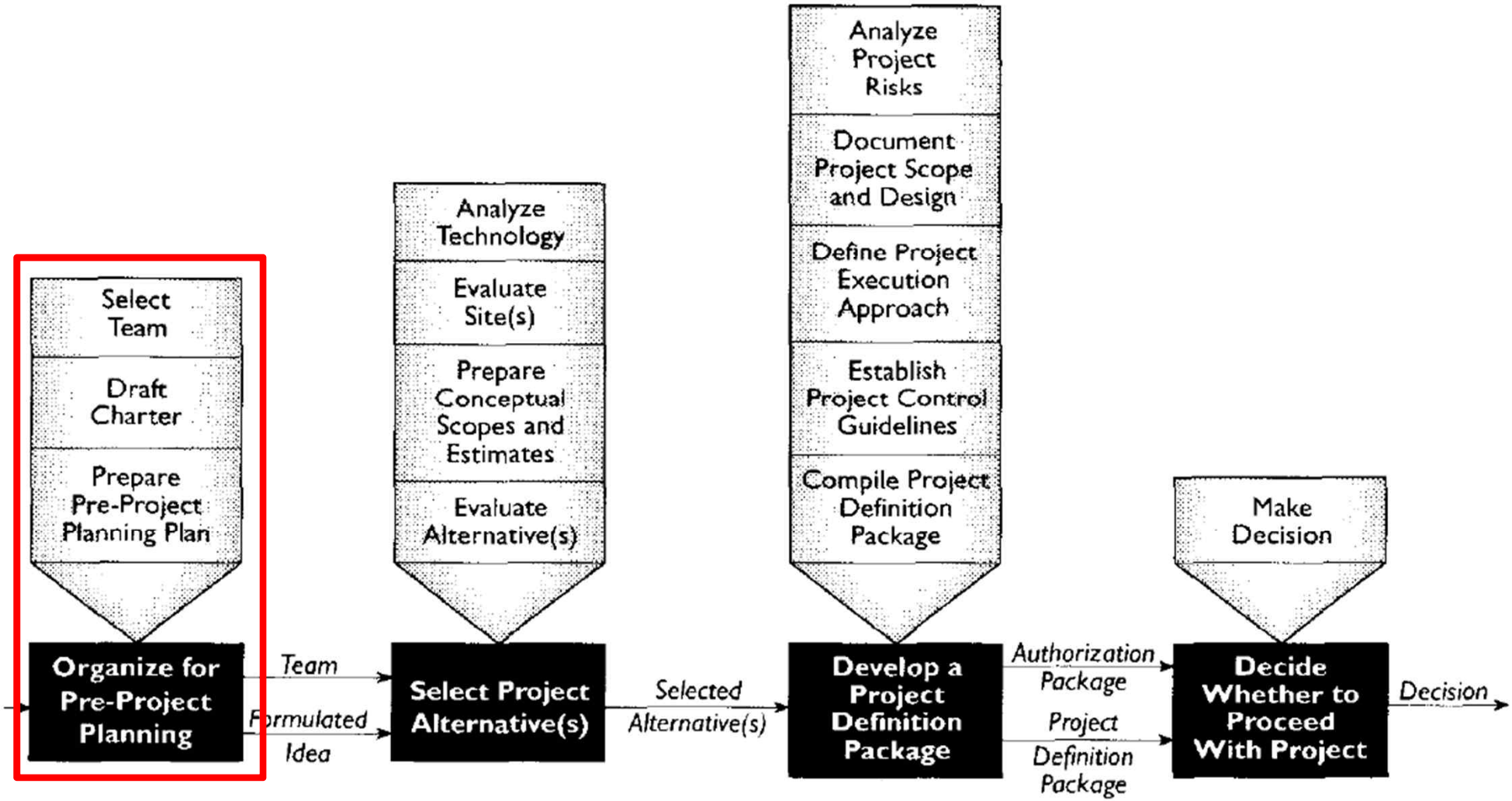
PPP Process


Select Team
Draft Charter
Prepare Pre-Project Planning Plan
Organize for Pre-Project Planning
Team
Formulated Idea
Analyze Technology
Evaluate Site(s)
Prepare Conceptual Scopes and Estimates
Evaluate Alternative(s)
Select Project Alternative(s)
Selected Alternative(s)
Analyze Project Risks
Document Project Scope and Design
Define Project Execution Approach
Establish Project Control Guidelines
Compile Project Definition Package
Develop a Project Definition Package
Authorization Package
Project Definition Package
Make Decision
Decide Whether to Proceed With Project
Decision

When is PPP Complete?

- Technology selected
- Site chosen
- Scope defined
- Cost and schedule determined
- Team assembled
- Project execution documentation
- Project team understands the project
- Decision maker's needs addressed
- Coherent recommendations
- Commitment

(1) Organize for PPP



(1) Organize for PPP

- **Select Team**
  - The correct functional and technical expertise, team training, team objectives and leadership are essential.
  - Expertise (knowledge), capability (skills), and authority (right for decision making)
  - Balance between project management, technology, and human factors
  - Long-term continuity with alignment

PPP Example

- **Scenario**
  - VP of Chemical Products conducted our business meeting and discussed the possibility of **manufacturing a new product, called FOCUS XP™** , that provides a unique opportunity for our company, Aggressive Chemical, Ltd (ACL), to develop a huge market that currently does not exist. This chemical compound was recently piloted and improved upon in ACL's R&D organization and all of the tests have been outstanding. Everyone seems upbeat and excited about the chance for success.

PPP Example

- **Scenario (Cont'd)**
  - Our forecast is that the product needs to be available on the market within the next 30 months in order to provide optimum return. The company anticipates **100 percent market share during the first year and erosion during subsequent years to 50 percent after five years of operation**. Two of our competitors are also developing a similar product, but we feel that we currently have a slight lead in our ability to capture the market, if we are able to reach the market. If we are late, our market share could be reduced by 25 percent or more during the first year.

PPP Example

- **Scenario (Cont'd)**
  - It is important to discuss construction timing of manufacturing facilities, volume, and return on investment (ROI). ACL's general corporate guidelines are that facilities must provide a return of at least 20 percent on invested capital. Our forecasters feel that the volume of FOCUS XP™ needed to meet **the market demand is 300 millions lbs. per year after two years of operation**.

Example – Select Team

- **Matrix of Stakeholders**

NO.	CRITCAL TEAM SKILLS NEEDED	SOURCE
1.	Planning/ Scheduling/ Costing	In-house/ Consultant
2.	Operations	In-house
3.	Process/Engineering	In-house/ Consultant
4.	Hazop/ Safety	In-house
5.	Construction	In-house/ Consultant
6.	Marketing	In-house
7.	Human Resources	In-house
8.	Finance	In-house

(1) Organize for PPP

- **Draft Charter**
  - Transform the project concept into a valid approach to competing the project
  - Typical contents
    - Mission statement (business needs, objectives)
    - Quality of deliverables
    - Organization chart with roles/responsibilities
    - Major milestones for PPP
    - Teambuilding procedures
    - Reporting requirements
    - Coordination procedures
    - Limits of authority
    - Time requirements
    - Budget requirements
    - Team code of conduct

Example – Charter

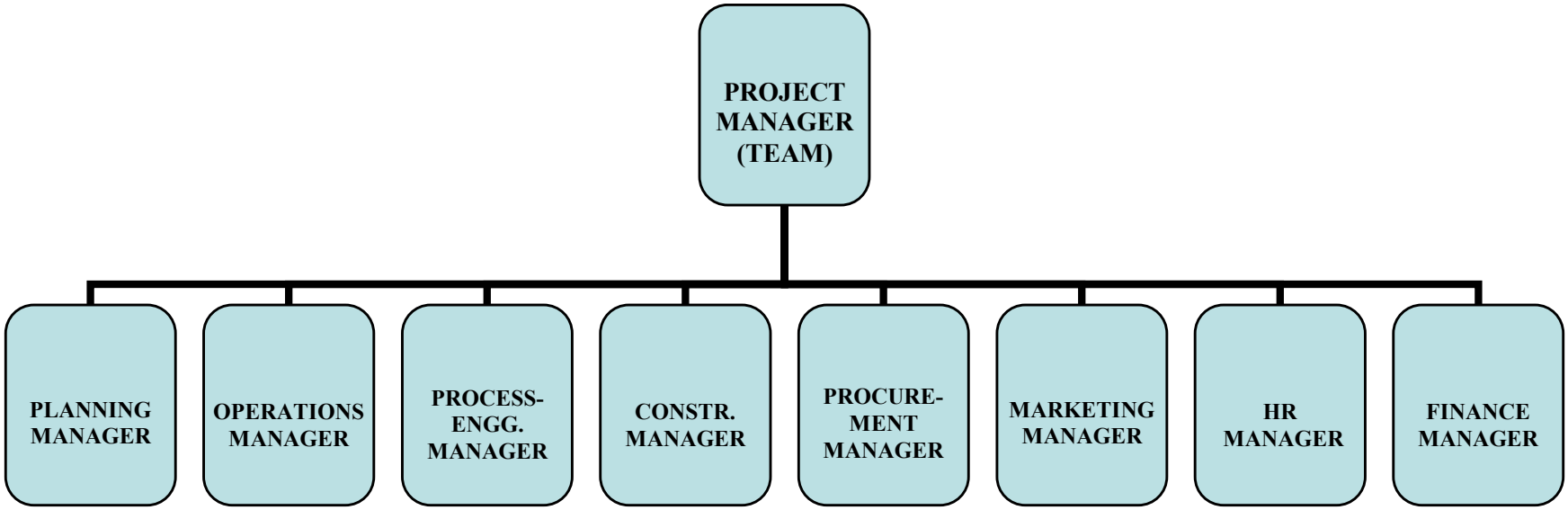
- **Mission/Objective Statement**
  - To aggressively lead the chemical industry
  - To run state of art R&D facilities developing products ahead of competition
  - To expand markets on global platform
  - To capture market imagination through innovative products
  - To be ever sensitive to safety at work and uphold the HSE principles in totality
  - Minimum ROI of 20% on investment capital

Example – Charter

- **Statement of Business Needs**
  - Product to be available in the next 30 months
  - 300 million lbs production after 2 years
  - Select best location to maximizing yield and minimizing cost
  - Identify worldwide distribution networks
  - Identify various interfaces with existing facilities, concurrent projects and study interrelations and impacts
  - Follow HSE standards for safe working

Example – Charter

- Organization Chart



(1) Organize for PPP

- **Prepare PPP Plan**
  - Based on approved charter, document who, how, and when
  - More clearly focused, organized, and validated concepts
  - To develop PPP plan, formulate and document
    - Defined deliverables
    - Schedule for PPP
    - Budget for PPP
    - Resources
    - Information
    - Location for PPP
    - Contract strategy
    - Permit analysis
    - Risk mitigation
    - Project outline
    - Work priorities
    - Specific team responsibilities

Example – PPP Plan

- **Quality and Quantity**
  - Quality of function/product
    - 90% yield directly impacts on quality.
  - Quantity of function/product based on assumptions

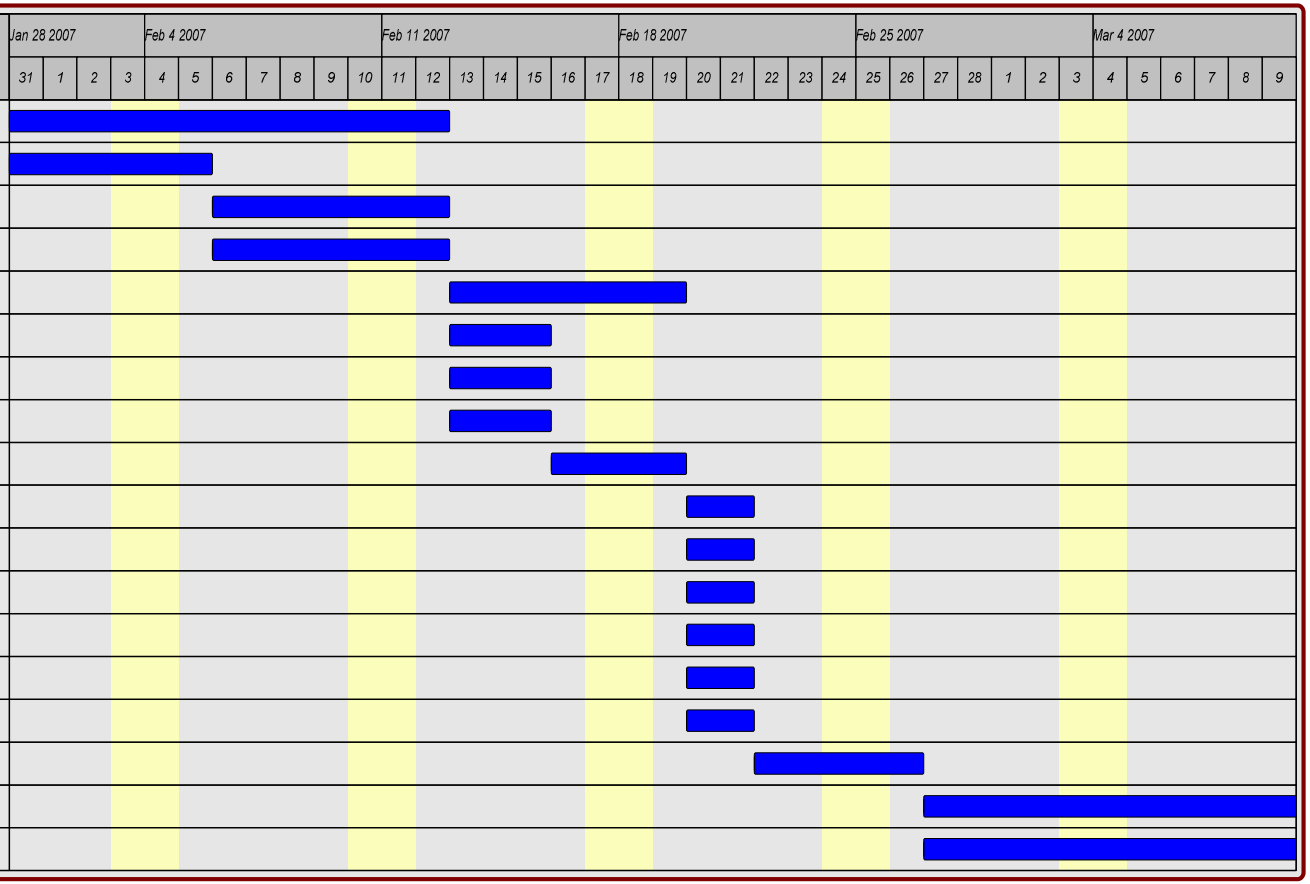
Year	Year 1	Year 2	Year 3	Year 4	After Year 5
Market demand (million lbs)	250	300	400	500	600
Market share (%)	100	97	75	60	50
Expected yield (%)	90	90	90	90	90
Quantity (million lbs)	278	323	333	333	333

- Example: 323 in 2nd year = 300*0.97/0.90
- The function needs to produce about 330 million lbs per year.

Example – PPP Plan

- Schedule/Milestones for PPP

ID	Task Name	Start	Finish	Duration
1	Organize for FEP	1/31/2007	2/12/2007	1.8w
2	- Select team	1/31/2007	2/5/2007	.8w
3	- Draft charter	2/6/2007	2/12/2007	1w
4	- Prepare FEP plan	2/6/2007	2/12/2007	1w
5	Select project alternatives	2/13/2007	2/19/2007	1w
6	- Analyze technology	2/13/2007	2/15/2007	.6w
7	- Evaluate sites	2/13/2007	2/15/2007	.6w
8	- Prepare conceptual scopes/estimates	2/13/2007	2/15/2007	.6w
9	- Evaluate alternatives	2/16/2007	2/19/2007	.4w
10	Develop a project definition package	2/20/2007	2/21/2007	.4w
11	- Analyze project risks	2/20/2007	2/21/2007	.4w
12	- Document project scope and design	2/20/2007	2/21/2007	.4w
13	- Define project execution approach	2/20/2007	2/21/2007	.4w
14	- Establish project control guidelines	2/20/2007	2/21/2007	.4w
15	- Compile project definition package	2/20/2007	2/21/2007	.4w
16	Make decision	2/22/2007	2/26/2007	.6w
17	Decision analysis	2/27/2007	3/9/2007	1.8w
18	- Project Definition Rating Index	2/27/2007	3/9/2007	1.8w



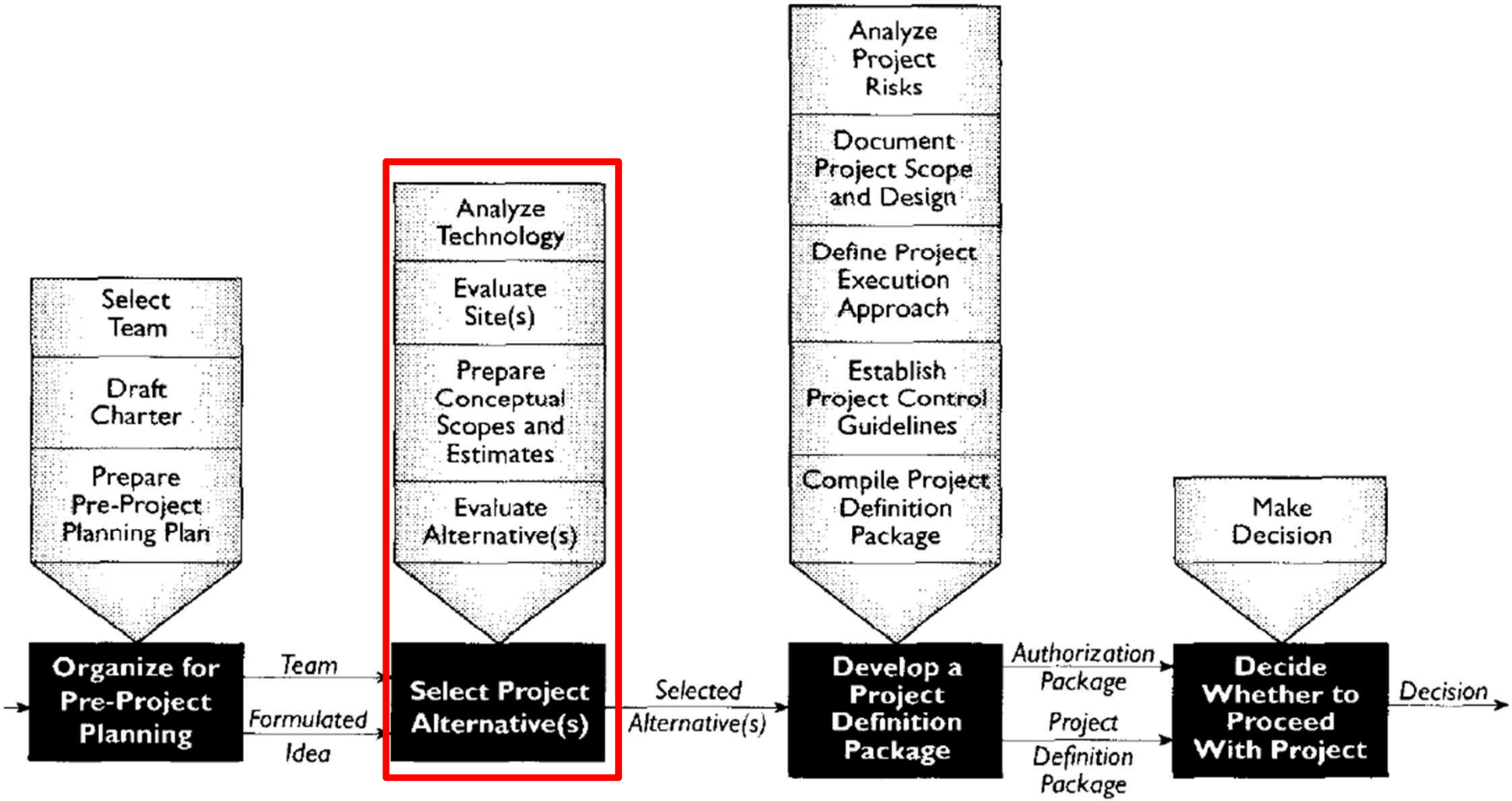
Example – PPP Plan

- **Budget**
  - Total conceptual estimated cost = $160 million
    - Cost for technology = $80 million
    - Other project cost = $80 million
  - Budget for PPP
    - 3-5% of total project budget
    - Since Go/No Go decision needs to be made in a complicated situation that has many alternatives, it had better put the maximum 5% for the PPP budget.
    - Therefore, budget for PPP = 5% * $160 million = $8 million

(1) Organize for PPP

- **Key Issues**
  - Input of right people at right time affects the budget and schedule estimate
  - Project objectives must be set early and align with business objectives
  - PPP should integrate into the capital budgeting schedule
  - Break work into manageable pieces and assign responsibility
  - Begin early and expect to expend resources

(2) Select Project Alternatives



(2) Select Project Alternatives

- **Analyze Technology**
  - Which technology is available for us? New or existing?
  - Needs and constraints of the technology in relation to objectives and problems of the project
  - Experience with processes?
  - Applications and market factors (common?)
  - Cost effective analysis
    - Maximize the net benefits
    - Minimize the amount of resources required
    - Maximize the level of service or other system performance measures
    - Life Cycle Cost Analysis (LCCA)

Example – Analyze Technology

- **Technology Alternative 1**
  - License the APEX™ process owned by Process Improvement Technology Systems (PITS), Inc.
  - Modify for use by adding other associated process technology in advanced development at ACL R&D
  - Research time: 3 months
  - Expected yield: 90%

- **Technology Alternative 2**
  - Develop all new technology process technology in-house
  - Research time: 6 -12 months
  - Expected yield: 95%
  - More expensive

Example – Analyze Technology

- Best choice: Alternative 1 Customization

TECHNOLOGY CONSIDERATION						
NO.	**TECHNOLOGY OBJECTIVES**	**WEIGHT**	**Tech 1 (PITS)**	**SCORE (PITS)**	**Tech 2 (New-in-house)**	**SCORE (New-in-house)**
1.	Cost	20	2	40	1	20
2.	Research Time and Pilot testing	15	2	30	1	15
3.	Efficiency	15	1	15	2	30
4.	Product Quality	10	1	10	2	20
5.	Environmental	5	1	5	2	10
6.	Up gradation	5	1	5	2	10
7.	Feasibility	5	2	10	1	5
8.	Ease of Operation	5	1	5	2	10
9.	Process flexibility	5	2	10	1	5
10.	Safety considerations	5	2	10	1	5
11.	Long-term competitive position	5	1	5	2	10
12.	Risk involved	5	2	10	1	5
	TOTAL SCORES	100		**155**		**145**

2: Best choice, 1: Second choice

(2) Select Project Alternatives

- **Evaluate Sites**
  - Strengths and weaknesses of alternate locations to meet owner requirements and maximize benefits for the owner
  - Concurrent with Analyze Technology
  - Consideration
    - Overall economic choice (present + future)
    - Benefits standpoint (market)
    - Cost standpoint (raw materials, labor, utilities, supply, and distribution cost)
    - Initial investment standpoint (ROI)

Example – Evaluate Sites

- **Location Alternative 1: Texas**
  - Permit time: 9-12 months
  - No seismic sensitivity
  - No dock facilities (major market Southeast Asia)
  - Lower construction cost (lower labor cost)
  - Closer to feedstock/raw materials
  - Lower taxes
- **Location Alternative 2: California**
  - Permit time: 12-18 months
  - Seismic sensitive location
  - Coast with dock facilities (major market Southeast Asia)
  - Higher construction cost (higher labor cost)
  - More environmental restrictions
  - CEO's preference

Example – Evaluate Sites

- Best choice: Alternative 1 Texas

LOCATION CONSIDERATION						
NO.	LOCATION FACTOR	WEIGHT	TX	SCORE	CA	SCORE
1.	Permit time requirement	20	2	40	1	20
2.	Distribution	20	1	20	2	40
3.	General construction cost	15	2	30	1	15
4.	Lowest labor cost	10	2	20	1	10
5.	Feedstock supply	8	2	16	1	8
6.	Close to raw material supply	5	2	10	1	5
7.	Land availability	5	2	10	1	5
8.	Taxes	5	2	10	1	5
9.	Environmental restriction	5	2	10	1	5
10.	Building codes for seismic zones	5	2	10	1	5
11.	CEO's preference	2	1	2	2	4
	TOTAL	100		**178**		**122**

2: Best choice, 1: Second choice

Example – Evaluate Sites

- **Site Specific Alternative 1: Texas**
  - Green-field site, co-located with existing facilities within existing plant
  - Previous location considerations
  - No environmental contamination
  - Minimum impact of wetland
- **Site Specific Alternative 2: California**
  - Recently mothballed facility (New facility can be developed by revamping this, and using as many of the existing components as possible)
  - Previous location considerations
  - No environmental contamination

**mothballed facility: a condition of long storage for possible future use*

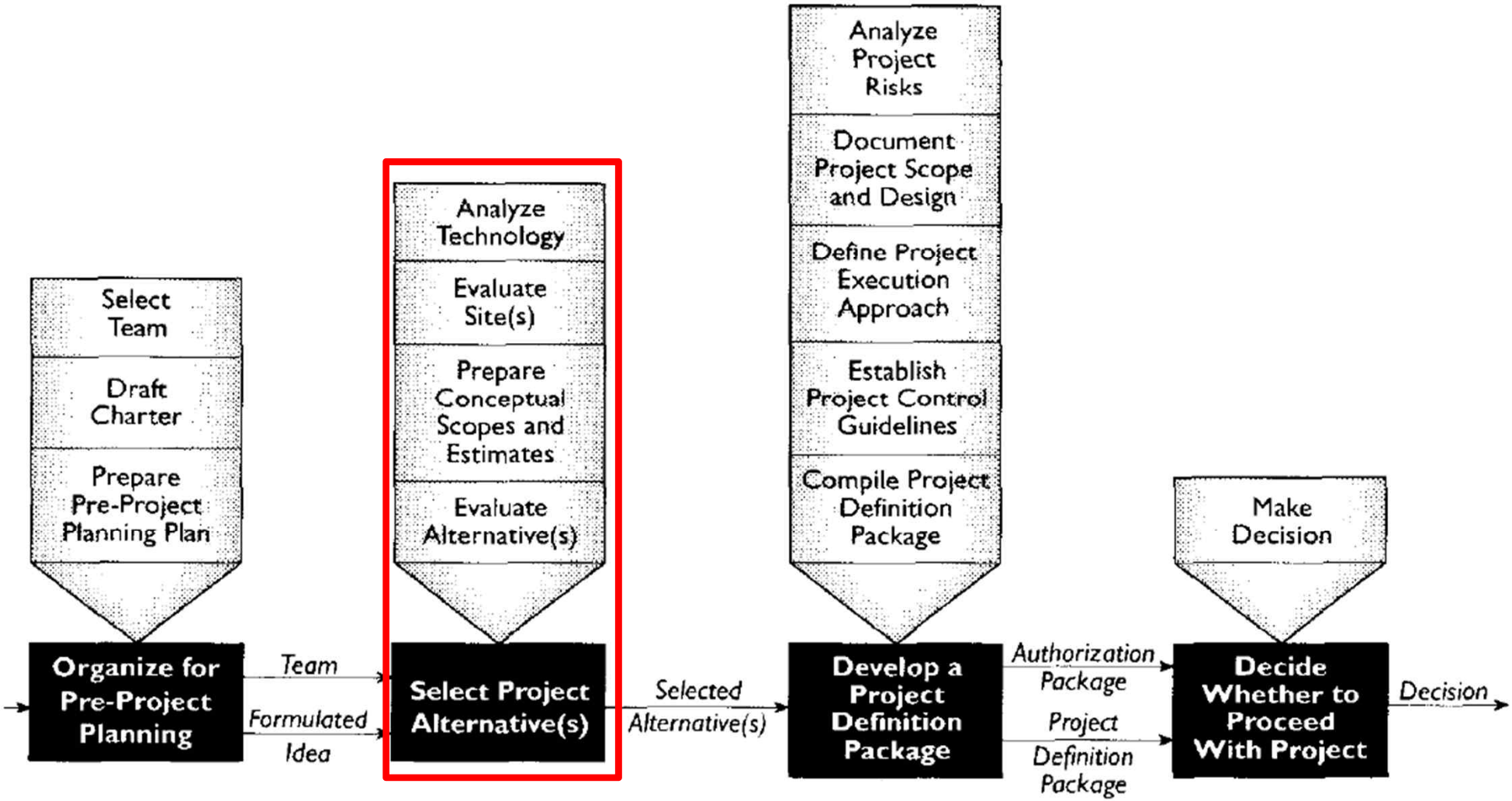
Example – Evaluate Sites

- **Best choice: Alternative 1 Texas**

SITE SPECIFIC CONSIDERATION						
NO.	**SITE OBJECTIVES**	**Weight**	**TX**	**Score**	**CA**	**Score**
1.	Ability to expand for future Capacity	**15**	2	30	1	15
2.	Access to markets	**12**	1	12	2	24
3.	Technology Compatibility	**10**	2	20	1	10
4.	Access to raw material/ feed stock	**9**	2	18	1	9
5.	Land availability	**9**	2	18	1	9
6.	Ability to attract and retain professional employees	**8**	2	16	1	8
7.	Competitor considerations	**8**	1	8	2	16
8.	Legal and Taxation issues	**7**	2	14	1	7
9.	Property tax rate	**6**	2	12	1	6
10.	Construction Costs	**6**	1	6	2	12
11.	Environmental Site Constraints	**5**	1	5	2	10
12.	Land acquisition cost	**5**	2	10	1	5
	Sub-Total	100		**169**		**131**
NO.	**SITE CHARACTERSTICS**	**Weight**	**TX**	**Score**	**CA**	**Score**
1.	Soil characteristics	**13**	2	26	1	13
2.	Seismicity	**13**	2	26	1	13
3.	Contiguous/neighboring area characteristics	**9**	2	18	1	9
4.	Hazardous waste clean up considerations	**9**	2	18	1	9
5.	Historical implications	**9**	1	9	2	18
6.	Weather and Climate	**8**	1	8	2	16
7.	Traffic/ communications/convenience	**8**	2	16	1	8
8.	Minimum start up time	**7**	2	14	1	7
9.	Hydrological considerations	**7**	1	7	2	14
10.	Topography	**6**	1	6	2	12
11.	Site layout	**6**	2	12	1	6
12.	Surface run off considerations	**5**	2	10	1	5
	Sub-Total	100		**170**		**130**
	TOTAL			**339**		**261**

2: Best choice, 1: Second choice

(2) Select Project Alternatives



(2) Select Project Alternatives

- **Prepare Conceptual Scopes and Estimates**
  - Provide input data for financial analysis during the next step: Evaluation of Alternatives
  - Reduce uncertainties to an acceptable risk level
  - Define boundaries
  - Avoid excess details
  - **Not** final estimate

(2) Select Project Alternatives

- **Prepare Conceptual Scopes and Estimates**
  - Project scope questions might include:
    - What type of construction is desired?
    - How much power is required to operate?
    - Where are the closest existing utilities located?
  - Usage scope questions might include:
    - What size of equipment is needed to meet our volume production?
    - What are the emissions limitation?
    - How much maintenance can be anticipated?

Example – Scope and Estimate

- **Best choice: Alternative 1 Texas**

			TX		CA	
A.	**PROCESS OPERATIONS**	**Weight**	**Impact**	**Score**	**Impact**	**Score**
1	Process reliability	**20**	3	60	3	60
2	Design concept	**15**	3	45	3	45
3	Emission parameters	**13**	2	26	2	26
4	Effluent characteristics	**12**	2	24	2	24
5	Feedstock proximity	**9**	3	27	2	18
6	O/M personnel availability	**8**	2	16	2	16
7	Existing employees' familiarity with process	**8**	2	16	2	16
8	Equipment List	**5**	3	15	3	15
9	Area requirement	**5**	3	15	3	15
10	Population separation requirement	**5**	3	15	3	15
11	**Sub-Total (A)**	100		**259**		**250**

1: High, 2: Medium, 3: Low Impact to Estimate

Example – Scope and Estimate

- **Best choice: Alternative 1 Texas**

1: High, 2: Medium, 3: Low

B.	SITE/BUILDING FACTORS	Weight	Impact	Score	Impact	Score
	Impact on plant start-up	**18**	3	54	2	36
	New Facility/ Renovation	**14**	3	42	3	42
	Cost implications	**10**	2	20	2	20
	Time implication	**10**	2	20	2	20
	Adequate accommodation space	**9**	2	18	2	18
	Roadways and bridges requirement	**9**	3	27	3	27
	Seismicity	**7**	2	14	1	7
	Soil characteristics	**6**	3	18	1	6
	Parking requirements	**5**	2	10	2	10
	Topography	**5**	2	10	1	5
	Cafeteria requirement	**4**	2	8	2	8
	Landscape	**3**	1	3	1	3
	Sub-Total (B)	100		**244**		**202**
C.	**UTILITY CONSIDERATIONS**	**Weight**	**Impact**	**Score**	**Impact**	**Score**
	Electrical system layout	**19**	3	57	2	38
	Number of meters required	**15**	3	45	2	30
	State/ Captive generation requirements	**17**	3	51	3	51
	Service water layout	**11**	3	33	2	22
	Drinking Water Layout	**8**	2	16	1	8
	Sewerage system	**8**	2	16	1	8
	DM water layout	**7**	3	21	1	7
	Cooling Water system	**7**	3	21	1	7
	Steam system layout	**4**	3	12	1	4
	Compressed air layout	**4**	3	12	1	4
	Sub-Total(C)	100		**284**		**179**
	TOTAL (A+B+C)			**787**		**631**

(2) Select Project Alternatives

- **Evaluate Alternatives**
  - Identify best alternative(s)
  - More than one alternative
    - Recognize
    - Allow time
    - Provide flexibility
  - Consistent evaluation criteria for analysis and comparison
    - Benefits, investment and timing, working capital, operating/non-operating requirements, business risk/ profitability, economic analysis

Example – Evaluate Alternatives

- **Technology Alternative 1 (APEX™): Best Choice**
  - Proven technology, with some modification requirement
  - Lower cost
  - Safer
  - More flexible
- **Site Texas: Best Choice**
  - Lower construction cost
  - Lower green-field establishment permits
  - Good resources from Texas regions
  - Efficient layout
  - Preliminary findings suggest minimum impact of wetlands
  - Transportation infrastructure growth in Texas
  - Lower land cost and property taxes

Example – Evaluate Alternatives

- **Critical scoping estimating parameters**
  - Process reliability
  - Design concept
  - Emission parameters
  - Effluent characteristics
  - Early commissioning
  - Technology/site cost implications
  - Electrical systems
  - Power generation
  - Service water systems

(2) Select Project Alternatives

- **Key Issues**
  - Cost vs. Time vs. Expertise
  - Alternatives affect both initial cost and downstream costs, including dispute potential
  - Economic vs. non-economic decision criteria
  - Understand the accuracy of estimates at this phase
  - Identify best alternative(s)