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Aalto University  
School of Chemical  
Engineering

# CHEM-E0115 Planning and Execution of a Biorefinery Investment Project (5 cr)

*Lecture 2  
Investment planning and decision making phase  
September 23, 2021  
Antti Mattelmäki*

# Agenda

- I. Introductions**
- II. What is a Project?**
- III. Investment Planning Process**
- IV. Feasibility Studies & Pre-Engineering Activities**
- V. Project Implementation Methods**
- VI. Project Financials: Budgeting and Financials Reporting**
- VII. Conclusions**

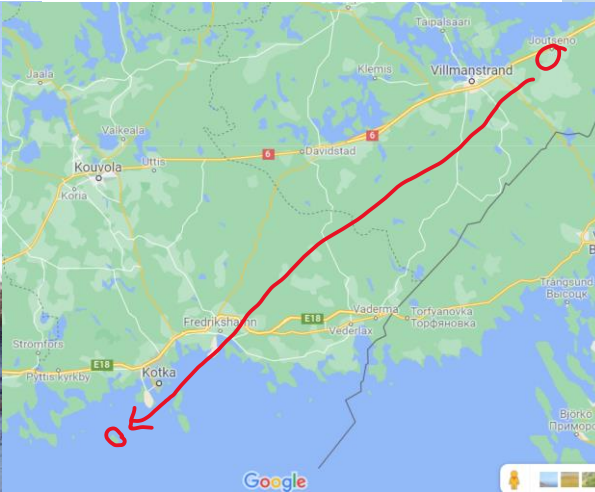


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# I. Introductions

# Antti Mattelmäki

<b>Project Manager, Process Industries at AFRY,</b>	<b>01/2020 –</b>
Andritz Oy, Sales Manager, Recovery Boilers	06/2013 - 12/2019
Andritz Oy, Sales Engineer, Recovery Boilers	02/2011 - 05/2013
Pöyry Finland Oy, Department Manager, Process Engineering	12/2008 - 01/2011
Andritz Oy, Process Engineer, White Liquor Plants	07/2005 - 11/2008
Andritz Oy, Sales Engineer, White Liquor Plants	09/2001 - 06/2005
Andritz-Ahlström Oy, Research Engineer, Heat Engineering	11/2000 - 08/2001
University of Oulu, Department of Process and Environmental Engineering	1995-2000



# II. What is a project?

# What is a project?

A project is a temporary effort that aims to a targeted goal, creating a unique outcome with limitations of time, costs and resources



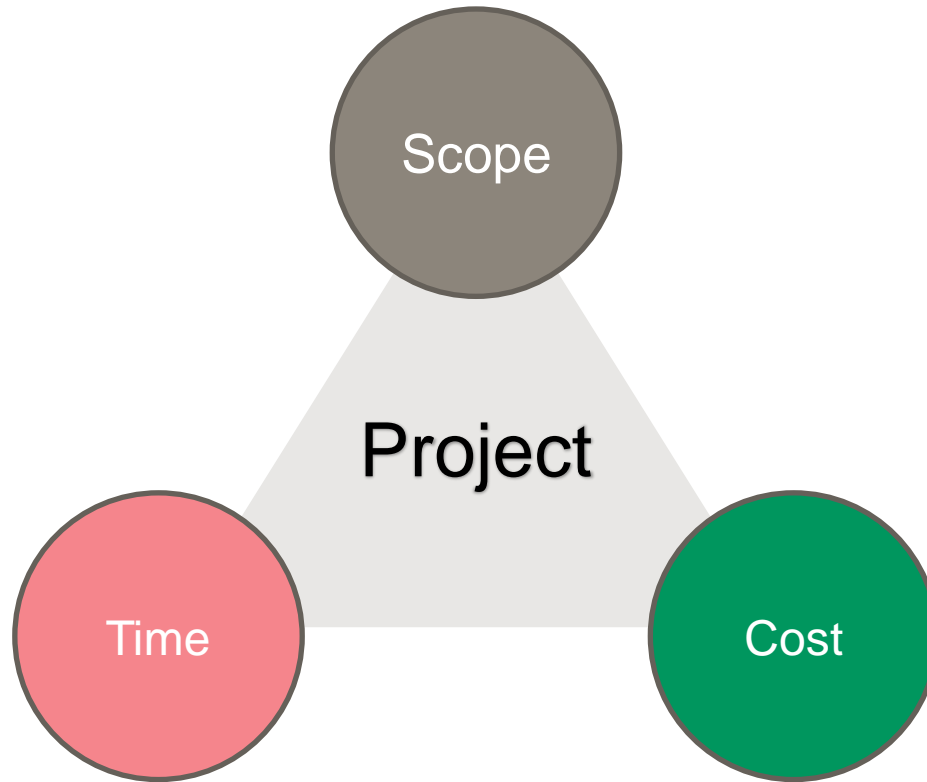
Project characteristics

Defined scope

Defined time schedule

Defined budget

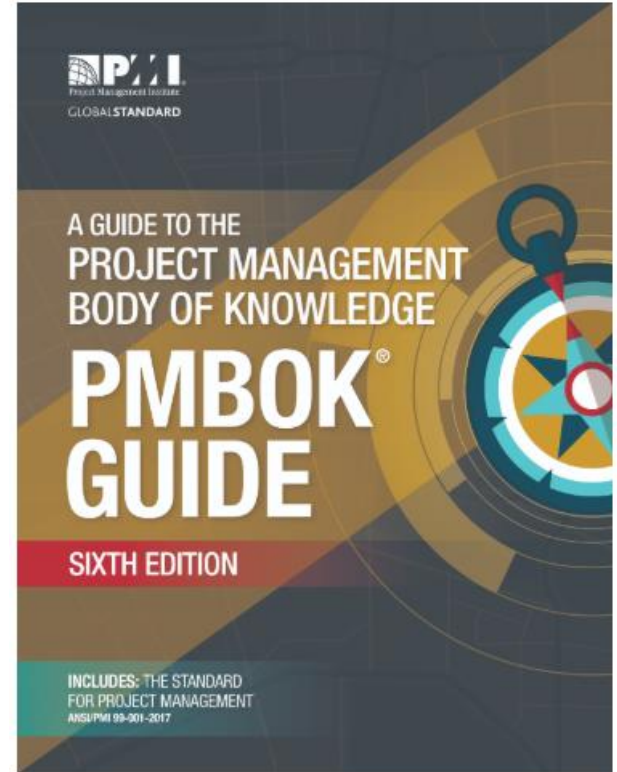
# Dimensions of Project Management





# PMBOK Knowledge Areas

- I. Project Integration Management
- II. Project Scope Management**
- III. Project Schedule Management**
- IV. Project Cost Management**
- V. Project Quality Management
- VI. Project Resource Management
- VII. Project Communications Management
- VIII. Project Risk Management
- IX. Project Procurement Management
- X. Project Stakeholder Management



# Scope Related Processes

**Include a description of the project product, its characteristics and how they are to be measured or assessed:**

## **Concept Development**

- Defining outlines of what the project product will do

## **Scope Development and Control**

- Documenting characteristics of the project product in measurable terms and controlling them

## **Activity Definition**

- Identifying documenting activities and steps required to achieve the project objectives

## **Activity Control**

- Controlling actual work carried out in the project

# Time Related Processes

**Aim to determine duration of activities and to ensure timely completion of the project:**

## **Activity Dependency Planning**

- Identifying inter relationships and the logical interaction and dependencies among project activities

## **Duration Estimation**

- Estimating duration of each activity in connection with the specific conditions and with the resources required

## **Schedule Development**

- Inter relating the project time objectives, activity dependencies and their durations as the framework for developing general and detail schedules

## **Schedule Control**

- Controlling realisation of the project activities, for confirming the proposed schedule or for taking adequate actions for recovering from delays

# Cost Related Processes

**Aim to forecast and manage the project costs and to ensure that the project is completed within budget:**

## **Cost Estimation**

- Developing cost estimates for the project

## **Budgeting**

- Using results from cost estimation to produce the project budget

## **Cost Control**

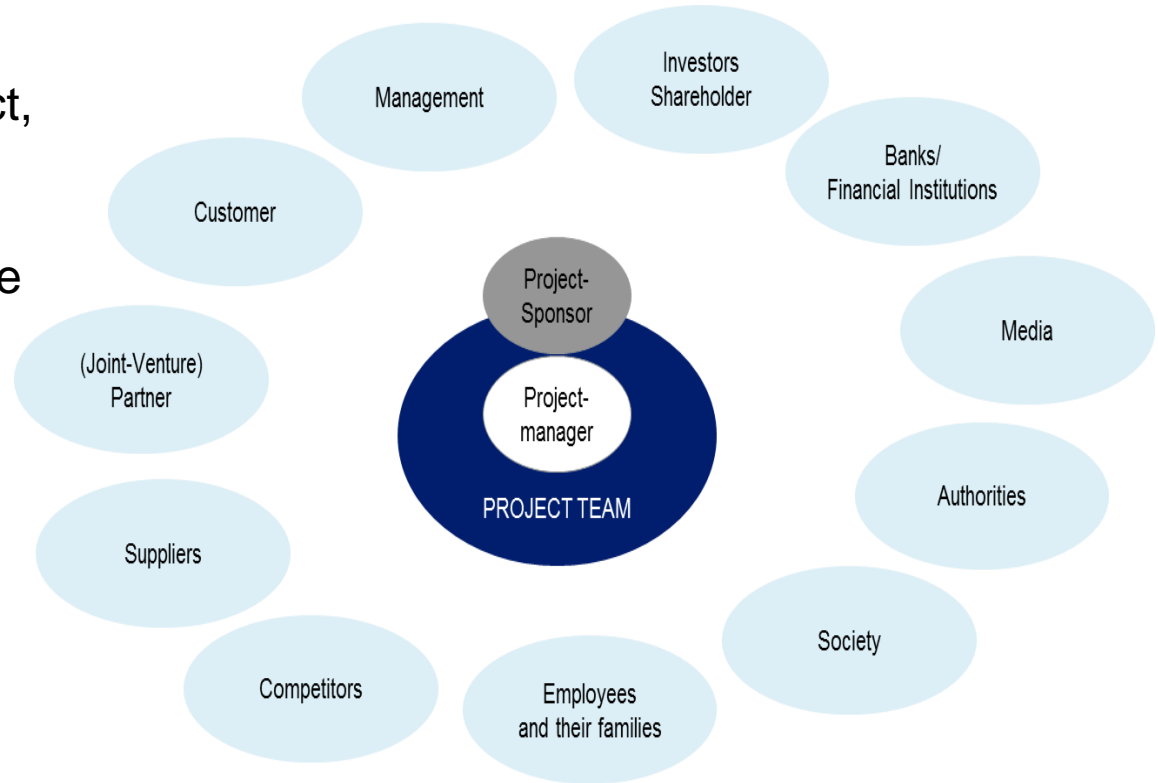
- Controlling costs and deviations from the project budget

# Project Functions

MAIN PROJECT FUNTIONS		Production
PROJECT SUPERVISION		<p>These main Functions cover the whole sphere of responsibilities required in any project – <b>irrespective of who does them</b></p>
PROJECT MANAGEMENT		
ENGINEERING MANAGEMENT		
PROCUREMENT MANAGEMENT		
CONSTRUCTION MANAGEMENT		
COMMISSIONING MANAGEMENT		
PROJECT CONTROL	PREPARATION FOR OPERATION	
QUALITY ASSURANCE	HEALTH, SAFETY AND ENVIRONMENT	
SECURITY MANAGEMENT	PERMITTING ASSISTANCE	

# Stakeholders

“an individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project”





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# 90% of Project Manager's tasks are about communication

*Quick quiz:*

- *Form a three person groups and discuss for 10 minutes how would you deal the following situation.*
- *Make notes and prepare to share two most important findings with the class.*





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# Case

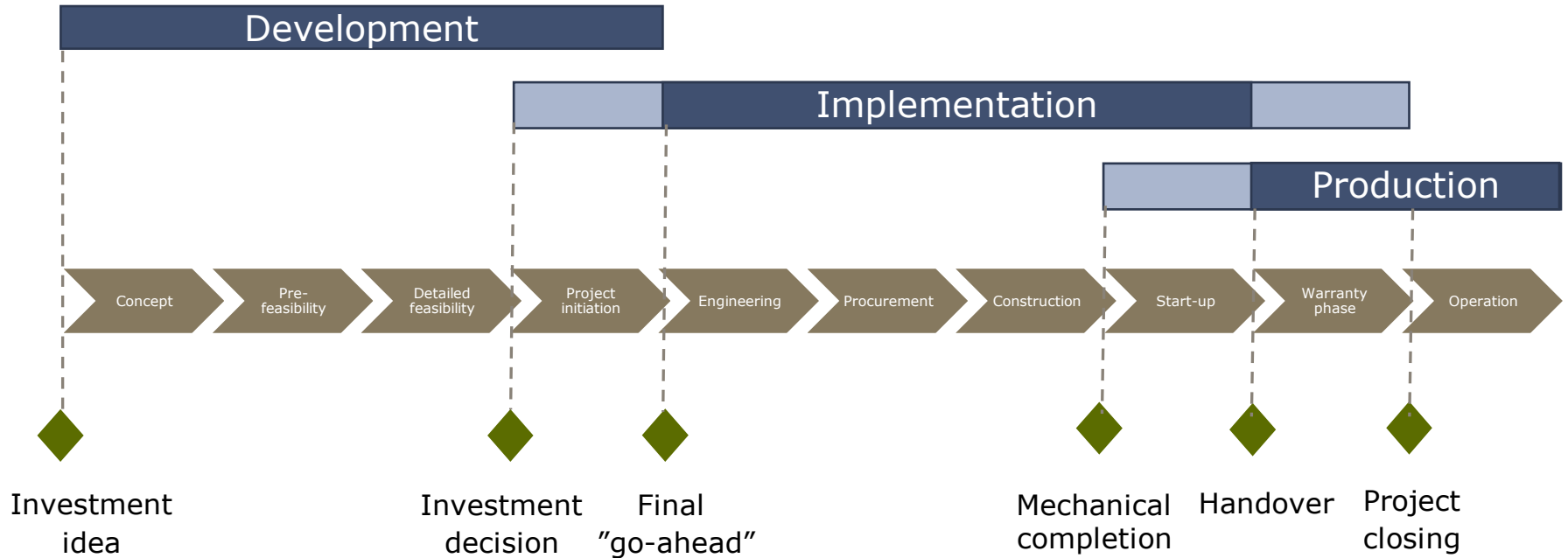
**You are a project manager and you receive phone call from one of your engineers. He says that he has not been able to send his engineering documents to the customer for customer's approval due to issues with the documents.**

**Project assistant has not been able to send out the material because the engineer did not use correct document management practices. Time is running and you would need to receive the customer comments to the engineering documents by next week to keep the project time schedule. What do you do?  
(10 minutes)**

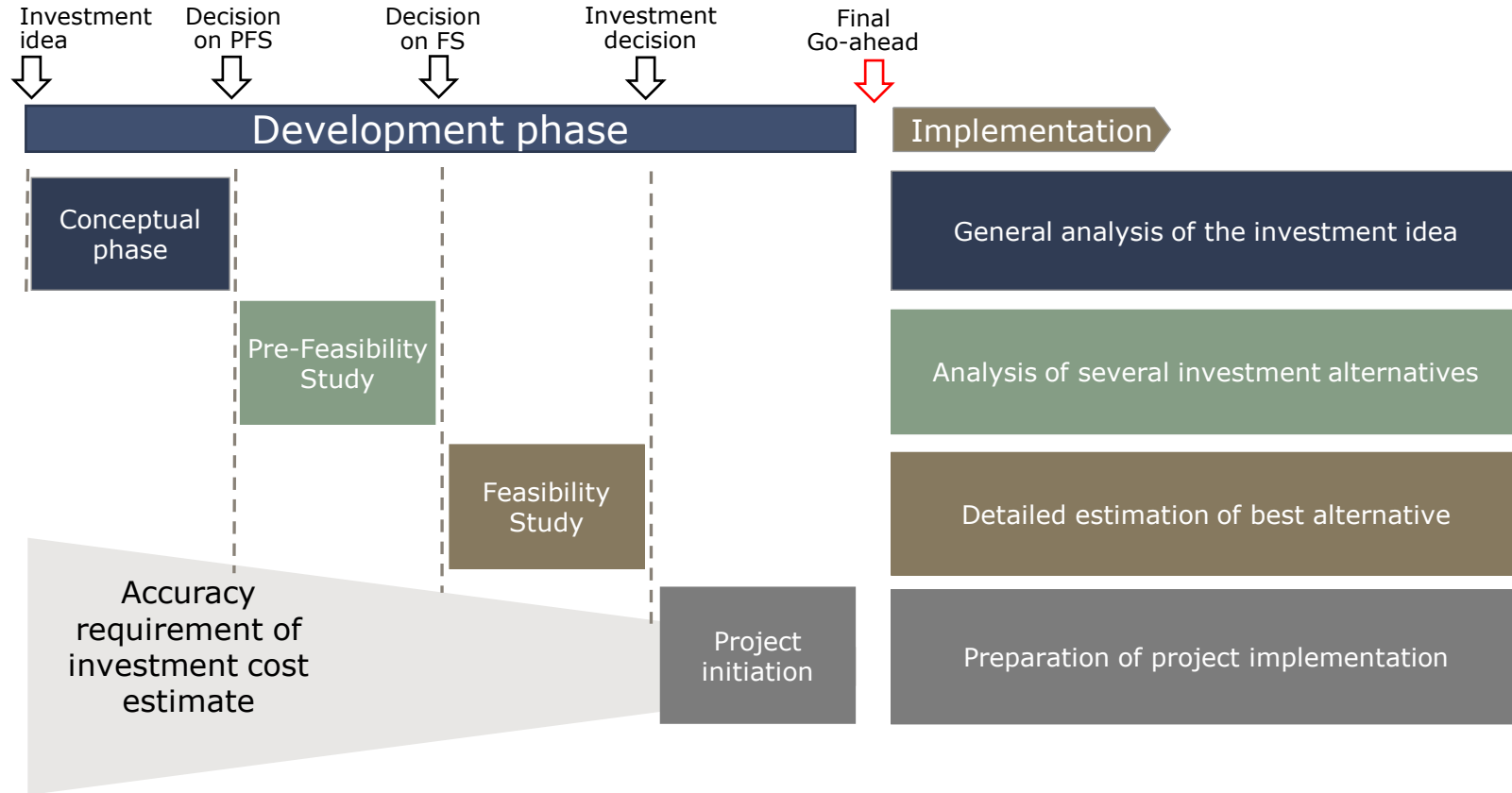


# III. Investment Planning Process

# Investment Project Life Cycle



# Investment Planning Process



# Project Development



General analysis of the investment idea

- Market analysis
- Product analysis
- Brief financial analysis

Analysis of several investment alternatives

- Analysis of different production processes
- Preliminary project execution concept
- Analysis of different market scenarios
- Analysis of location for production
- Preliminary investment cost estimate
- Preliminary profitability analysis

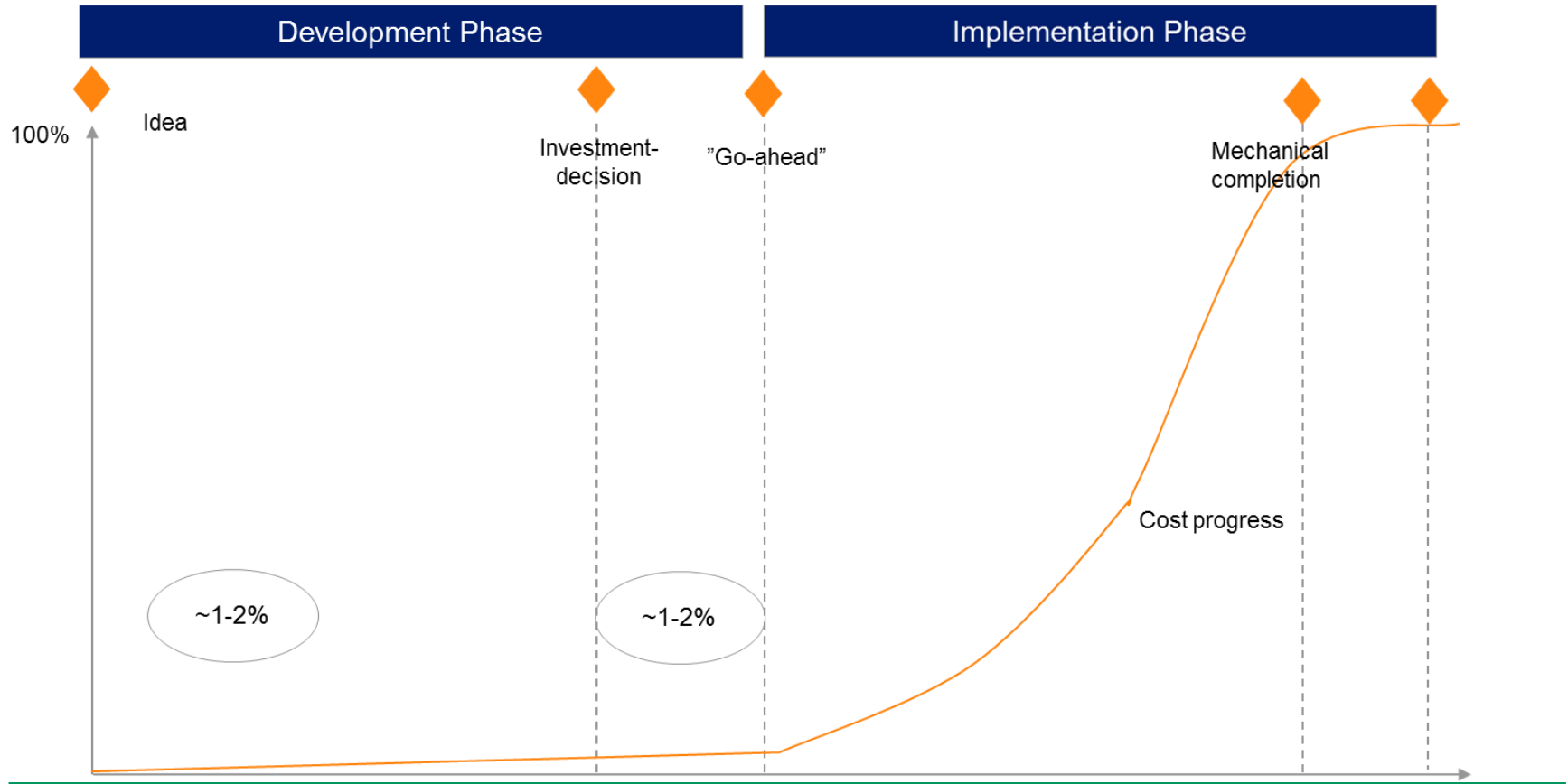
Detailed investigation of best investment alternative

- Pre-/Basic Engineering
- Implementation concept
- Raw material supply
- Marketing and sales strategy
- Organization structure
- Investment cost budget
- Detailed profitability analysis
- Financing concept
- Procedure for authority approvals

Preparation of project implementation

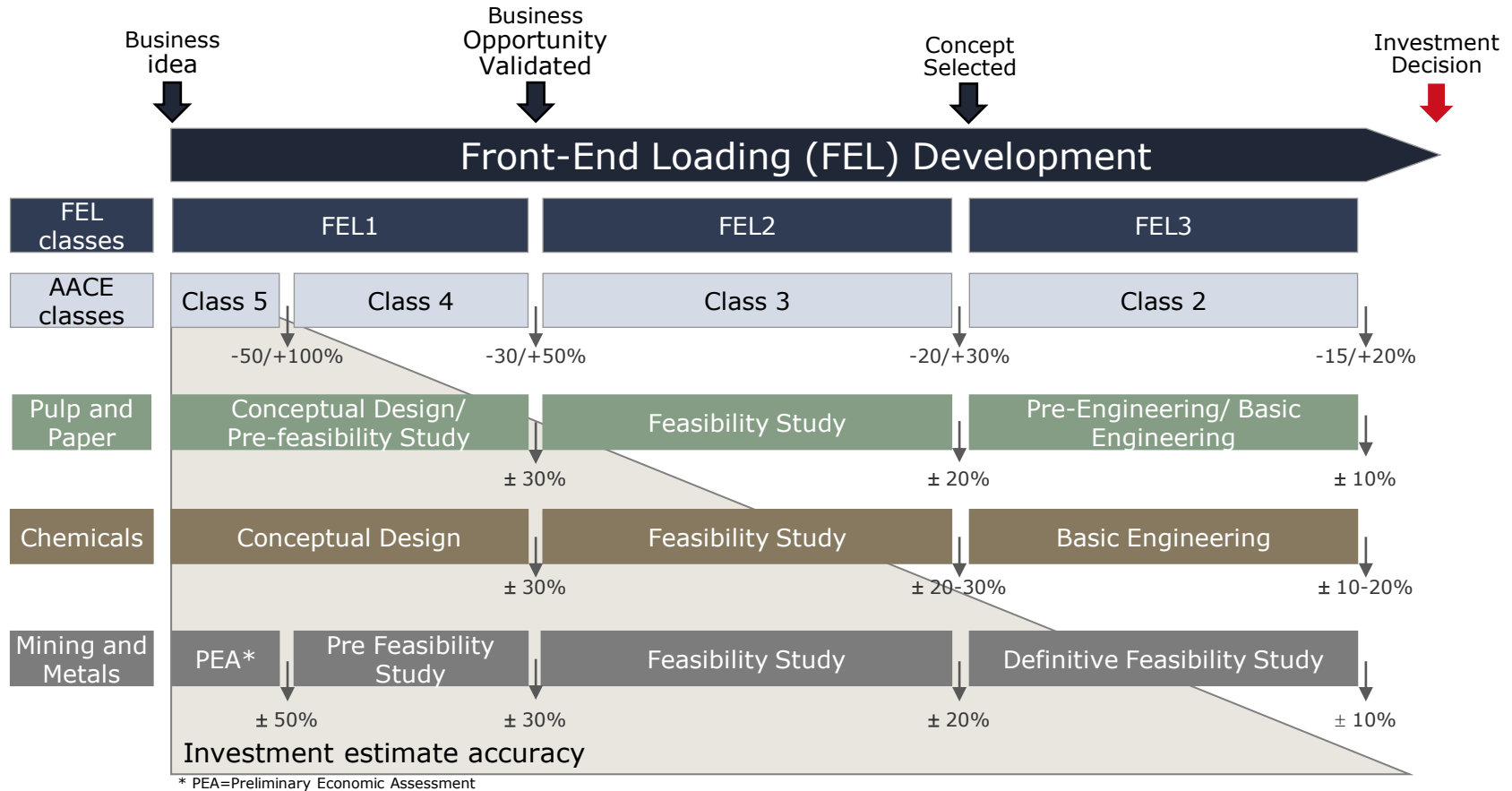
- Detailed execution planning
- Inquiry and negotiations of main execution packages
- Start approval procedure with authorities
- Closing of financial arrangements

# Time Frame of Investment Cost

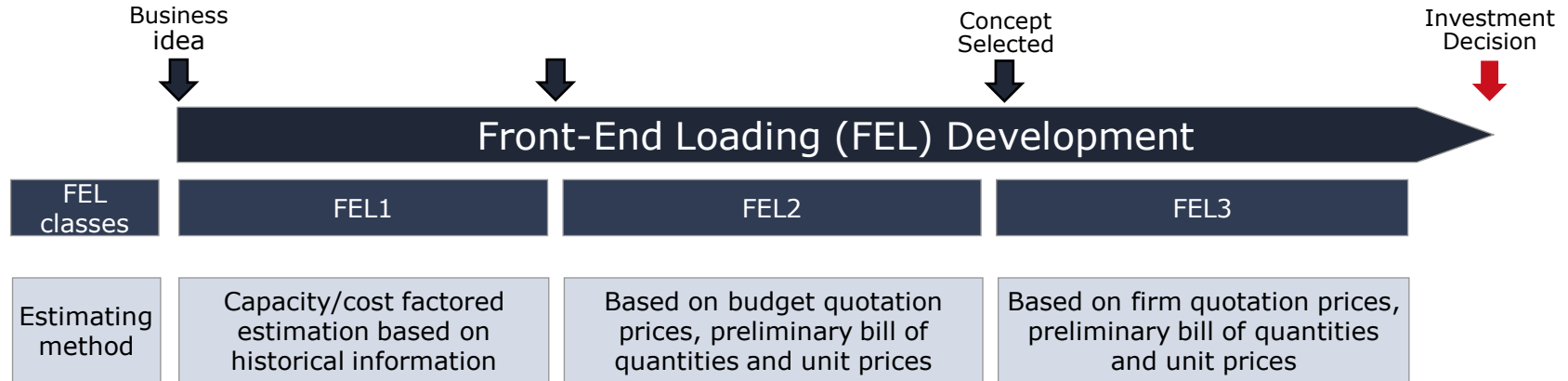


# IV. Feasibility Studies & Pre-Engineering Activities

# FRONT END-LOADING (FEL) AND COST ESTIMATE ACCURACY



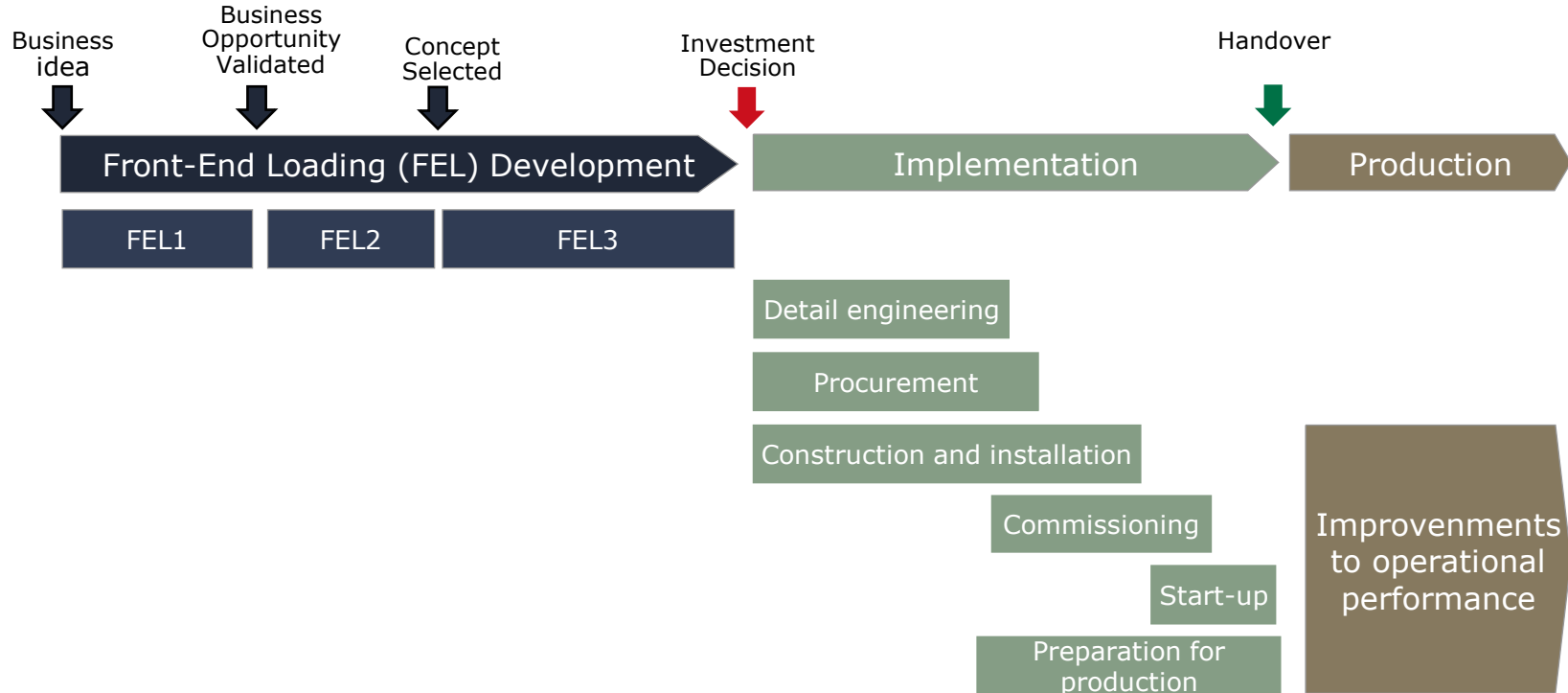
# FRONT END-LOADING (FEL) AND ESTIMATING METHODS



1. The estimating method is selected according to the accuracy required
2. The method may also be influenced by AFRY's familiarity with the type of project and the content of our cost database
3. Existing methods for the various disciplines and cost categories varies from project to project
4. Requirements for engineering deliverables also define reasonable and achievable accuracy level



# Project Lifecycle



# Main Components of Feasibility Studies

	Pre-Feasibility study	Feasibility study
Raw material	<ul style="list-style-type: none"><li>• Forest resources</li><li>• Forest operations</li><li>• Wood supply</li></ul>	<ul style="list-style-type: none"><li>• Forest inventory</li><li>• Forest management</li><li>• Logging &amp; Wood transportation</li><li>• Cost of raw material</li></ul>
Markets	<ul style="list-style-type: none"><li>• Demand and competition</li><li>• Product mix</li><li>• Sales prices</li></ul>	<ul style="list-style-type: none"><li>• Product development</li><li>• Market shares &amp; Sales volumes</li><li>• Marketing strategy</li><li>• Distribution system</li></ul>
Infrastructure	<ul style="list-style-type: none"><li>• Mill location</li><li>• Transport connections</li><li>• Supplies and facilities</li></ul>	<ul style="list-style-type: none"><li>• Site &amp; community development</li><li>• Water, power &amp; fuel supply</li><li>• Materials &amp; chemicals supply</li><li>• Logistics development</li></ul>

# Main Components of Feasibility Studies

	Pre-Feasibility study	Feasibility study
Mill concept	<ul style="list-style-type: none"><li>• Process development</li><li>• Environmental protection</li><li>• General layouts</li></ul>	<ul style="list-style-type: none"><li>• Process flow diagrams</li><li>• Material balance sheets</li><li>• Building &amp; structures</li><li>• Description of main equipment</li></ul>
Human resources	<ul style="list-style-type: none"><li>• Manpower survey</li><li>• Manpower requirements</li><li>• Manpower costs</li></ul>	<ul style="list-style-type: none"><li>• Detailed organisation structure</li><li>• Recruitment and training plan</li><li>• Detailed personnel costs</li><li>• Know-how transfer</li></ul>
Economic aspects	<ul style="list-style-type: none"><li>• Manuf. &amp; investment cost</li><li>• Economic and financial evaluation</li><li>• Financing</li><li>• Institutional and legal aspects</li></ul>	<ul style="list-style-type: none"><li>• Detailed manufacturing &amp; investment cost estimates</li><li>• Financing &amp; Construction schedules</li><li>• Commercial profitability</li><li>• Contribution to National Economy</li></ul>

# IV. Project Implementation Methods

# Introduction

- The project **implementation policy or –method** is a model which describes **how** a single project will be implemented
- In addition to main models there are **mixtures of all these**, and also different names given to these mixtures or even to same methods
- **Money is one driver** in selection of the implementation method
- **Different players** in the project favor different implementation policies but also their **main driver is money**
- End of the day its the **client** who **decides** which way to go and will also take the consequences
- There is **no one single policy or method that is superior** to others in all cases. The evaluation have to be done case by case
- Selection of any policy or method will not make any work to disappear but it will cast the **corner stone for project success or failure**

# Decision Parameters

What could be parameters  
for the  
project implementation  
method?

# Project Implementation Method

- The right implementation method is crucial to **meet cost and schedule targets** of the project
- **Regardless of the implementation method same work has to be done**
- Selection of the implementation method **determines the roles, responsibilities and liabilities** of the project parties in performing, supervising and approving
- **Interactive work** is a necessity to reduce the investment costs
- Common language, standard **scope definitions**, transparency and clarity are needed

# Decision Parameters

**In implementation method decision-making process, a large number of aspects related to the project execution need to be taken into account, such as:**

- Financing concept?
- Previous experiences of methods, pros and cons?
- Availability of own personnel to manage and control the project?
- Availability of experienced suppliers, contractors, service providers?
- Who has the main process core knowledge in several processes?
- How to effectively integrate several processes i.e. efficient interface management?
- Main challenge in project – Project Driver?
- Project complexity and degree of tailoring?
- Own risk taking?

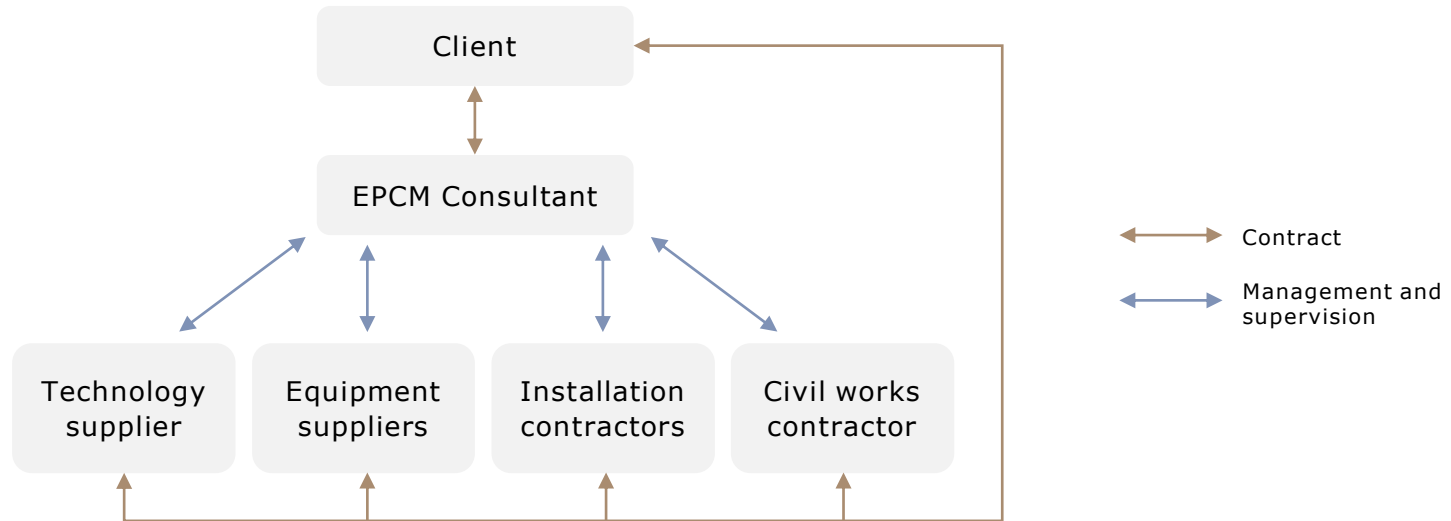


# Implementation Methods, examples

- EPCM = **E**ngineering - **P**rocurement - **C**onstruction **M**anagement
- EPS = **E**ngineering - **P**rocurement – **S**upervision/Service/Supply
- EPC = **E**ngineering - **P**rocurement - **C**onstruction
- OB = **O**pen **B**ook
- EP = Engineering - Procurement
- ESS = Extended Scope of Supply
- BOO = Build-Own-Operate
- BOOT = Build-Own-Operate-Transfer
- BOT = Build-Own-Transfer
- DB = Design-Build
- DBO = Design-Build-Operate
- DBFO = Design-Build-Finance-Operate
- FBO = Finance-Build-Operate
- FBOM = Finance-Build-Operate-Maintain

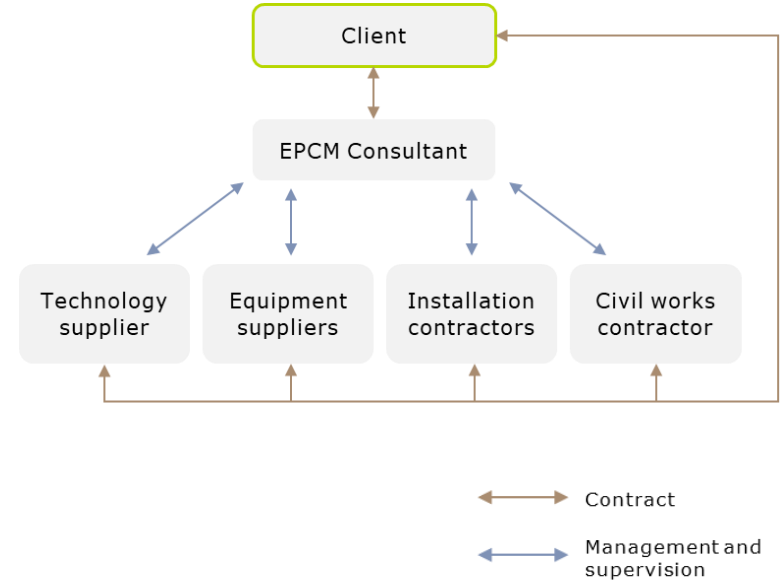
# EPCM – Principle Structure

Engineering – Procurement – Construction Management



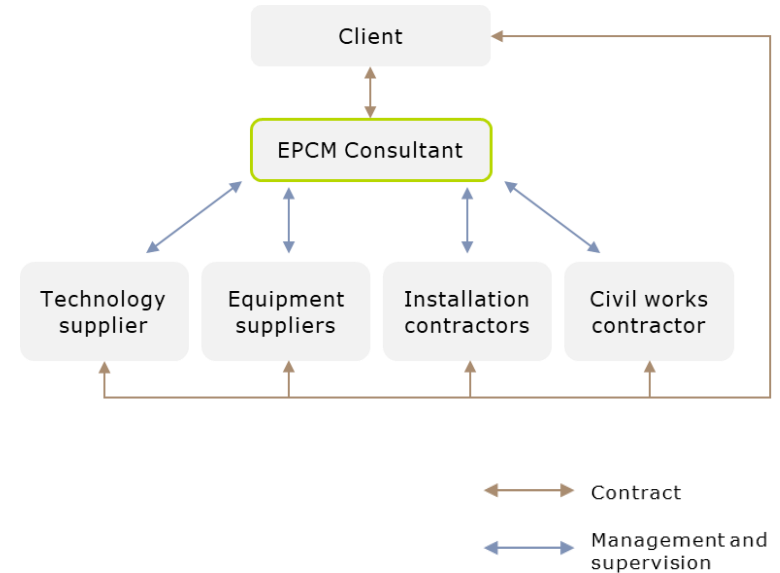
# EPCM – Roles and responsibilities

- **Client** is the owner of the project
- Has the ultimate responsibility of the project
- Is in contractual relationship with suppliers and contractors
- Makes all critical decisions in the project to ensure
  - Minimum risks in execution
  - Minimum risks in cost escalations
  - The quality of the services provided
- Is responsible to apply all permits needed



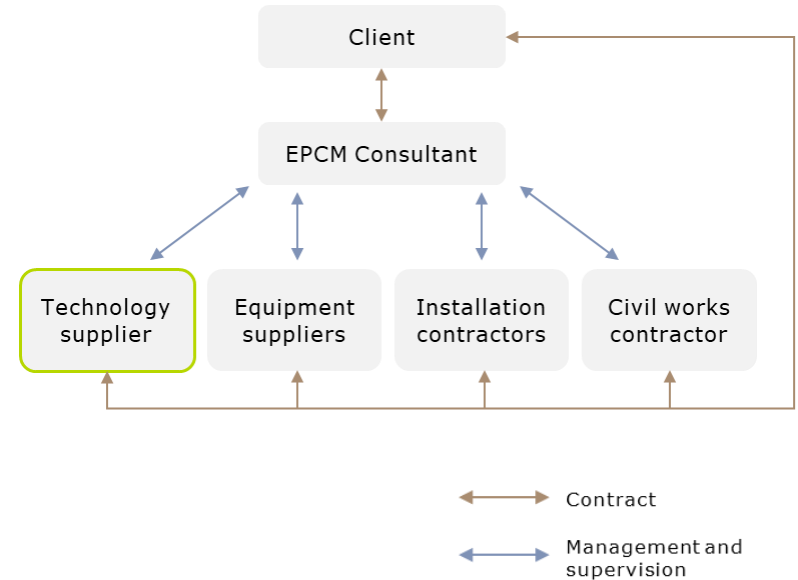
# EPCM – Roles and responsibilities

- **EPCM Consultant** ensures the execution of the project within the scope of the EPCM Contract
- Manages the project incl. detail engineering, procurement and construction within the time schedule and budget
- Responsible to coordinate the activities between the project parties
- Responsible for detailed engineering
- Facilitates permitting



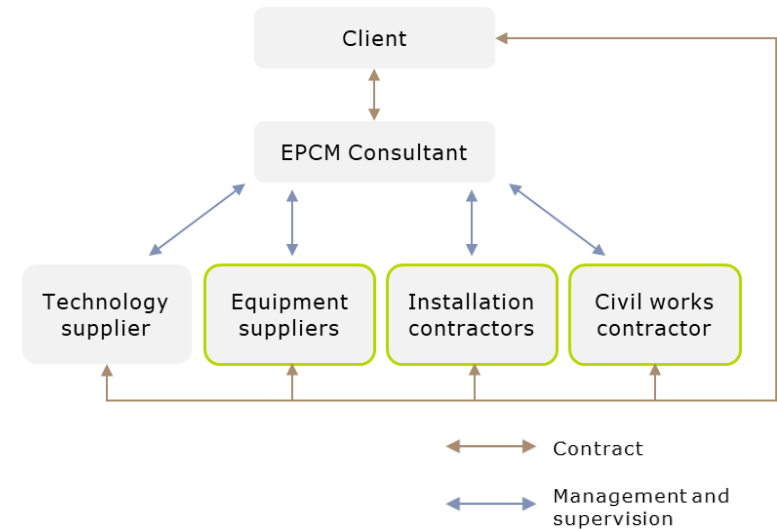
# EPCM – Roles and responsibilities

- **Technology Supplier** provides technology licensor package and may supply main equipment
- Gives performance guarantees for the technology
- Participates in the detailed engineering
- Participates in the commissioning and start-up
- Gives operational instructions

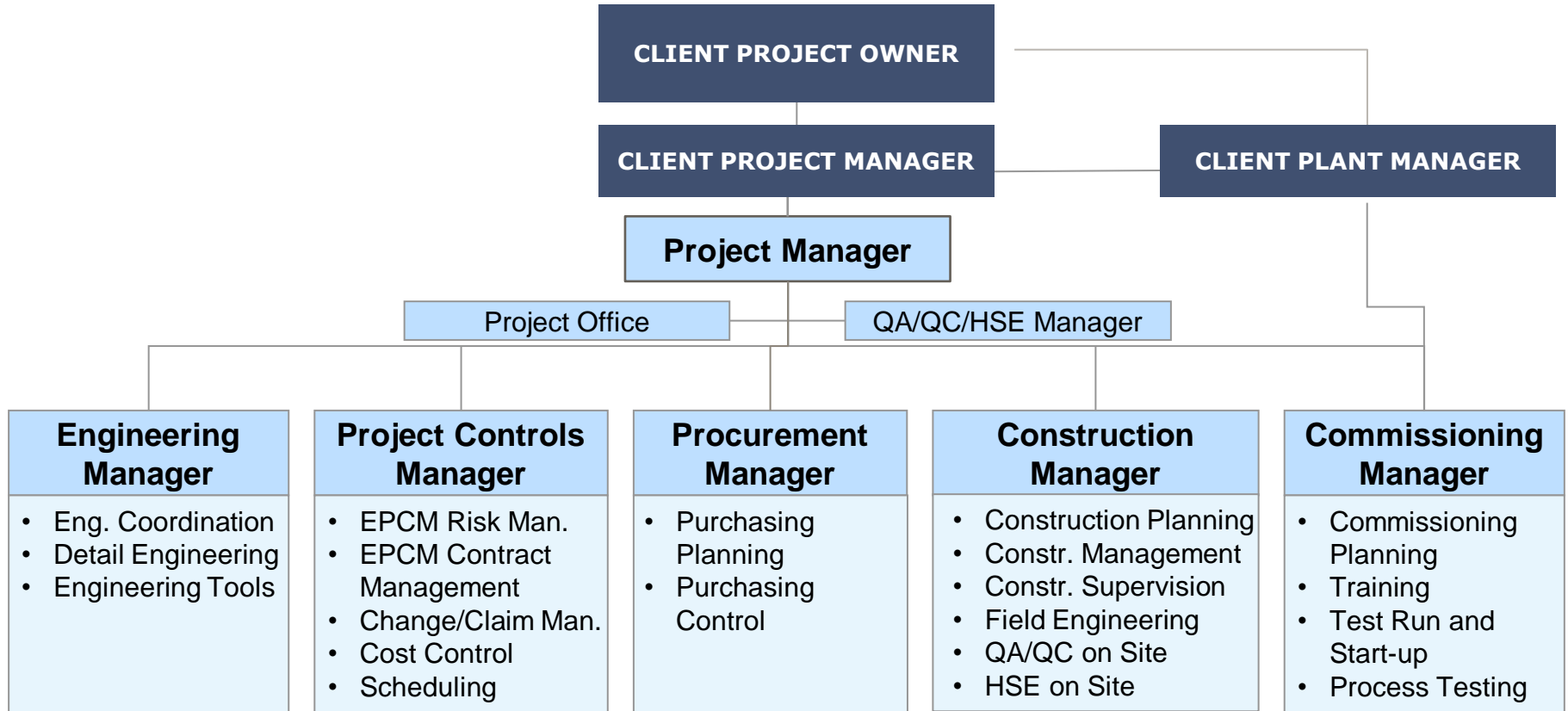


# EPCM – Roles and responsibilities

- Managed by the EPCM consultant
- Liable for their works
- Equipment suppliers
  - Manufacturing and supply of equipment
  - Guarantees for the equipment
  - Training of the operating personnel
  - Participates in the commissioning and start-up
- Installation contractors
  - Typically two main installation contracts signed
    - Automation & electricity
    - Piping & equipment assembly
- Civil works contractor
  - Responsible for the building and infrastructure construction

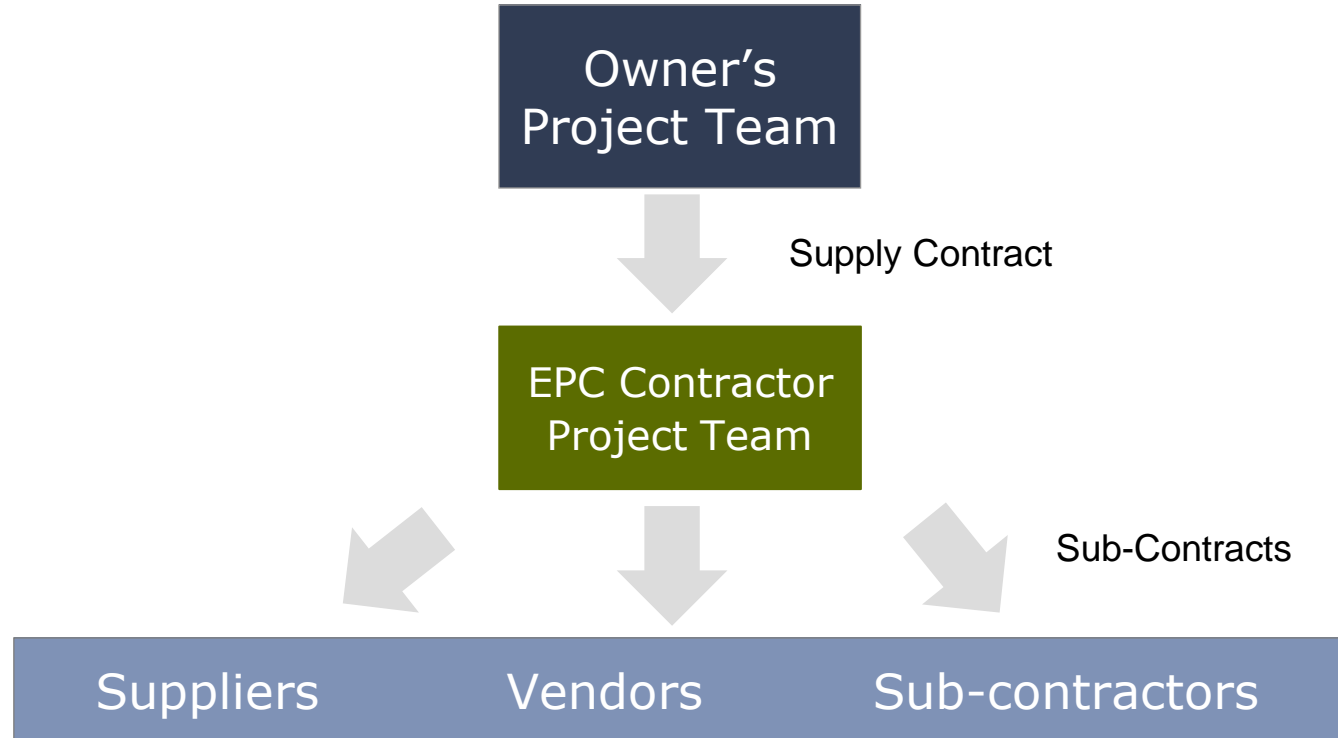


# EPCM Project Organisation



# EPC – Principle Structure

Engineering – Procurement – Construction

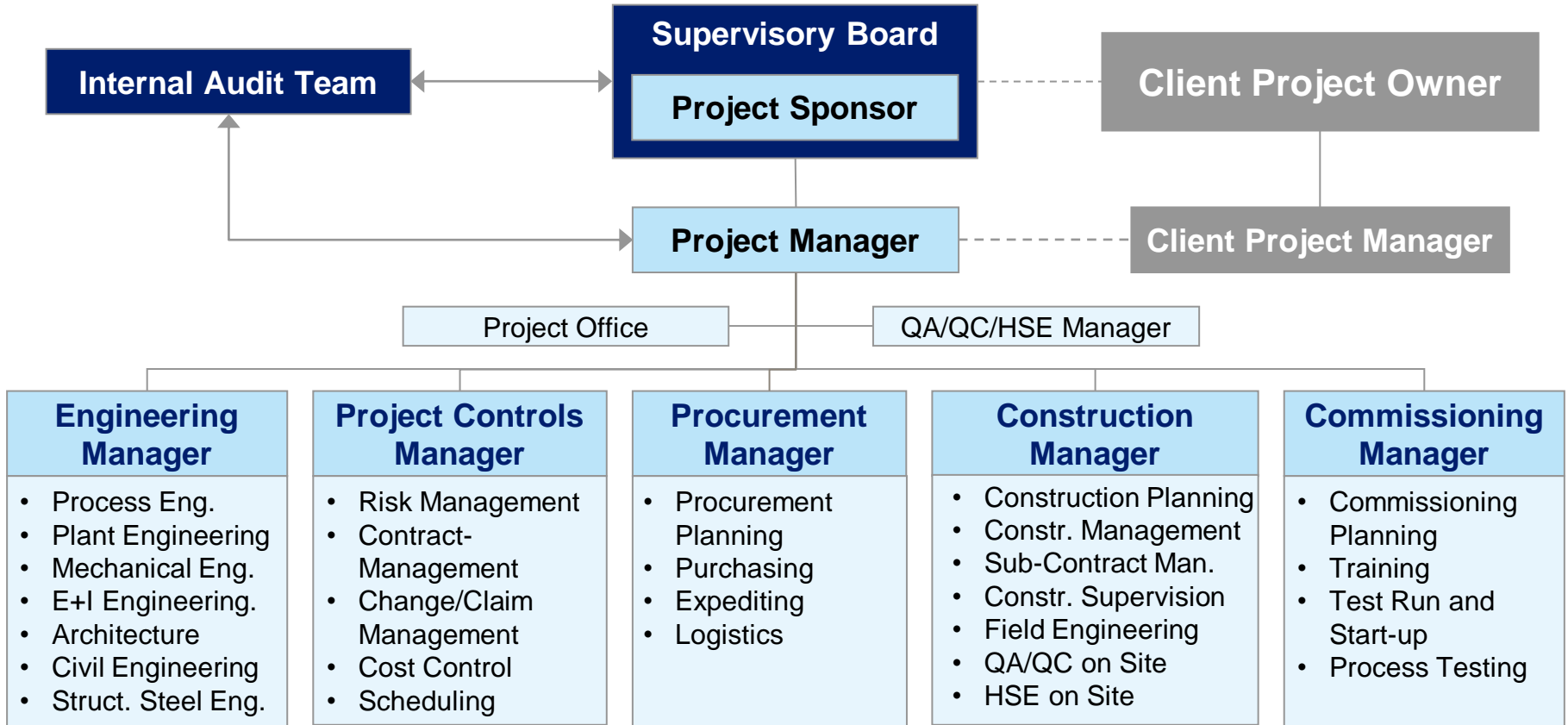




# EPC – Main Characteristics

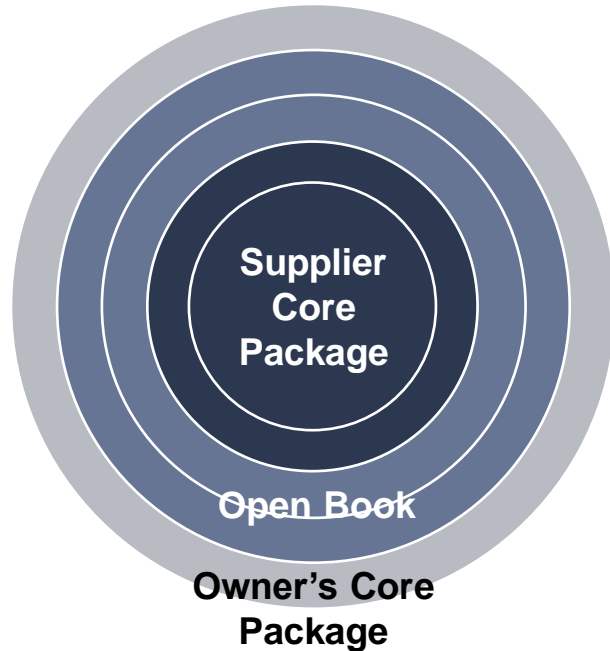
- **EPC-Contractor takes over full responsibility for the project execution through a fixed price contract**
- **All Sub-Contracts in the project are placed by the EPC-Contractor with the resp. supplier/vendor/sub-contractor**
- **Project owner has limited rights to take decisions after signature of the EPC-contract**
- **Risks, but also possible gains are transferred to the EPC-Contractor**
- **To cover such risk, EPC-Contractor will include a risk provision/contingency in his fixed price**

# EPC Project Organisation



# OB – Main Characteristics

## Open Book

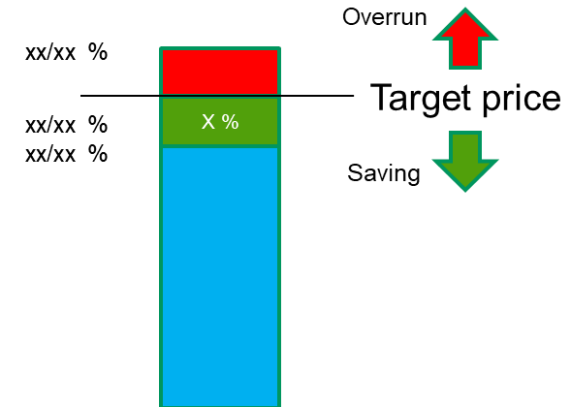
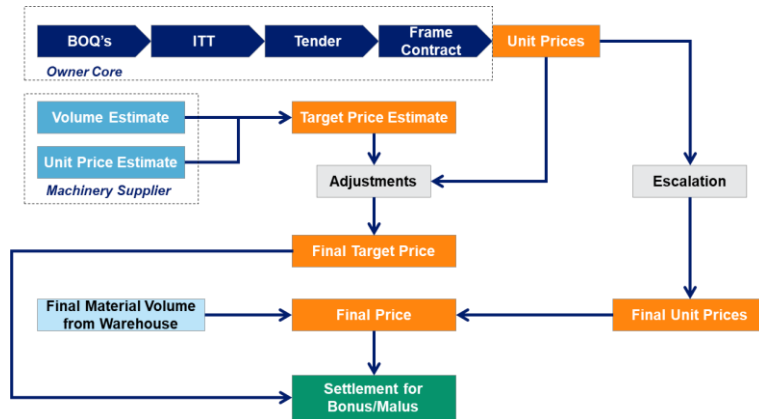


Supplier Core package includes Supplier's core capabilities and profit from core + OB portion (e.g. main process machinery, basic engineering, detailed process engineering, MEI erection supervision for main process machinery and open book items)

Open Book contains items with shared cost budget and limited risk portion. (e.g. AEI components, tanks and towers, mechanical and piping erection, steel structures)

Owner Core Package includes their core capabilities (e.g. civil, overall project management, BoP, site management, site infra etc.)

# OB – Main Characteristics



- Target price agreed between supplier and customer
- Orders placed in Owner's name
- Risk and opportunity divided

# Comparison EPCM vs. EPC

Advantages/Disadvantages  
of the two methods ?

# Comparison EPCM vs. EPC

## EPCM

### Advantages

- Owner keeps full control on the project
- Owner benefits from cost savings
- Transfer of certain risk to several parties
- Selection of Suppliers/sub-contractors on basis of detailed specification

### Disadvantages

- Complex project structure -> Increased coordination effort
- No cost cap for Owner
- Financing more difficult
- Full process responsibility and project risk remain with the Owner

## EPC

### Advantages

- Full project responsibility with contractor
- Clear structure – single point of contract
- Completion guarantee
- Fixed lump sum price
- Sound basis for financing

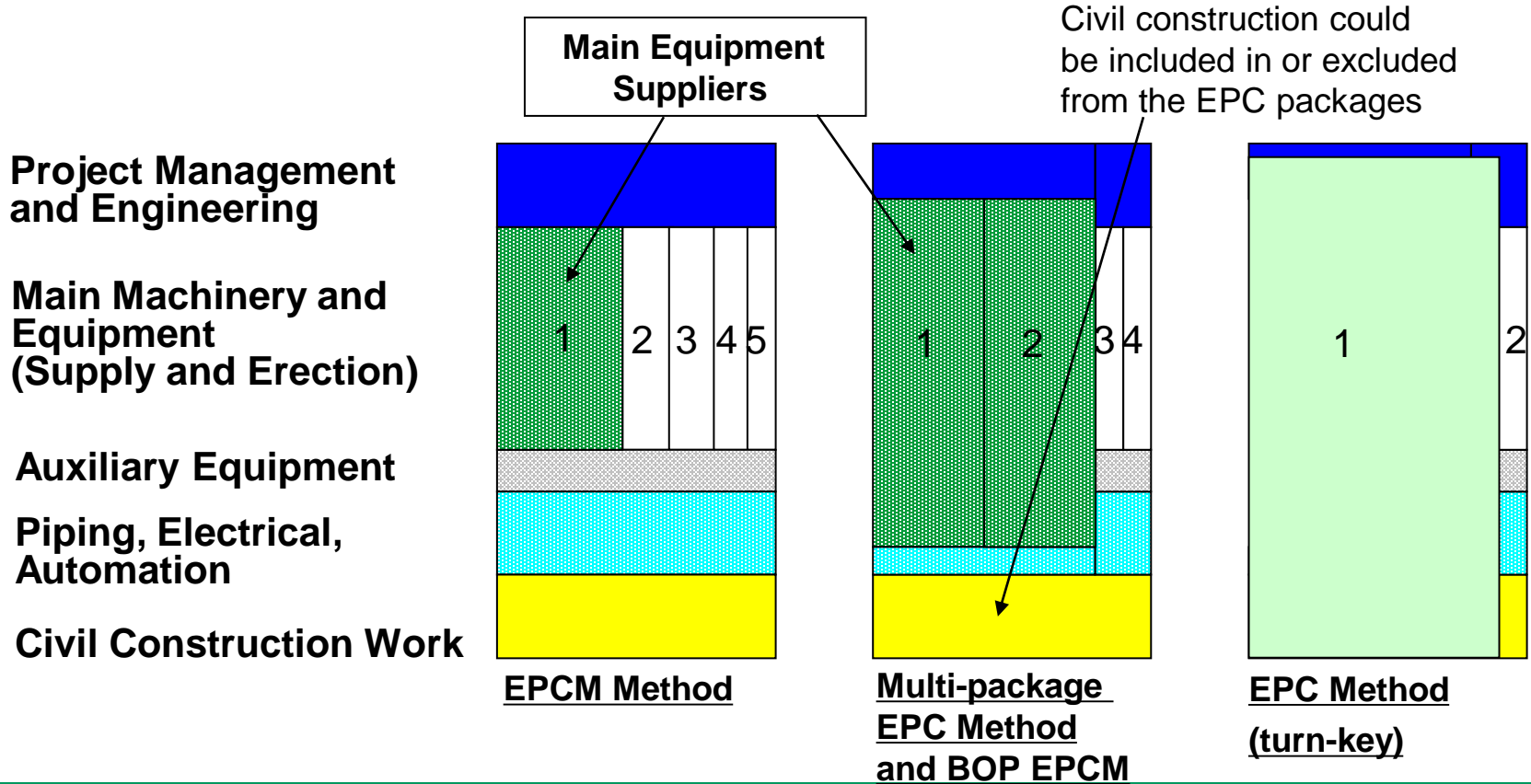
### Disadvantages

- Need for early detailed specification of technical solution
- Owner's participation is limited
- Owner will still suffer from bad performance of contractor
- Contractor may compromise on quality in order to save cost

# Comparison from Owner's point of view

	EPCM	EPC
Need for early decisions	Low	High
Flexibility for modifications	High	Low
Owner's influence possibility	High	Low
Cost budget	Estimate	Fixed lump sum
Financial risk exposure	Medium	Low
Risk provision	Only realized risk	Incl. in contract price
Transparency of cost	High	Low
Overall project risk	High	Medium

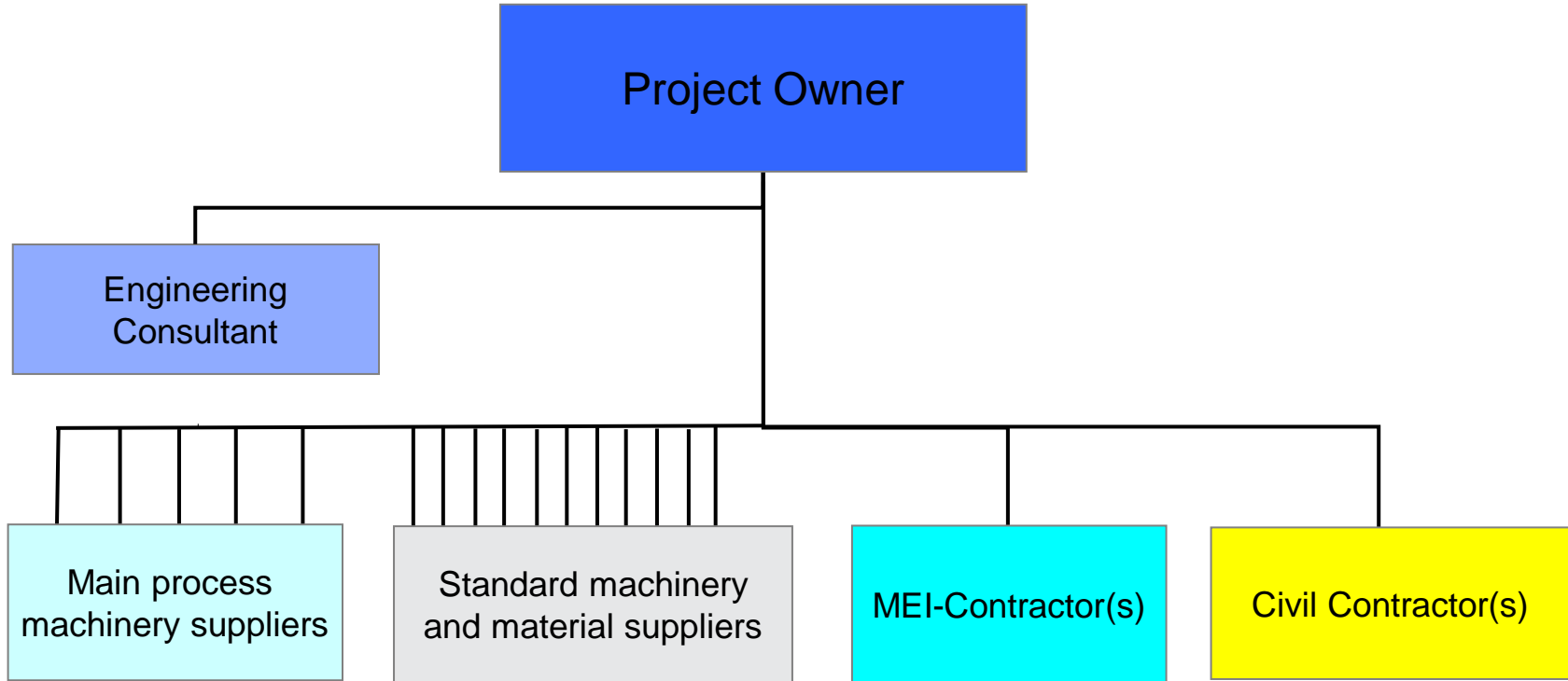
# Project Implementation Methods





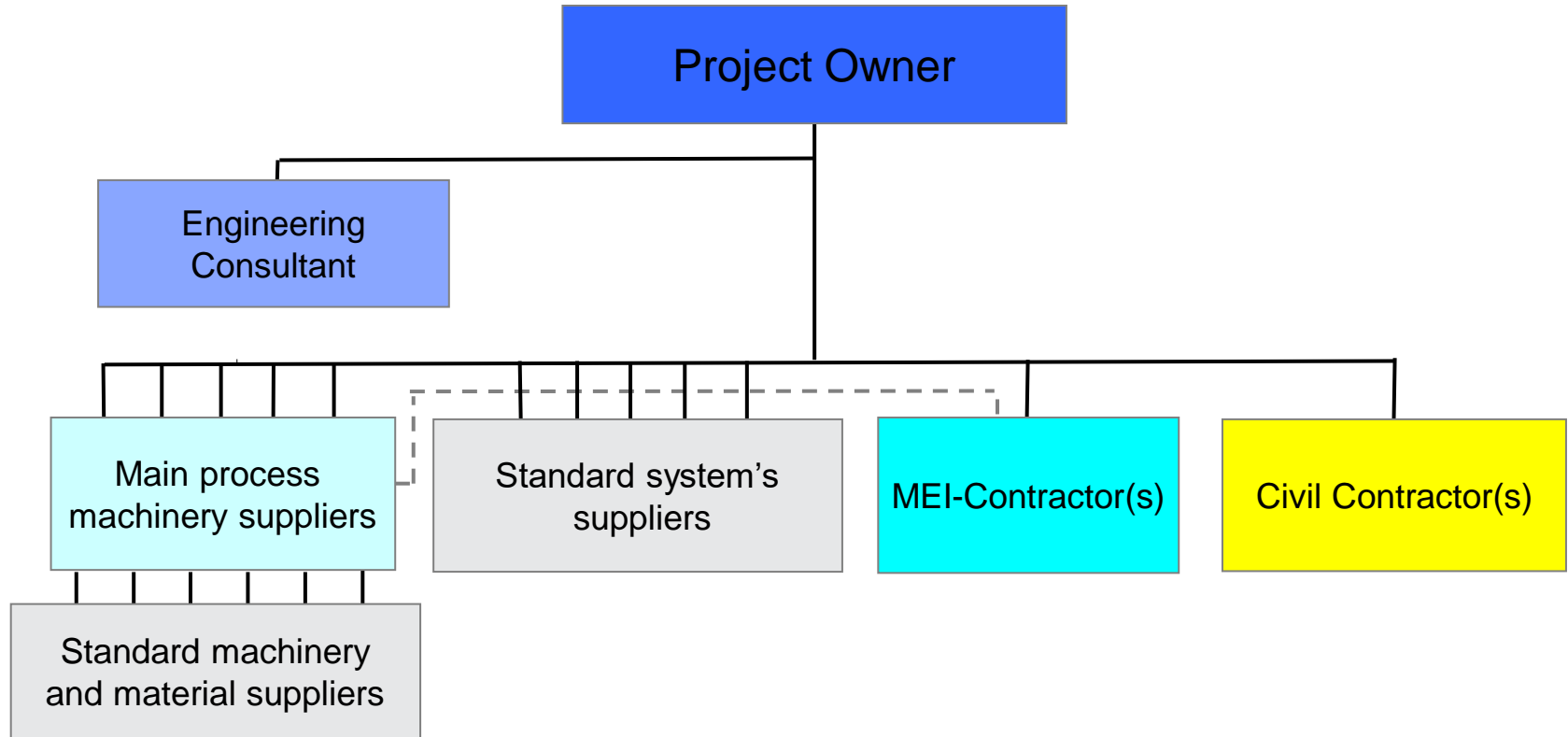
# Implementation Methods

EPCM – Engineering, Procurement and Construction Management



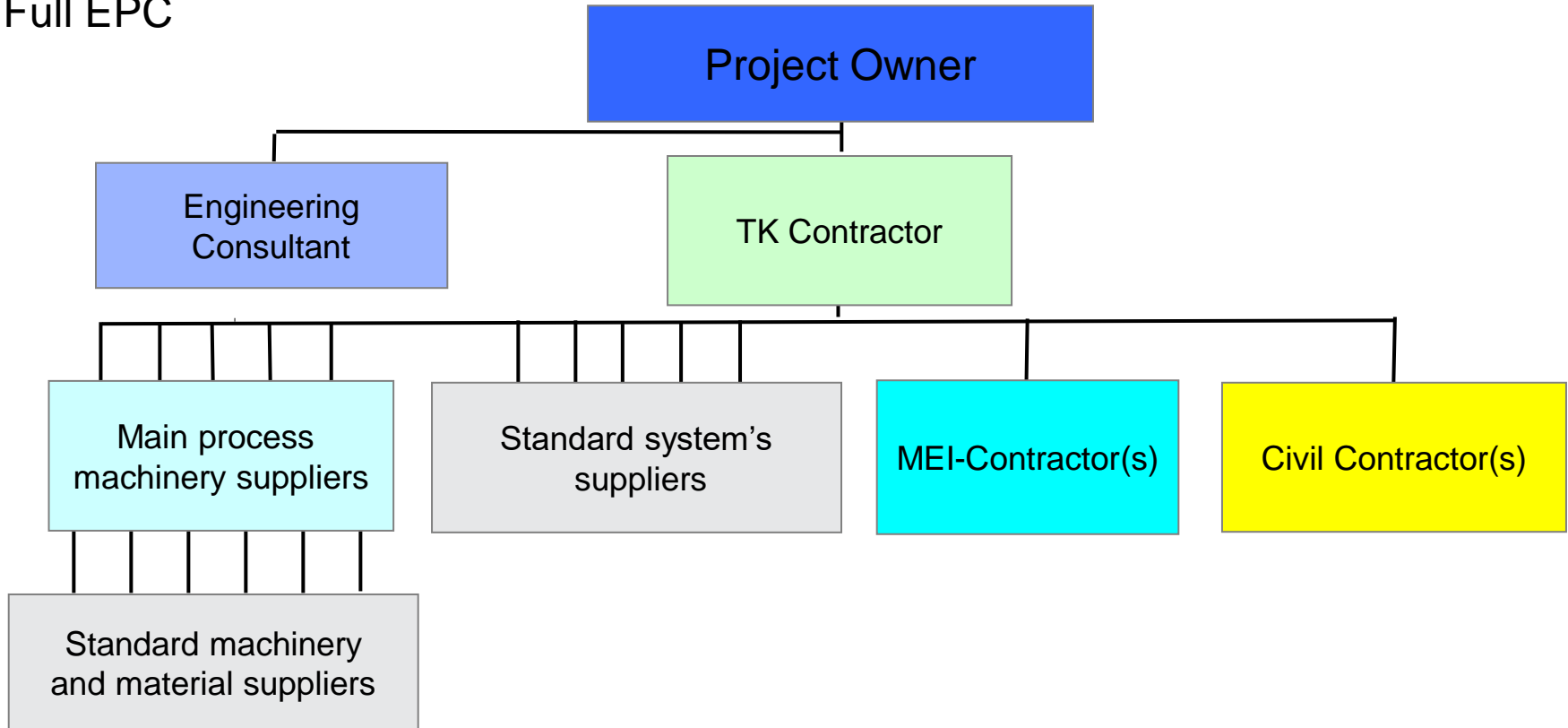
# Implementation Methods

Multi-package EPC – Engineering, Procurement, Construction

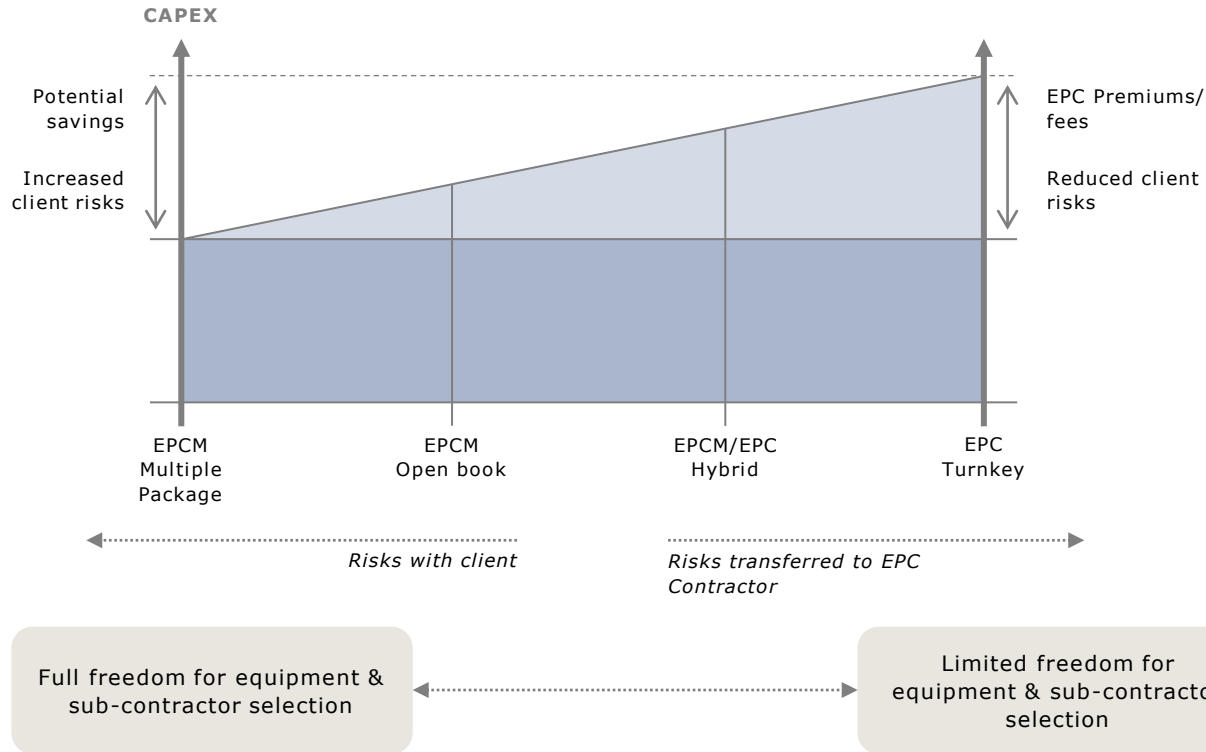


# Implementation Methods

Full EPC



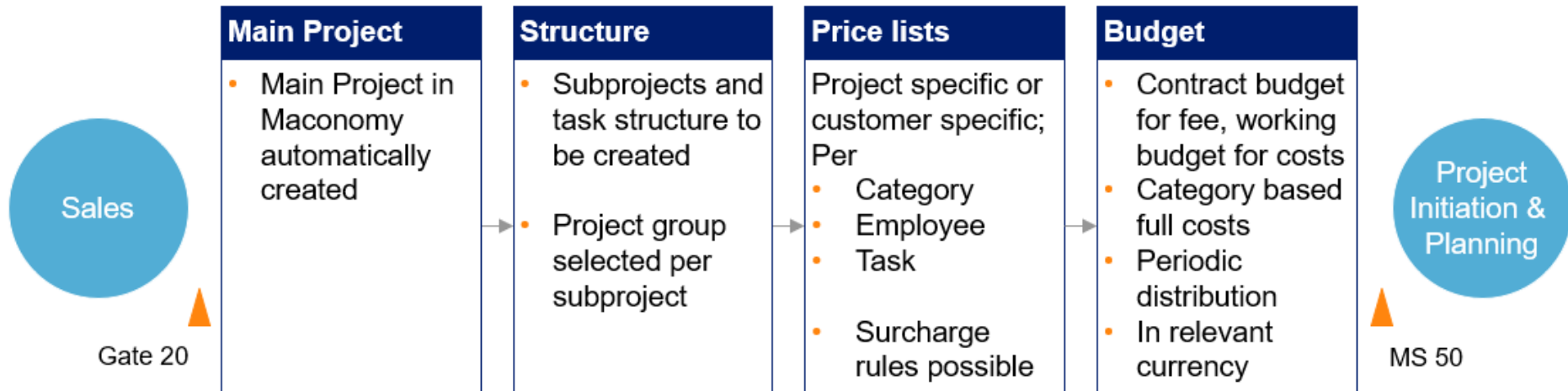
# Who Carries the Risk



# VI. Project Financials: Budgeting and Financials Reporting

# Budgeting

Already in the proposal phase, a project budget can be created to support the sales process – in any case the budget needs to be created during project initiation



# Business Management System (BMS) processes during project execution



## Project execution

- Project managers tasks during project execution such as resource planning, timesheet entries, invoicing, progress evaluation and reporting are completed within the Business Management System
- During the Project execution these processes are recurring and eventually need to be done on a weekly or monthly basis or when required

# BMS Project Overview Page

Overview		Current budgets and profitability		Useful dates		
<b>Actuals</b>		<b>Profitability (in base currency)</b>		<b>Project Date</b>		
Hours		3936.50	<a href="#">Budget Details</a>	Start Date	20.10.2015	
Unsubmitted Hours	<b>Actual costs</b>	21.00	Contract Price	845,817.00 EUR	Estimated Ending Date	15.10.2019
Cost, Time		300,218.79 EUR	Cost Budget (Working Budget)	747,356.58 EUR	Work Completed On	-
Cost, Expenses		20,231.72 EUR	Profit (PC2), excl. CBD	98,460.42 EUR	Date of Last Transaction	9.10.2016
Total Cost		320,450.51 EUR	Profit % (PC2), excl. CBD	11.64 %		
			Risk Allowance	53,500.00 EUR		
<b>Remaining ETC</b>		<b>Invoicing (excl. VAT)</b>		<b>Report Links</b>		
Hours		2848.00	<a href="#">Invoice History</a>	Subproject overview	<a href="#">Open in InfoView</a>	
Cost, Time	<b>Remaining costs</b>	268,378.73 EUR	Last Invoice, Date	30.9.2016		
Cost, Expenses	<b>(Estimate to complete)</b>	158,527.34 EUR	Next Invoicing Date, Planned	-		
Total Cost		426,906.07 EUR	Hours, Invoiced	3644.50		
			Total Invoiced	0.00 EUR		
			Total paid	0.00 EUR		
			Total unpaid	0.00 EUR		
			Total overdue	0.00 EUR		
			Billing Price of uninvoiced hours	0.00 EUR		
			Billing Price of uninvoiced expenses	0.00 EUR		
<b>EAC</b>		<b>Summarized invoice history</b>		<b>Links to other applications</b>		
EAC at	<b>Current estimated cost budget</b>	1.10.2016		Secure database (coming soon)		
Hours	<b>(Estimate at completion)</b>	6784.50		PRA	<a href="http://rmterp.one.p...">http://rmterp.one.p...</a>	
Cost, Time		568,597.52 EUR				
Cost, Expenses		178,759.06 EUR				
Total Cost		747,356.58 EUR				
<b>Current Financial POC</b>		<b>Percentage of completion</b>		<b>Email Addresses</b>		
Financial POC %	<b>(actual costs/total costs)</b>	42.88 %		Project Manager Email		
<b>Earned value figures from last technical POC</b>				Budget Approver Email Address		
Technical POC Date		-				
Technical POC %	<b>Technical POC and</b>	0.00 %				
Planned value	<b>the respective key figures</b>	0.00 EUR				
Earned value		0.00 EUR				
Spent value		0.00 EUR				

Shortcut to LH059 report

Shortcut to risk allowance tool

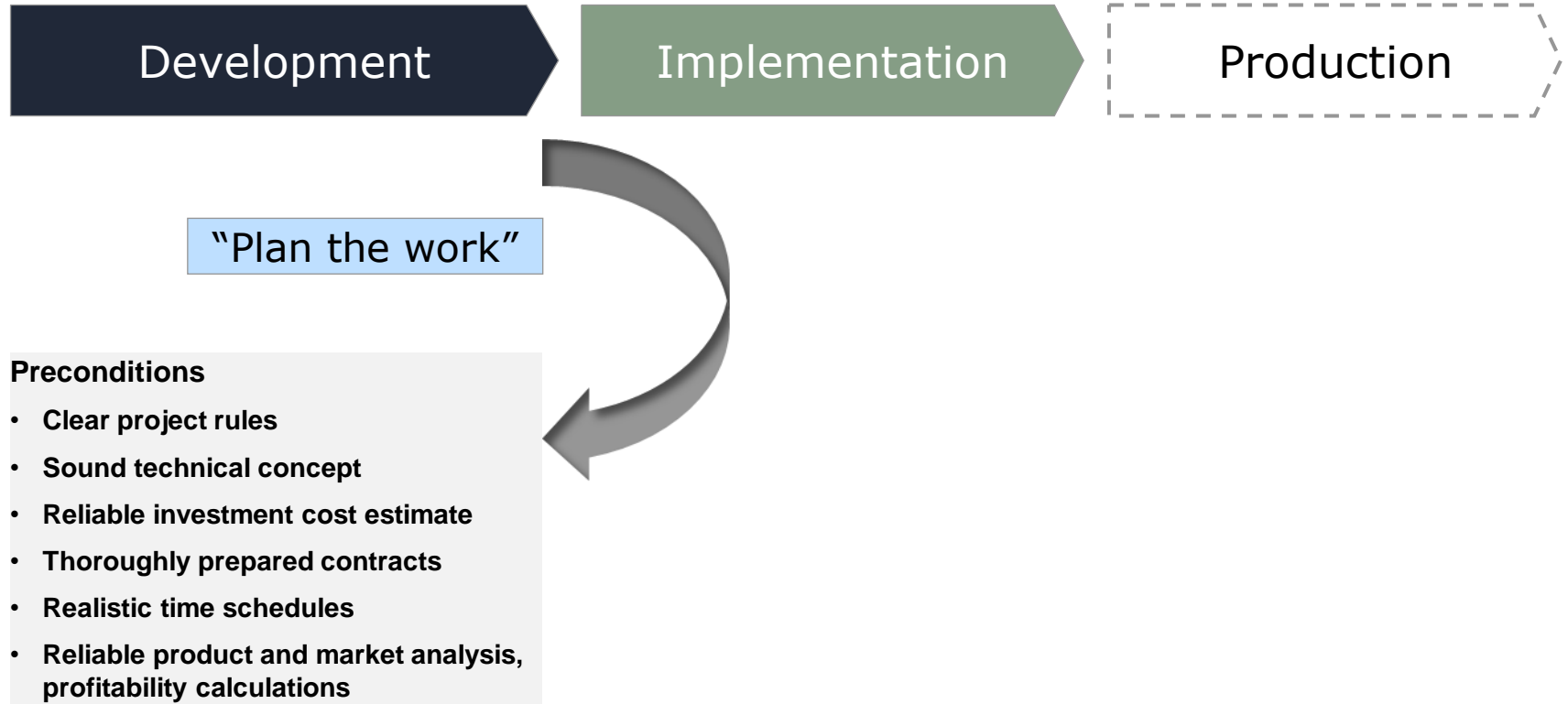


# Importance of Project Financial Reports

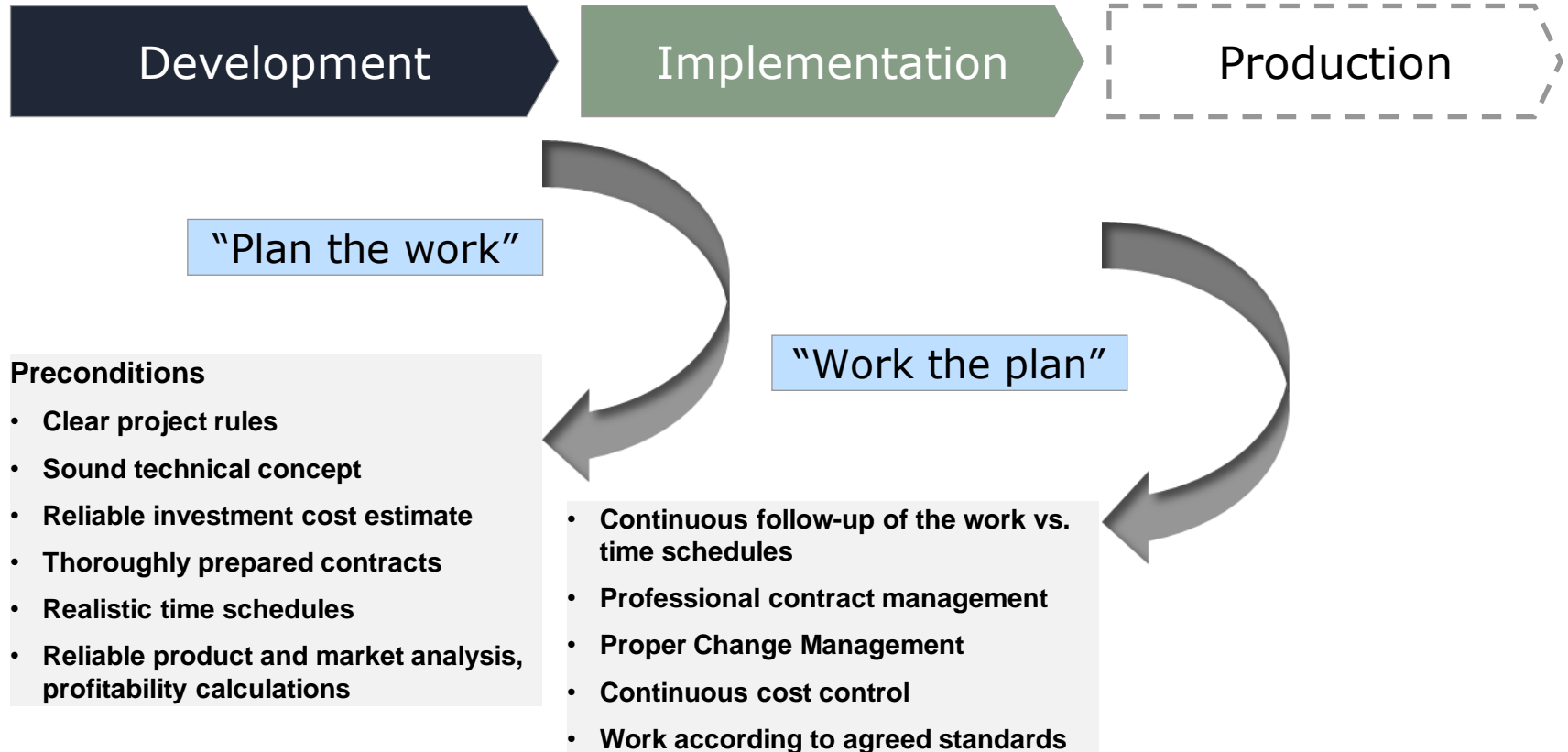
- **Project Financial Reports form the basis of AFRY's business reporting and therefore business results!**
- **Better or more accurate Project Financial Reports will help management to tackle issues early and could also save costs e.g. lowering the need to borrow money**
- **Project cash flow forecast should be reviewed during the sales negotiations in order to verify that more cash is coming in as customer payments than what is going out as salaries and other operational costs**

# VII. Conclusions

# Successful Investment Project



# Successful Investment Project

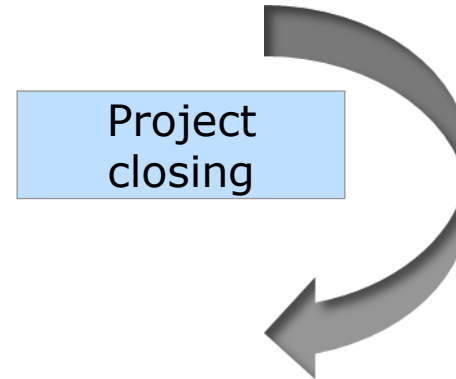


# Successful Investment Project



## Criteria

- The plant is completed within schedule
- The plant is completed within budget
- Production starts / develops as planned regarding product quality and quantity
- Product sales begins according to the market preconditions
- Operation & maintenance runs reliably

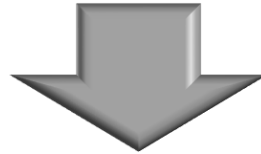


# Conclusion 1/2

- **Safety** during the project and of the operating mill
- Optimum life cycle costs – both **investment and operating costs**
- Project implementation **within budget and schedule**
- **Fast ramp-up** of the production to the projected level
- Production of required **quality** cost efficiently
- **Environmental aspects** in operations in compliance with regulations

# Conclusion 2/2

Successful project implementation  
is all about  
**Management of Risk**



Select project implementation method so,  
that risks are allocated to such party,  
which is best positioned to manage it !

# Questions from students





Aalto University  
School of Chemical  
Engineering

# Thank you!

*Antti Mattelmäki  
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