

CoTM 6203 Advanced Construction Material & Equipment Management

Lecture 6 - Procurement management

Introduction

- Purchasing can be separated into two types of activities:
 1. Procurement and
 2. Supplier scheduling and follow-up
- Procurement includes the functions of *establishing specifications, selecting suppliers, price determination, and negotiation*.
- Supplier scheduling and follow-up are concerned with the *release of orders to suppliers, working with suppliers to schedule delivery, and follow-up*.
- The goals of supplier scheduling are the same as those of production activity control: *to execute the master production schedule (MPS) and the material requirements plan (MRP)*, ensure good use of resources, minimize work-in-process inventory, and maintain the desired level of customer service.

Procurement process

- The main functions involved in the procurement process are:
 1. Procurement strategy
 2. Approved tender list
 3. Pre-tender survey
 4. Bidder selection
 5. Request for quotation (*RfQ*)
 6. Tender evaluation
 7. Purchase order
 8. Expediting, monitoring and inspection
 9. Shipping and storage
 10. Erection and installation
 11. Commissioning and handover

Procurement Strategy

- Before any major purchasing operation is considered, a purchasing strategy must be drawn up which sets out the criteria to be followed. These include:
 - The *need* and *purpose* of the proposed purchase
 - Should the items be *bought* or *leased*?
 - Should the items be *made in-house*?
 - Will there be construction *element involved*? *If yes*, it will be necessary to draw up *subcontract documentation*. If no construction or assembly element, a straight purchase order will suffice.
 - How many companies will be involved in the tender?

Procurement ...

- Will there be **open or selective tendering**? This often depend on the value and strategic or **security restrictions**. Are there prohibited areas for purchase or restrictive shipping conditions?
- What are the major risks associated with the purchase at every stage?
- What are the country of jurisdiction for settling disputes and what dispute procedures will be incorporated?
- What contract law is applicable, what language will be used, in what currency will the goods be paid for?
- How will bids be opened and assessed and by whom? With public authorities tenders are usually opened by a committee.

Contract administration

- The basic foundation that all projects are unique is especially true in construction and extends to the various project delivery methods and contract arrangements.
- Special attention is needed during planning and executing of the procurement contracts to ensure that the correct expertise and skills for the design and construction of highly integrated components are satisfied.
- When coupled with the large number of contractors required to perform the work, the expertise for contract administration and management quickly become the controlling factors for a successful project.
- Interpreting and understanding general and special conditions within contracts, procurement documents, and associated reporting requirements are a vital contract administration function.

Supply Chain Management (SCM)

- There is a growing need for construction organizations to adopt *SCM* strategies to counter industry competition that is not only regional or national, but also global.
- Buyers are increasingly seeking the **best value for their money**, and **advances in technology and transportation** have provided the ability to buy from practically any company anywhere in the world to **reduce costs, add value**, and **remain competitive**.
- **Inventory is a non-value-added asset** and a significant cost element for the contractor.
 - **An effective *SCM* strategy can enable a business to achieve a reduction in inventory-related costs.**

Supply Chain ...

- On the other hand, the chain of organizations involved in producing and delivering a product is complex and is fraught with many inherent uncertainties, such as inaccurate cost forecasting, delays in import or export processes, unknown or late equipment deliveries, breakdowns, or substandard material quality.
 - Such events can contribute to time and cost overruns on a project.
- The more complex the supply chain, the greater the degree of uncertainty, and the more adverse the impact on the supply chain.
- *Lean production, total quality management, prefabrication, and modular construction* methods are enabling many organizations to realize major gains by eliminating waste from their operations in terms of time and cost.

Make-or-Buy Analyses

- Buyer and seller activities include specific techniques for assessing source selection criteria and procurement strategies.
- The make-or-buy analysis in construction relies on either *self-performing the work or soliciting bids from subcontractors for the work*.
- On certain projects, these buyers and sellers may contemplate a competitive bidding advantage by evaluating the procurement alternatives available to them.
- This also involves determining the *degree of contractual risk* that an organization is willing to assume or the amount of potential revenue it is willing to *forgo in exchange for transferring the risk to an outsourced entity*.

Material cost

- It is customary for the contractor to solicit and receive specific price quotations for most of the materials required by the job being priced.
- Exceptions to this generality are stock items such as plyform, nails, and construction lumber, which the contractor purchases in large quantities and of which a **running inventory is maintained**.
- Written quotations for special job materials are desirable so that such important considerations as **prices, freight charges, taxes, delivery schedules**, and **guarantees** are explicitly understood.
- Most material suppliers tender their quotations on printed forms that include stipulations pertaining to terms of payment and other considerations.

Material ...

- For example, the contractor receives, during the bidding period, written price quotations from material dealers covering specific job materials, such as transit-mix concrete, structural and reinforcing steel, steel pilings, and guardrails.
- These must all meet the specifications developed by the architect-engineer and are subject to approval before they can be delivered to the job site.
- If quantity survey has been prepared with precision, materials usually can be accurately priced based on the supplier quotations.

Material ...

- When material costs are entered on the summary sheets, they must all have a common basis, for example, delivered to the job site and without sales tax.
- Prices as entered will ordinarily include **freight, drayage, storage, and inspection**.
 - It is common practice to enter material prices without tax, adding this as a lump-sum amount on the final recap sheet.
- It is not unusual in some types of projects for the owner to provide certain materials to the contractor for use on the project.
- In such a case, contractors need not add this material price into their estimates.
- However, all other charges associated with the material, such as handling and installation expense, must be included.

Methods of procurement

- 1) The following methods shall be used in public procurement (*The Ethiopian Federal Government Procurement and Property Administration (PPA) Proclamation*):
 - a) Open Bidding
 - b) Request for Proposals
 - c) Two stage Tendering
 - d) Restricted Tendering
 - e) Request for Quotation
 - f) Direct Procurement/single source

Methods of ...

- 2) Except as otherwise provided in this Proclamation [*Proclamation No. 649/2009*], public bodies shall use open bidding as the preferred procedure of procurement.
- 3) Public bodies may use a method other than open bidding only where conditions for use of such other method stipulated under this Proclamation are satisfied.
- 4) Public bodies shall not split procurement requirements for a given quantity of goods, works or services with the intention of avoiding the preferred procurement procedure stated under this Proclamation or in the procurement directive.

Open International Bidding (*Article 59*)

- 1) Open international bidding shall be used whenever in national open bidding an effective competition cannot be obtained unless foreign firms are invited to bid or for procurements above a threshold level for national bidding to be determined by a directive to be issued by the Minister.
- 2) A procurement may be effected by means of national competitive bidding notwithstanding that the cost of the procurement exceeds the threshold established in the directive for national bidding if it is ascertained that the required object of procurement is available only locally.

Open international bidding shall respect the provisions (*Article 59-3*)

- The invitation to bid and the bid documents shall be in the English language.
- Technical specifications of the goods, works and services shall be compatible with national requirements, and conform as far as possible with international standards or standards widely used in international trade.
- General and special conditions of contract shall be of a

Other provisions (*Article 59-4*)

- Without prejudice to the threshold to be established in the directive to be issued by the Minister and provided that conditions for using **other methods of procurement than open bidding** are satisfied, public bodies may conduct procurement through international competitive bidding (*ICB*) by means of restricted tendering, request for proposals, request for quotation or direct procurement where it is ascertained that it is impossible to carry out effective procurement without the participation of foreign companies.

Large Value Procurement (*Article 60*)

- 1) There shall be established a central body, which shall be in charge of the execution of large value procurements having national significance procurements of supplies for which a demand is shown by more than one public body and sale of public property to be disposed off, by a regulation to be issued by the Council of Ministers.
- 2) The Minister shall identify and update the types of procurements to be executed on account of their national **significance by the central body** which shall be established pursuant to sub article (1) of this Article.

Procedure of Framework Contract (*Article 61*)

- 1) Framework contracts may be used to fulfill similar procurement requirements of various public bodies or recurrent procurement requirements of a public body.
- 2) The following procedure of framework contract shall be followed to meet similar procurement requirements of public bodies within a given time frame:
 - a) The Agency shall undertake a survey of the similar requirements of public bodies, issue a list of goods and services constituting such requirements and update the list regularly.

Procedure of ...

- b) Public bodies shall prepare a forecast of their requirements of goods and services falling under the list mentioned in sub-article (2) (a) of this article and communicate the same to the body authorized to conduct large procurements.
- c) The body to be established in accordance with article 60(1) of this proclamation shall conclude and administer framework contracts in the manner prescribed herein and the directive to be issued by the Ministry.

Procedure of ...

- d) Public bodies shall on the basis of the framework contract signed by the central body of procurement conclude the procurement by making order with the suppliers of goods and services that they require.
- e) The order that public bodies place with the suppliers for goods and services of their requirements under the framework contract shall confirm to the terms of the framework contract regarding price, terms of payment and other matters related to the execution of procurement.

Procedure of ...

- 4) The framework contract shall be awarded through open bidding procedure and may remain valid for 3 years.
- 5) In procuring goods and services under a framework contract to fulfill their recurrent requirements, public bodies shall have to adhere to the criterion of fixing prices of goods and services to be determined in the directive to be issued by the Minister.

Choosing procurement methods

- The range of procurement options and the different ways of combining them reveal a confusing array of methods, as each is distinguished from the other on a different basis.
- What is **needed is a more conceptual way of distinguishing** the various methods from each other, because contracting, funding, selection and payment methods can all be combined with different modes of ownership in many different ways.
- Simple labels such as *PFI*, partnering, general contracting, and so on, communicate little about the way that a project is structured.
 - In fact, these different methods are not mutually exclusive categories of doing work.

Choosing ...

- By grouping the procurement variables, it ought to be possible to describe any construction procurement method.
- These aspects of procurement are variously represented in every procurement method, even though **a procurement method is usually characterized by only one factor.**
 - For example, *PFI* involves private sector investment in major infrastructure projects, whereas in *DB* the contractor's responsibility for design is the defining characteristic.
- To bring more clarity to the distinctions between procurement methods, the categories in Table next slide are suggested.

Conceptual definitions in procurement

Category	Examples
Source of funding	Owner-financed, public sector-financed, developer-financed, PFI, PPP.
Selection method	Negotiation, partnering, frameworks, selective competition, open competition.
Price basis	Work and materials as defined by bills of quantity, cost reimbursement, whole building, a fully-maintained facility, performance.
Responsibility for design	Architect, engineer, contractor, in-house design teams, supplier.
Responsibility for management	Client, lead designer, principal contractor, joint venture, construction manager
Amount of sub-contracting	0-100%

- Using this Table, it is clear that describing a project as *PFI* does not indicate where the responsibility for design lies.
- Describing a project as general contracting does not indicate how much sub-contracting there is, or how the contractor was selected.
- To adequately describe how something is procured, all six categories are needed

Conceptual Procurement

- In setting up a construction project, discussion and decisions are needed under each of these six areas.
- The source of funding may not be an option, as it may simply be a matter of policy or even regulation for any given client. But it needs to be **explicit**.
- The methods of selection open to the client may be a matter of choice or preference, but in many cases, particularly in the public sector, there are regulations about **how suppliers may be selected**.
- The choice about how the price is calculated is a mechanism for **apportioning risk**.

Conceptual ...

- The amount of sub-contracting is an indication of the scale of the co-ordination and management task for a project, but is also a response to the technical complexity of the project.
- One interesting and somewhat surprising point about the Table is the number of combinations of the six variables.
- Given that there are at least five options in each of the six categories, there are thousands of **different** ways of procuring a given construction.
- In fact, there are many more, because the options given here are only examples, and the amount of sub-contracting and subsequent consequences for the supply chain provides many more different ways of structuring a procurement method.

Procurement of construction projects

- Procurement is the process of selecting a team for successfully conducting a construction project.
- Selecting the right team is becoming more and more difficult as construction projects increase in complexity. However, team building is a key factor for project success (Winch, 2010).
- Building the team is primarily a task for the project owner (or simply the owner, sometimes called the client or the employer). This may be a difficult task because even small projects now need a large number of designers, managers, consultants, contractors and suppliers.
- Moreover, a large set of different external entities must be considered at all times of the project development, such as local authorities, public service suppliers and so on.

Project Procurement Management in Construction

- Construction projects are often multilayered hierarchies characterized by numerous buyers and sellers, with many of the project stakeholders serving in both capacities, and multiple levels of procured goods and services.
- Typical contractual relationships exist between the owner and the general contractor, and between the general contractor and its subcontractors and suppliers.

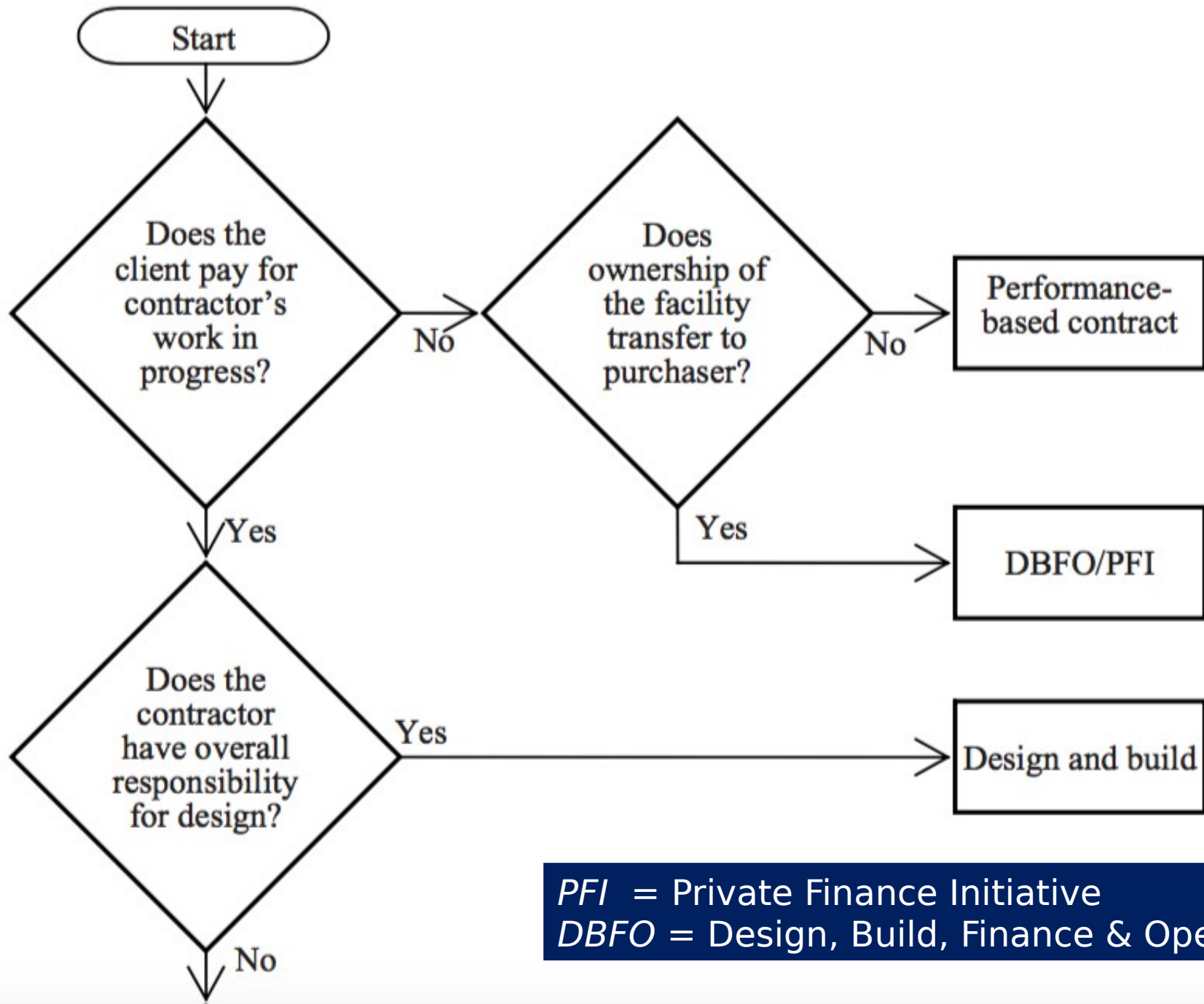
Project Procurement ...

- Examples of project procurements include acquisition of property, engineering and design or turnkey services, construction, and even operational services.
- From a contractor's perspective, this may include the acquisition of labor, lower-tier subcontracting services, materials, and equipment from vendors and suppliers.
- Basically, procurement in construction is conducted to better transfer the performance risk to sellers who specialize and are skilled in a particular scope of work.

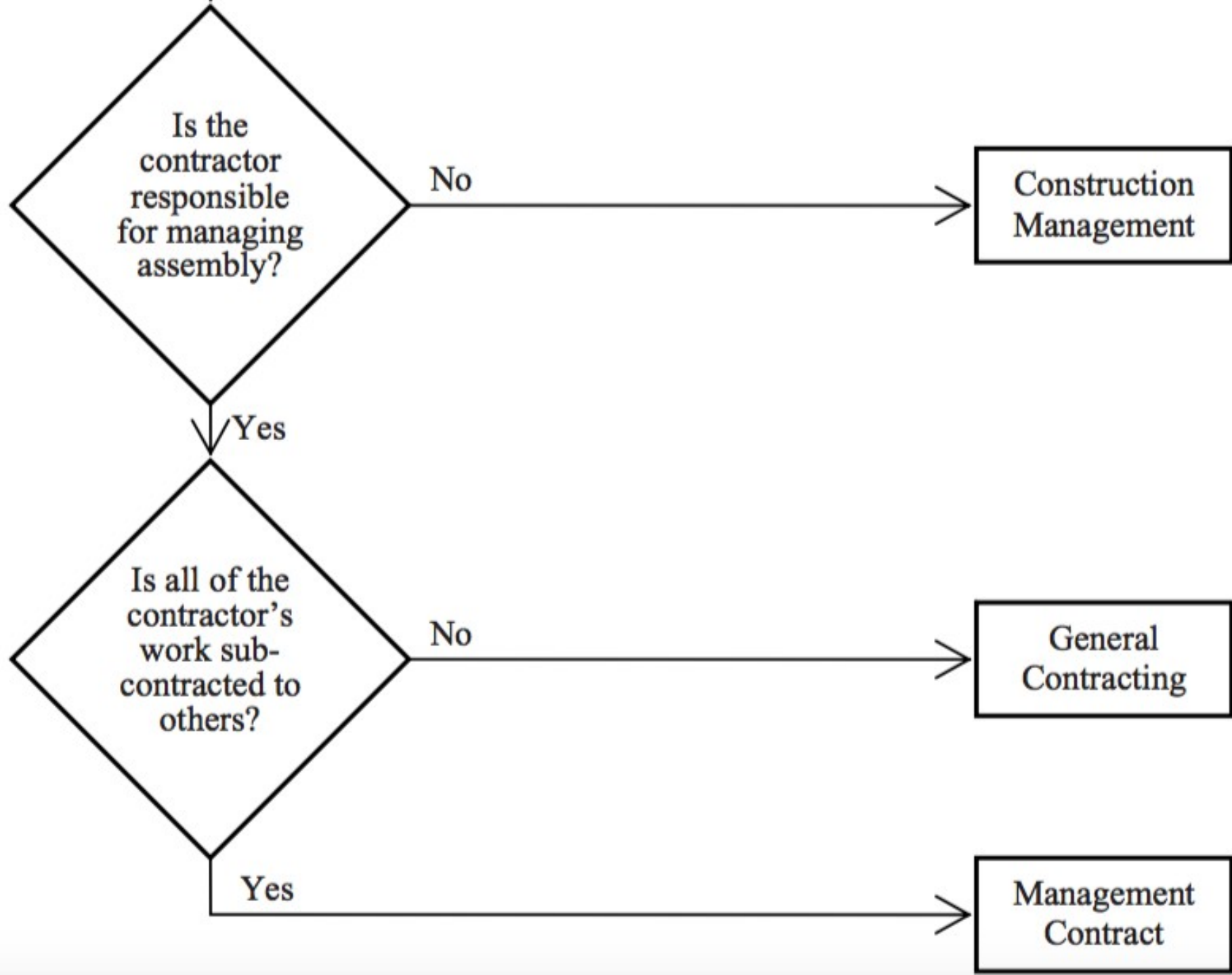
Project Procurement ...

- The buyer-seller relationship on a small project is relatively straightforward: two organizations contractually doing business together.
- In construction, that basic relationship exists between the owner of the project and the primary performing organization, or general contractor.
- From that point on, the procurement process for the performing organization (seller) is repeated multiple times and, perhaps, hundreds of times on large projects.
 - An example of this repetition is the general contractor procuring specialty services such as mechanical or electrical services, which in turn procure equipment and materials from a lower-tier subcontractor, which in turn procures the finished goods and materials from a supplier of a manufacturing organization.

Identifying construction project procurement methods



PFI = Private Finance Initiative
DBFO = Design, Build, Finance & Operate



The Construction Management Method

- The term *Construction Manager (CM)* basically refers to the professional construction management firm that is responsible for managing the entire construction process.
- Construction management is most beneficial when working on large, complex, and long-term projects where there are likely to be multiple Prime Contractors and the Owner requires extra management resources to control the project.
- There are many forms of management methods. The role of the CM in a project may vary substantially and can be performed under a variety of contractual terms. However, there are two commonly used approaches to construction management:
 - 1) Construction Manager as Agent and
 - 2) Construction Manager at Risk

Construction Manager as Agent

- Under this form of construction management, the Owner contracts with a professional construction management firm who acts as the Owner's agent in the role of a Consultant.
- The CM is retained prior to the design phase **providing preconstruction services** such as **value engineering, estimating, cost control, schedule analysis and bid review, and undertaking the administrative responsibilities of managing all trade contractors during construction.**
- The CM will not perform himself any particular trade work or other construction works.
- Under this arrangement, the Owner contracts directly with the required trade Contractors like a General Contractor to complete the project. Thus there will be 3 sets of contracts:
 1. Owner – CM

Construction Manager at Risk

- Under this form of construction management, the CM is responsible for both services and construction. Under this arrangement, the CM contracts with all the trade Contractors to complete the project. With this method, there are two sets of Contracts by the Owner:
 - 1) Owner – CM
 - 2) Owner – Designer
- The CM assumes responsibility for the performance of the trade contracts like a General Contractor under the traditional method and is paid for the work done by trade contractors either on cost reimbursement basis or fixed price basis.
- The CM is retained prior or during the design phase providing preconstruction and construction services.
- Under this concept, the CM holds the risk of subletting the construction work to trade subcontractors and guaranteeing completion of the project for a negotiated price

Integrated Project Delivery (IPD)

- *IPD* is anticipated by many as the delivery method that will transform the way future projects are conceived, designed, documented, constructed, and managed (operated and maintained) through the facility life cycle.
- *“IPD is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.”*
 - (Source: Integrated Project Delivery – A Working Definition, Version 2, June 13, 2007, McGraw-Hill Construction)

Integrated ...

- In a very real and tangible sense, this approach to project delivery can be considered a sustainable approach to design and construction at a fundamental level.
- When all participants in this process are committed both to the success of each other and to the project in all respects, the results will properly incorporate functional, budgetary, schedule, and environmental considerations in an intelligent, integrated, and effective manner.
- The flow of an *IPD* project from conceptualization through implementation to occupancy differs from other project delivery methods.

☐ Integrated design process

WHAT

HOW

WHO

REALIZE

Conceptualization

Criteria Design

Detailed Design

Implementation
Documents

Agency Coord
Final Buyout

Construction

Classout

Agency

Owner

Designer

Design Consultants

Constructors

Trade Constructors

Integrated project delivery and design process

Advantages and Disadvantages of the IPD project delivery method

Advantages	Disadvantages
• Higher-quality decision making regarding project cost, physical performance, implementation schedule, and life cycle performance. • Better understanding of the facility design with greater evaluation of design options. • Earlier detailed visualization of the facility during the design phases. • Enhanced detection and resolution of conflicts between building components. • Increased coordination of construction documentation. • Greater component prefabrication opportunities. • Optimized site utilization through more effective implementation planning. • Efficient delivery of products, materials, and equipment to the site. • Reduction of construction waste.	• From the owner's perspective, cost savings as the result of this delivery method may not be fully realized. • From the perspective of each of the participants, the distribution of liability and responsibility may not be "<i>comfortable</i>" or fully understood in the absence of full and complete trust on the part of all participants.
• One of the core elements around which <i>IPD</i> is structured is the technological development of Building Information Modeling (BIM), which is the basis of how design and construction documents should be prepared and used under <i>IPD</i>.	

Procurement and management of subcontracts

- Managing subcontracts is fundamental to every construction project.
- A large amount of the construction risk is transferred to the subcontractor and, as a result, contracts between the construction company and the subcontractors become very important.
- Informal (or verbal) agreements are replaced by formal contracts, which include standard clauses binding the two parties.
- Insufficient effort on the part of the subcontractor can affect the construction project objectives (time-frame, cost, quality, safety, *etc.*); therefore, subcontract management directly affects the

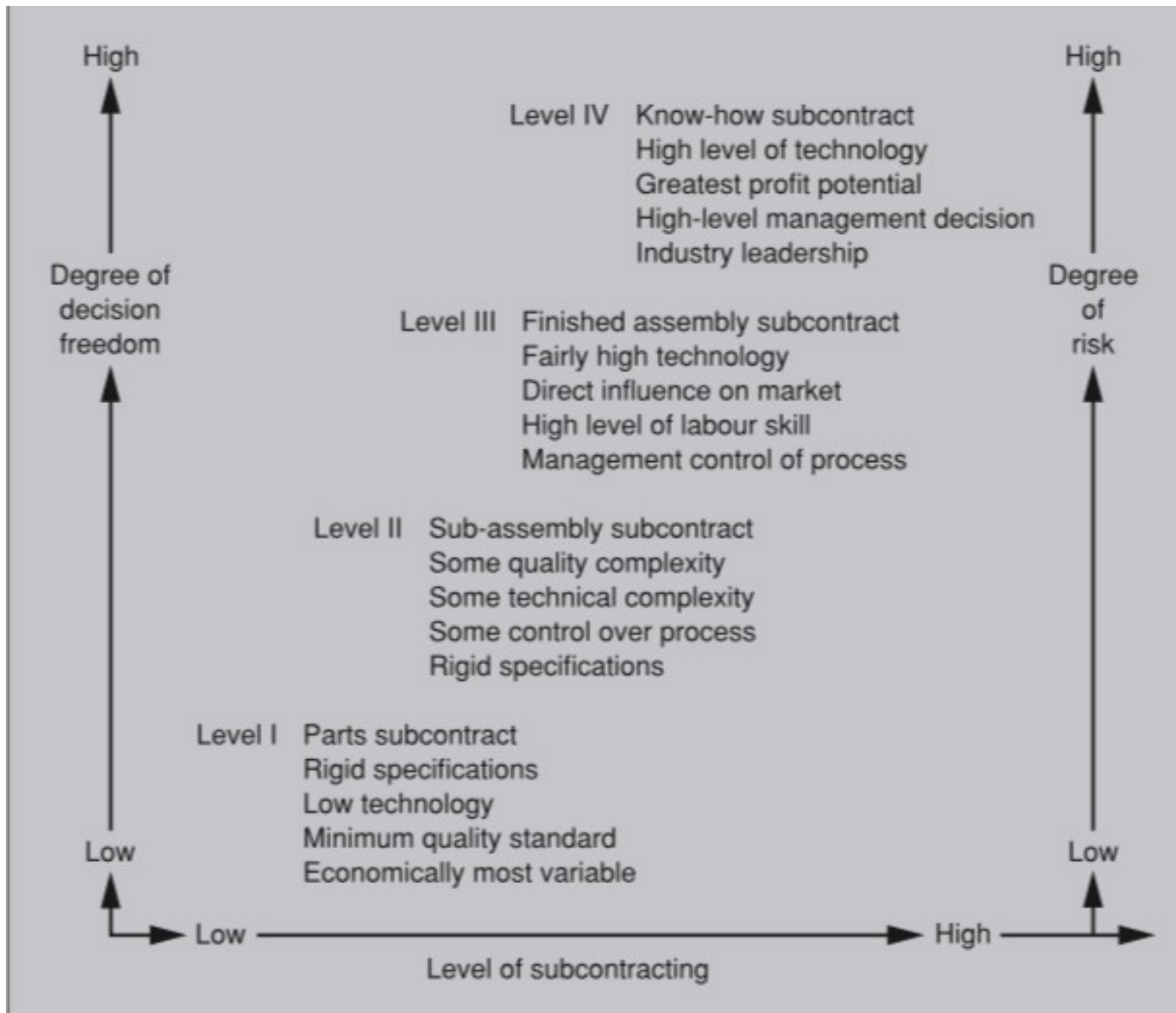
Procurement ...

- Choosing a subcontractor requires the preparation of a tender process, which may vary in terms of complexity.
- The first step involves defining the **scope of the work to be carried out**, such that it can be adequately publicized to the interested companies.
- This definition must be as specific as possible to avoid subsequent problems during the execution of the works.
- It may be appropriate to attach shop drawings and technical specifications for the construction project, to eliminate gaps.
- The bid may be based on a **fixed price for all the work contracted or be on a unit price basis**, in line with the main contract.

Procurement ...

- The subcontract is normally awarded to that company that bids a lower price while guaranteeing optimal quality; later, the contract must be prepared and signed.
- Unethical practices should be avoided at all costs during the process, such as disclosing the price offered by one subcontractor to a rival subcontractor, to obtain a reduction.
- The process should be fair, to create an atmosphere of trust between the contractor and the subcontractor.

Subcontracting



Subcontracting procedure

1. Establishment of a supplier database including basic contact data of the firm, documentary proof that the subcontractor complies with all requirements demanded by regulations (external or internal to the company), accredited experience, evaluations of previous work if possible, or indirect references from other companies, clients, employees, *etc.*
2. Preselection of subcontractors based on the evaluations compiled in the database.

Subcontracting ...

3. Specific definition of the service to be outsourced, by indicating general conditions and technical specifications relating to the construction project, as well as delivery and invoicing.
4. Requests and evaluations of bids.
5. Awarding the tender to the optimal bidder, according to the analysis carried out by the contractor.
6. Formalization and signing of the order or contract.
7. Provision of permits and access cards to the construction site for the subcontractor.
8. Monitoring and control of the outsourced service (procedures and paperwork).
9. Final evaluation of the work and update of the database

Purchase of materials and equipment

- The purchase of materials is an area of subcontracting which does not include labour or specific equipment, and therefore performance does not depend on time.
- These materials are installed and set up directly by the main contractor, or alternatively by a subcontractor.
- It is also possible that the subcontractor may be directly responsible for the acquisition of materials.

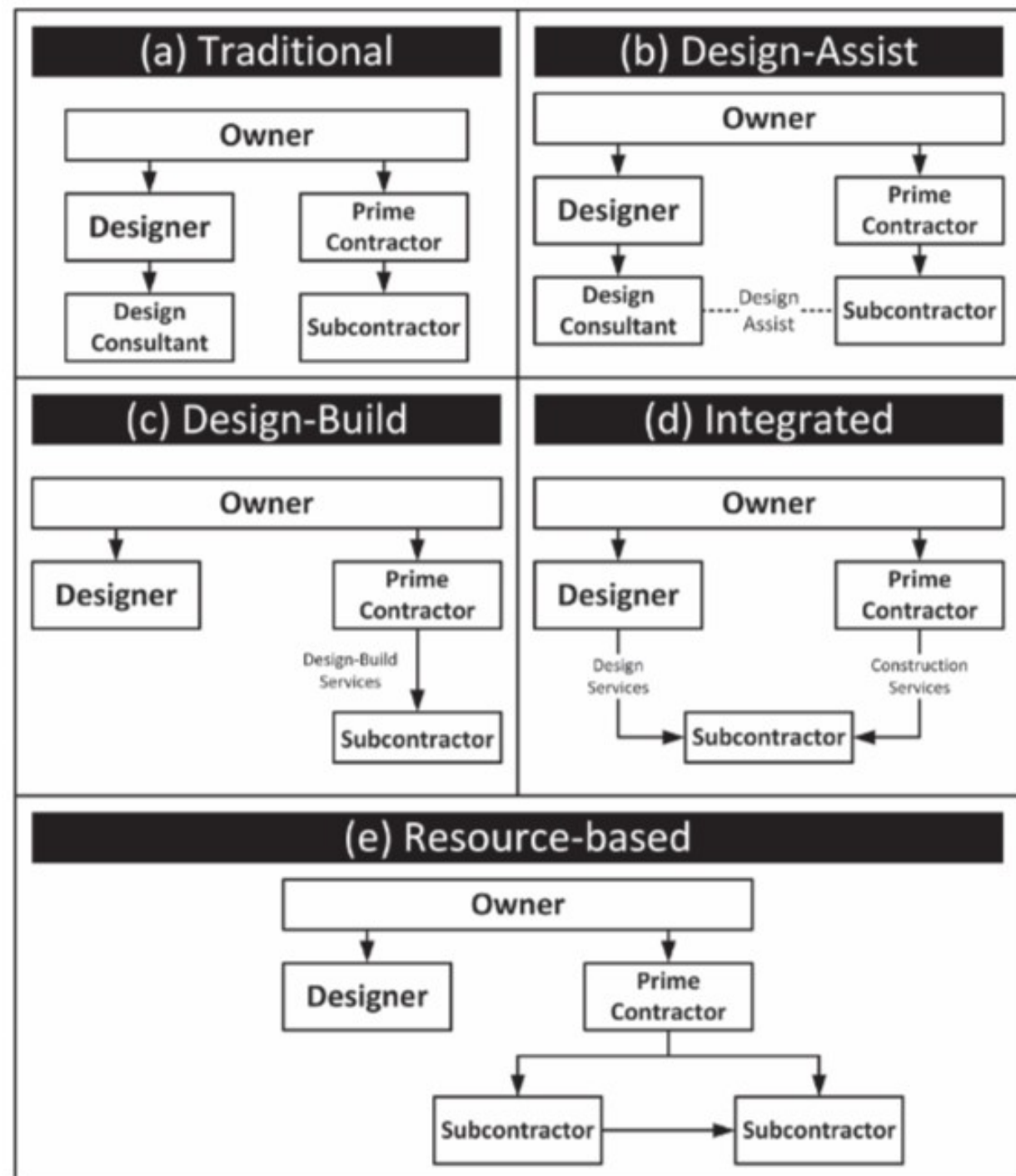
Purchase ...

- If the purchase depends directly on the main contractor, the transaction is called **supply and the vendor is called the supplier**.
- Three kinds of materials can be differentiated (Halpin and Woodhead, 1998):
 1. **Bulk materials** that require simple or no fabrication and can be delivered from storage locations to the site at short notice – one to five days (fill materials, masonry, concrete, paving materials, water and waste piping, *etc.*)
 2. **Standard items** that require some fabrication by the manufacturer, and they are stocked in small quantities, being manufactured for the project after the order is signed (e.g. Bricks, ceramic tiles, standard steel elements, formwork, insulation products, valves, *etc.*)
 3. **Materials that are customized** for a specific project and they must conform to unique requirements.

Purchase orders (*P.O*)

- Specific contracts, called *P.Os*, are normally used to formalize the acquisition, varying its complexity from a formal contract to a mail (email or fax) order.
- In the case of complex and specifically fabricated materials or elements, the *P.O* has to include **detailed specifications** (shop drawings, product data and samples) coming from the design project or developed from it by the main contractor or the project manager.
- Five basic items should be included in any *P.O*: **quantity; description** (as detailed as necessary); **unit price; special instructions** related (mainly) to **delivery** and **payment** of items (shipping and invoicing); and **signature** of the parties involved in the contract.

Types of Subcontracting



Suppliers receive a *PO*, whereas subcontractors execute a subcontract agreement with the GC. There are two major types of purchase orders: a long form and a short form. The long-form *PO* is usually authored by the project manager, an experienced project engineer, or a staff procurement specialist in the main office. This *PO* is for materials with larger values, those with longer lead times, and/or those that require of-site fabrication and submittal approval. An example of a long-form *PO* for our heavy-civil I-90 highway overpass case study project is included. Suppliers who will typically receive a long-form *PO* include those providing:

- Concrete reinforcement steel (rebar), when installed by a separate subcontractor or the GC;
- Ready-mix concrete;
- Pre-cast concrete;
- Structural steel, when installed by a separate subcontractor or the GC;
- Wood framing, including fabricated lumber like glue-lam beams and trusses, when installed by a separate specialty subcontractor;
- Windows, if not a curtain-wall system, which will be subcontracted;
- Doors, frames, and hardware; and
- Specialties, such as toilet accessories, fire extinguishers, lockers, signage, and corner-guards; most of these are installed by the general contractor's

MATERIAL PURCHASE ORDER CONTRACT

Gateway Construction Company
2201 First Avenue
Spokane, WA 99205
509-642-2322

TO:	Idaho Precast Box 455 Highway 101 Coeur d' Lane, ID 83814	PURCHASE ORDER NO.:	1732.12
		DATE:	April 21, 2018
FOR:	Pre-Cast Concrete Beams	PURCHASE ORDER VALUE:	\$230,400.00
SHIP TO:	I-90 Jobsite, Missoula, MT	SHIP VIA:	Your Truck
SCHEDULED DELIVERY DATE:	July 1, 2018, Pending confirmation with project superintendent		

SPECIFIC INCLUSIONS:

1. Supply concrete and reinforcement steel and formwork and other means and methods necessary to fabricate all concrete pre-cast beams according to Montana State specification section 035600, contract drawings, and bid item # 059.
2. Bid item 59 currently scheduled for 20 beams at 48 feet long each for a total of 9,600 LF at the Idaho Precast bid amount of \$240/LF for a total purchase order amount of \$230,400.00.
3. Fabricator is responsible to prepare and submit fabrication drawings for approval by the State engineer no later than May 5, 2018. Fabricator shall not begin fabrication of pre-cast beams until the State has approved the fabrication drawings. Any earlier fabrication will be at supplier's risk.
4. Fabricator is responsible to prepare installation drawings, for installation by others, no later than June 15, 2018.
5. All shipping and transportation costs, including cross-state taxes, are the responsibility of the fabricator.

SPECIFIC EXCLUSIONS: Truck unload and installation by others

This Purchase Order is subject to additional terms and provisions printed on the reverse hereof.

SELLER:

By: Jim Bergerson
Title: Idaho PC CEO

Purchase Order Prepared By:

BUYER:

By: Rachel Radcliff
Title: GCC Project Manager

Fritz Johnson, GCC Project Engineer

The short-form purchase order is, by definition, shorter than the long-form PO. The long-form PO will have much more detail, ne print, or boilerplate terms and conditions. The short-form PO is usually authored by the superintendent, often with assistance from the field engineer or project engineer. The materials purchased on the short form are usually “*of-the-shelf*” and ready for pick up at a local material supply warehouse. The value of materials purchased with the short-form PO is often limited to a certain value, say \$200 or less, or for as-needed unit price items with no set total lump sum value. Larger value materials are purchased with the long form. Some examples of materials purchased with the short-form PO include nails, caulking, glue, small tools, short-term equipment rental, gravel and dirt, smaller orders of lumber,

PURCHASE ORDER

Gateway Construction Company
2201 First Avenue
Spokane, WA 99205
509-642-2322

To: Grizzly Aggregates
Route 5, Box 643
Missoula, MT 59801

Attention: G. Adams
Phone No.: 406-655-1422

P.O. No.: 1732.05
Date: 4/15/2018
Job Name: I-90 Overpass

Job Address: Missoula, MT

When Required: As Needed			Ship Via: Your Truck, 5 CY Minimum		
No.	Quantity	Unit	Description	Unit Price	Amount
1	Min 5	CY	Drain Gravel	\$30/CY	\$
2	Min 5	CY	Sand Bedding	\$20/CY	\$
3	Min 40	LF	16" Diameter PVC Culvert	\$12/LF	\$
4	Min 5	CY	Landscape Topsoil	\$40/CY	\$
				TOTAL	\$

Purchase Order Instructions: Material only to be ordered by persons noted above. All deliveries are to be scheduled. Driver is required to wear a hard-hat, orange vest, and construction boots

Requested By: Randy Buckwater Superintendent	Approved By: Randy Buckwater Superintendent	Purchased By: Firtz Johnson Project Engineer
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Application of *ICT* in monitoring

- Application of *ICT* throughout the construction supply chain is a current fact.
- Tserng *et al.* (2005) explain the use of web-based technology, personal digital assistants, barcode scanning, and data entry mechanisms in a very detailed way, using a construction real-case.
- Once the main contractor has awarded each job to a particular supplier, it is decided which component or element will be **traced or monitored using barcodes**.
- There are six key phases where each element is monitored and controlled: ***production, test and storage, delivery, on-site inspection, inventory, and installation.***
- Mobile devices scan the barcodes at the proper places and times, and the information is centralized through a web-based portal system

Application ...

- Data is thus acquired on-site, enabling monitoring of the operations on-line and control of the construction progress in real-time.
- There is also a feedback loop between the supplier and the contractor about the status of the construction project.
- Thus, **rescheduling** can be done if necessary, in a collaborative way.
- Information sharing is faster and more efficient; hence, **issues can be detected sooner**, misunderstandings can be avoided and corrective actions can be implemented faster in coordination

Sourcing

- *Sourcing* is the set of business processes required to purchase goods and services.
- Managers must first decide which tasks will be outsourced and those that will be performed within the firm.
- For each outsourced task, the manager must decide whether to source from a *single supplier or a portfolio of suppliers*.
- If a *portfolio of multiple suppliers* is to be carried, then the role of each supplier in the portfolio must be clarified.
- The next step is to identify the *set of criteria* that will be used to select suppliers and measure their performance.

Sourcing

- There are 3 types of sourcing: *sole*, *multiple*, and *single*.
- 1. *Sole sourcing* implies that only one supplier is available because of patents, technical specifications, raw material, location, and so forth.
- 2. *Multiple sourcing* is the use of more than one supplier for an item. The potential advantages of multiple sourcing are that **competition will result in lower price** and better service and that there will be a continuity of supply.
- 3. *Single sourcing* is a planned decision by the organization to select one supplier for an item when several sources are available. **It is intended to produce a long-term partnership.**

Sourcing

- Managers then select suppliers and negotiate contracts with them.
- Contracts define the role of each supply source and should be structured to improve supply chain performance and minimize information distortion from one stage to the next.
- Once suppliers and contracts are in place, procurement processes that facilitate the placement and delivery of

Role in the competitive strategy

- *Sourcing* decisions are crucial because they affect the level of *efficiency and responsiveness* the supply chain can achieve.
- In some instance, firms outsource to responsive third parties if it is too expensive for them to develop this responsiveness on their own.
- Firms also outsource for efficiency if the third party can achieve significant *economies of scale* or has a lower underlying cost structure for other reasons.
- In other instances firms have kept the *responsive process* in-house, to maintain control.
- Outsourcing decisions should be driven by the desire for growth in total supply chain profitability.

Sourcing-Related Metrics

- A manager should track the following sourcing related metrics that influence supply chain performance.
- *Days payable outstanding* measures the number of days between when a supplier performed a supply chain task and when it was paid.
- *Average purchase price* measures the average price at which a good or service was purchased during the year. The average price should be weighted by the quantity purchased at each price.
- *Range of purchase price* measures the fluctuation in purchase price during a specified period. The goal is to identify if the quantity purchased correlated with the price.

Sourcing-Related ...

- *Average purchase quantity* measures the average amount purchased per order. The goal is to identify whether a sufficient level of aggregation is occurring across locations when placing an order.
- *Fraction on-time deliveries* measures the fraction of deliveries from the supplier that were on time.
- *Supply quality* measures the quality of product supplied.
- *Supply lead time* measures the average time between when an order is placed and the product arrives.

Selecting suppliers

- The objective of purchasing is to get all the right things together: *quality*, *quantity*, *delivery*, and *price*.
- Once the decision is made about what to buy, the selection of the right supplier is the next most important *purchasing decision*.
- A good supplier is one that has the technology to make the product to the required *quality*, has the *capacity* to make the *quantities* needed, and can run the business well enough to make a *profit* and still sell a product *competitively*

Factors in Selecting Suppliers

- These are what the supplier is expected to provide and are the basis for selection and evaluation. Considering this, there are several factors in selecting a supplier.
 - Technical ability
 - Manufacturing capability
 - Reliability
 - After-sales service
 - Supplier location
 - Lean capabilities
 - Other considerations
 - Price

Factors in Selecting Suppliers

- Does the supplier have the technical ability to make or supply the product wanted?
- Does the supplier have a program of product development and improvement?
- Can the supplier assist in improving the products?
- These questions are important since, often, the buyer will depend upon the supplier to provide product improvements that will enhance or reduce the cost of the buyer's products.
- Sometimes the supplier can suggest changes in product specification that will improve the product and reduce cost.

Manufacturing capability

- Manufacturing must be able to meet the specifications for the product consistently while producing as few defects as possible.
- This means that the supplier's manufacturing facilities must be able to supply the quality and quantity of the products wanted.
- The supplier must have a **good quality assurance program**, competent and capable manufacturing personnel, and **good manufacturing planning and control systems to ensure timely delivery.**

Reliability

- In selecting a supplier, it is desirable to pick one that is reputable, stable, and financially strong.
- If the **relationship is to continue**, there must be an atmosphere of **mutual trust and assurance** that the supplier is financially strong enough to stay in business.
- If the product is of a technical nature or likely to need replacement parts or technical support, the supplier must have a **good after-sales service which** include a good service organization and inventory of service parts.

Supplier location

- Sometimes it is desirable that the supplier be located near the buyer, or at least maintain an inventory locally.
- A close location helps shorten delivery time and means emergency shortages can be delivered quickly.

Lean capabilities

- Companies competing in a lean environment depend on suppliers to quickly deliver small quantities of product, to keep inventories at a low level.
- Today's companies operate with very little inventory of raw materials and require accurate, on time deliveries from their suppliers.
- Suppliers who simply keep extra inventory to meet these demands will soon have increased costs and pressures to increase their prices.

Lean ...

- Buyers in a lean environment need suppliers who value their new relationship, **working in partnership to remove waste from the system.**
- As a result, these suppliers need to have information and delivery systems in place that allow them to quickly ship exactly what the customer needs without increased cost or effort.

Lean ...

- Lean production can be defined in many ways, but the most popular is the *elimination of all waste and continuous improvement of productivity*.
- Waste means anything other than the minimum amount of equipment, parts, space, material, production time, and workers' time absolutely necessary to add value to the product.
- This means the ideal approach is that there should be no surplus, there should be no safety stocks, and lead times should be minimal:
 - *"If you can't use it now, don't make it now."* From an organizational view, waste refers to anything that is unnecessary and adds no value in the customer's eyes and for which they are unwilling to pay.

Other considerations

- Sometimes other factors such as **credit terms, reciprocal business, supplier health** and **safety record**, and **willingness** of the **supplier to hold inventory** for the buyer should be considered.
- **Price** - The supplier should be able to provide **competitive prices**.
 - This does not necessarily mean the **lowest price**.
 - It is one that considers the ability of the supplier to provide the necessary goods in the quantity and quality

Item Cost

- Item cost is the price paid for a purchased item, which consists of the cost of the item and any other direct costs associated in getting the item into the plant.
- These could include such things as *transportation*, *custom duties*, and *insurance*.
- The inclusive cost is often called the **landed cost**.
- For an item manufactured in-house, the cost includes *direct material, direct labor, and factory overhead*.

Total landed cost

- The *total landed cost* of an item includes the price paid plus all the *handling* and *delivery costs* associated with getting the *product to production*.
- A buyer will often get a price and **per unit transportation discount** by ordering in larger quantities. However, the total cost may increase when the costs of storage and inventory are included.
- A **low landed cost** still may not be a good decision when the total cost of ownership to the company is considered.
 - For example, a carpenter will pay a lower price for a lower grade of wood.

Total ...

- However, the time spent on sorting out knots and defects and the decreased yield of good material will incur production-related costs, which will increase the total cost of the final product, perhaps canceling any savings made in price.
- The **total cost concept looks at the total costs of an item, and not at just the price paid for materials.**
- $\text{Revenue} = \text{Cost} + \text{Profit}$
- $\text{Construction cost} = \text{Direct cost} + \text{Indirect cost}$
- $\text{Direct cost} = \text{Labor} + \text{Material} + \text{Equipment} + \text{Subcontractors}$
- $\text{Indirect cost} = \text{Jobsite general conditions} + \text{Home office general conditions}$

Costs associated with a manufactured item

- Costing cannot be an **exact science**, as any buyer who negotiates cost-based prices, perhaps with a cost analyst sitting in with them, becomes aware.
- Apart from variable costs, which vary directly and proportionately with the quantity produced, the cost of production must include a contribution to overheads and profit.
- Sales revenue must, in the long term, cover the full cost of staying in business, including profit, if the seller is to survive – even though in the short term a firm that is short of work may accept prices that do not make a full contribution to overheads and profit in order to keep people and plant busy.

Prime costs (direct materials, direct labour, direct expenses) + factory overheads (fixed and variable expenses) = works cost

Works cost + administrative and sales overheads = total cost

Total cost + profit = SALES PRICE

Partnership between suppliers & buyers

- In today's supply chain environment, the type of relationship between the supplier and the buyer is crucial to both.
- Ideally, the relationship will be ongoing with a mutual dependency.
- The supplier can rely on future business, and the buyer will be ensured of a supply of quality product, technical support, and product improvement.
- Communications between buyer and supplier must be open and complete so both parties understand the problems of the other and can work together to solve problems to their mutual advantage.
- Thus, supplier selection and supplier relations are of the utmost importance.

Final Selection of Supplier

- Some factors in evaluating potential suppliers are quantitative, and a dollar/Birr value can be put on them.
- *Price* and *landed cost* are obvious examples.
- Other factors are qualitative and require some judgment to determine them.
- These are usually specified in a descriptive fashion.
- The supplier's technical competence might be an example.
- The challenge is finding some method of combining these two major factors that will enable a buyer to pick the best supplier.

Final ...

- One method involves a supplier ranking method, as follows:
 1. **Select those factors** that must be considered in evaluating potential suppliers.
 2. **Assign a weight to each factor.** This weight determines the importance of the factor in relation to the other factors.
- Usually a scale of 1 to 10 is used. If one factor is assigned a weight of 5 and another factor a weight of 10, the second factor is considered twice as important as the first.
- When developing the factors and their weights, the buyer can use input from the people who will be affected by the supplier selection. This will help the buyer in making a more informed decision and will improve the

Final ...

3. **Rate the suppliers for each factor.** This rating is not associated with the weight. Rather, suppliers are rated on their ability to meet the requirements of each factor. Again, usually a scale of 1 to 10 is used.
4. **Rank the suppliers.** For each supplier, the weight of each factor is multiplied by the supplier rating for that factor. For example, if a factor had a weight of 8 and a supplier was rated 3 for that factor, the ranking value for that factor would be 24. The supplier rankings are then added to produce a total ranking. The suppliers can then be listed by total ranking and the

Example of this method of selecting suppliers

Factor	Weight	Rating of Suppliers				Ranking of Suppliers			
Suppliers		A	B	C	D	A	B	C	D
Function	10	8	10	6	6	80	100	60	60
Cost	8	3	5	9	10	24	40	72	80
Service	8	9	4	5	7	72	32	40	56
Technical Assistance	5	7	9	4	2	35	45	20	10
Credit Terms	2	4	3	6	8	8	6	12	16
Total (rank of suppliers)						219	223	204	222

Transportation Terms

- The transporters of goods have used terminology for many years to specify who pays the cost of transportation and who owns the goods in-transit.
- The four basic terms in common use (*North American*) are based on the term **FOB, Freight On Board**, which specifies who is responsible for the goods and pays the insurance to protect against risk for the goods.
- The 4 **FOB** terms used allow wise buyers and sellers to take advantage of their own area of expertise to keep costs as low as possible.

Transportation ...

- A small company with a low shipping volume often pays higher transportation fees than a large supplier.
- In the case of a small buyer, it is often better to get the **shipper to pay for transportation** and bill the buyer at a **lower total cost**.
- A company with their own fleet of trucks would want to take responsibility for the freight charges.

Four *FOB* terms

1. *FOB origin, freight collect*. The seller makes the goods available at their dock and all risk and costs of transportation are assumed at this point by the buyer.
2. *FOB origin, freight pre-paid*. The seller delivers the goods to the buyer but the buyer has the risk of the goods while in-transit and pays the insurance.
3. *FOB destination, freight pre-paid*. The seller is responsible for all costs of risk and transportation to the buyer's location.
4. *FOB destination, freight collect*. The seller is responsible for the risk to the buyer's location but the buyer is responsible for the freight.

Incoterms

- The term *FOB* indicates the point of transfer of ownership for **North American shipments** only, which does not necessarily conform to the international standards of Incoterms.
- *International Commercial Terminology (Incoterms)* was developed by the *International Chamber of Commerce in 1936* to establish standards governing the responsibilities between buyers and sellers when transporting goods within and across international boundaries.

Incoterms

- The terms have been subsequently updated, and the definitions in this lecture are based on *Incoterms 2010*. In-transit goods represent a major investment to buyer and seller and run many risks of damage or loss.
- It is essential that a clear understanding exists as to **who actually owns the goods at a given time or location in the SC and who will pay the expenses incurred to transport the goods.**
- Another risk when transporting hazardous goods is the potential for accidents or spills and the potential environmental cleanup costs.

Incoterms

- There are 3 responsibilities to be addressed:
 1. Cost of transportation of the goods.
 2. Ownership or insurance against risk of the goods.
 3. Preparation of customs documentation for the movement of the goods.
- Incoterms are divided into two groups:
 1. Rules for **any mode** or modes of transport.
 2. Rules for **sea and inland waterway** transport.

Terms for any mode(s) of transport

- *EXW (named place): Ex Works*. The seller makes the goods available at their premises. The buyer is responsible for all charges to transport and insure the goods, including customs documentation. The buyer bears all risks for transporting the goods.
- *FCA (named carrier): Free carrier*. The seller is responsible for preparing the export documentation and delivering the goods to the transporter named after the *Incoterm*. The risk then passes to the buyer, who takes responsibility for all subsequent transportation costs.

Terms for ...

- *CPT (named destination port): Carriage Paid To*. The seller is responsible for export documentation and pays the freight to the named destination. However, the risk passes to the buyer when the goods have been delivered to the first carrier.
- *CIP (named destination): Carriage and Insurance Paid to*. The seller pays the costs of transportation to the destination and prepares the export documentation. Risk transfers to the buyer when the goods have been delivered to the first carrier.

Terms for ...

- *DAT (named place): Delivered At Terminal.* The seller prepares the export documentation and bears transportation costs to deliver the goods to the named terminal or port. Both parties must agree at which point within the terminal the risk is transferred from seller to buyer.
- *DAP (named place): Delivered At Place.* The seller delivers the goods to the buyer, who assumes responsibility for the unloading at the named place.

Terms for ...

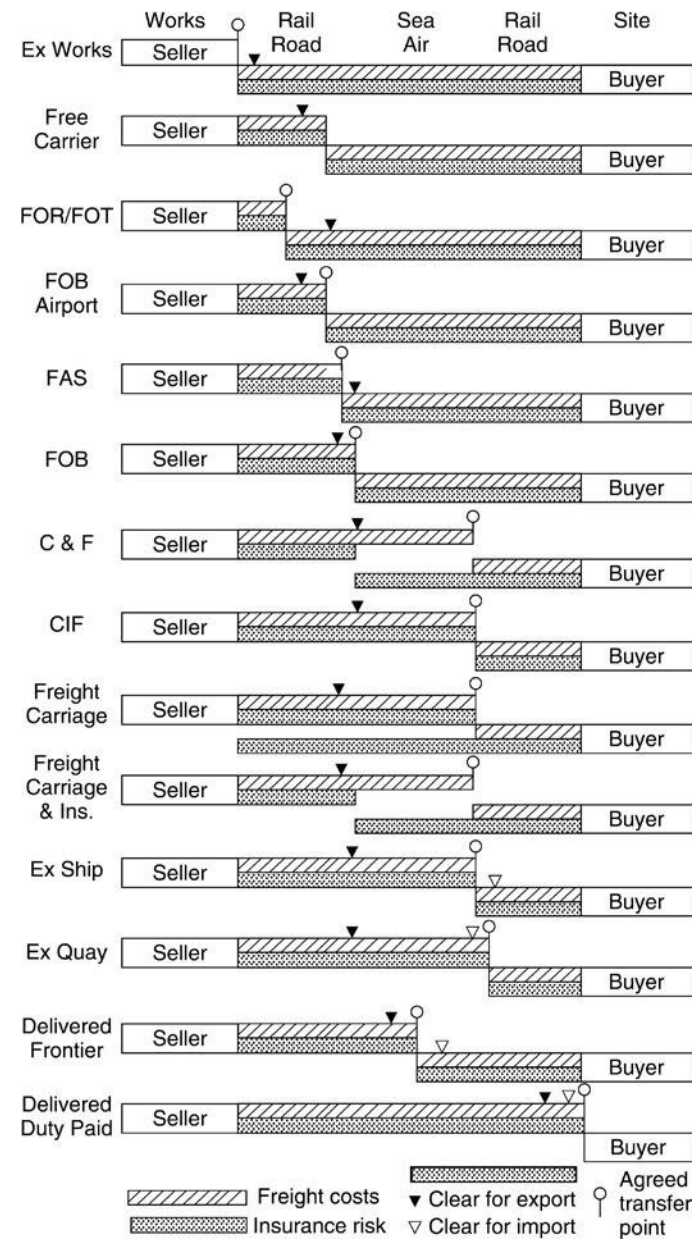
- Both parties must agree at which point at the destination place the risk is transferred from seller to buyer.
- *DP (named destination): Delivered duty paid*. The seller pays all the costs of shipping, export documentation, and any duties to the named destination, which is typically the buyer's location.

Terms for Sea and Inland Waterway Transport

- *FAS (named ship): Free Alongside Ship.* The seller is responsible for export documentation and the transportation of the goods to the point of ship loading at the port of export. Risk is passed to the buyer once the goods are delivered to the port of shipment. The buyer pays loading costs, freight, insurance, unloading costs, and transportation from the import port.
- *FOB (named ship): Free On Board.* The seller is responsible for export documentation and delivery of the goods onto the named vessel or “*past the ship’s rail.*” *FOB* destination designates that the seller is responsible until the buyer takes possession. Note that this term is similar but not the same as the term *FOB* introduced earlier for North American freight.

Terms for Sea ...

- *FR (named destination port): Cost and Freight.* The seller is responsible for export documentation and pays for the freight to the port of destination. However, when the goods “*pass the ship's rail*” in the port of shipment, the buyer assumes the risk for the goods. This *Incoterm* is intended for use when shipping product that is not containerized.
- *CIF (named destination port): Cost, Insurance, and Freight.* The selling price includes the cost of all transportation costs and insurance to the named destination port. The seller is responsible for acquiring the insurance policy, but the responsibility of the goods ends when the goods are aboard the vessel.



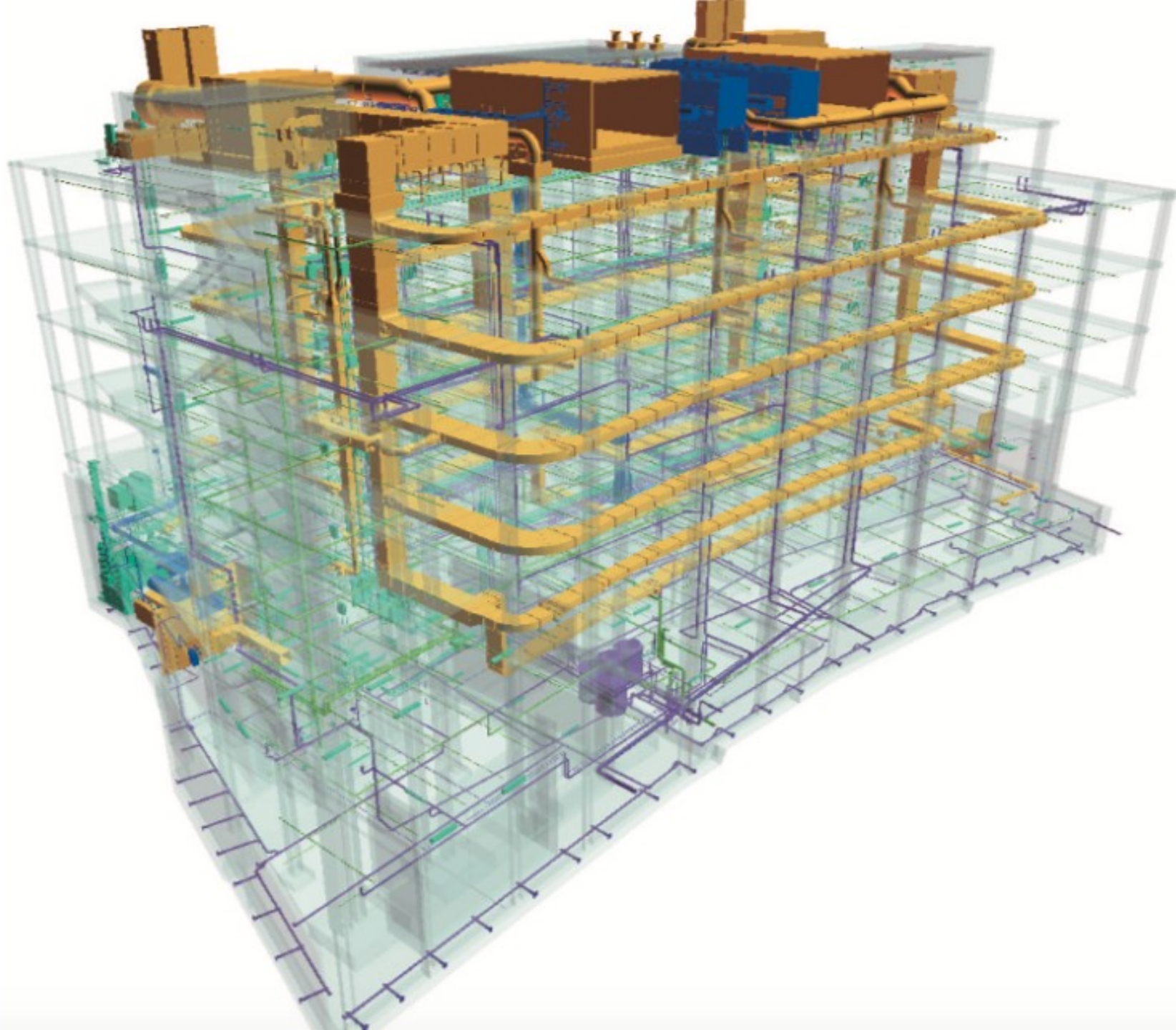
Building Information Modeling

- Efforts are currently under way to develop new ways of managing the complexity of the interdisciplinary information that goes into the design and construction phase activities of a building.
- The National Institute of Building Sciences (NIBS) has formed the buildingSMART alliance, whose aim is to optimize a computer software system that standardizes the design, construction, operation, and maintenance process for buildings by compiling all of the related information in a single electronic format.
- The software, known as *Building Information Modeling (BIM)*, has revolutionized the way buildings are designed, constructed, and maintained.

BIM ...

- Architects and engineers use *BIM* to generate a 3D model of a building with embedded links to other project information.
- In its current state, *BIM* has a range of capabilities, including drawing, construction estimating and scheduling, interdisciplinary coordination, and generating fabrication protocols.
- *BIM* also runs analysis of structural design solutions, building code compliance, projected energy performance and consumption models, and daylight penetration (see fig in next slide).

A *BIM* model illustrating the capability of visualization and analysis of various building systems.



BIM ...

- The use of the *BIM* system results in enhanced efficiencies during the construction process itself.
- Construction methods, sequences, and details can be studied using the modeling process, resulting in fewer mistakes, fewer changes, and, ultimately, shorter construction schedules.
- The software allows for *complete material takeoffs* to be generated, eliminating the painstaking process of calculating material quantities by hand.

BIM ...

- By designing in a *3D model systems*, integration can be visualized and better coordination realized.
- Information from models can be fed directly to material fabricators, eliminating the need for shop drawings and ensuring tight dimensional tolerances.
- Students of construction should become familiar with the *BIM* software, because its use in the construction industry is becoming widespread.

Standards Bid Documents (*SBD*) developed by PPA of Ethiopia (<http://www.ppa.gov.et>)

- SBD Works ICB
- SBD Health Sector Goods ICB
- SBD Non-Consultancy Services NCB
- SBD Textbooks NCB
- SBD Non-Consultancy Services ICB
- SBD Information Systems NCB
- SBD Information Systems ICB
- *Framework Agreement (FA)* SBD Goods NCB
- FA SBD Goods ICB
- SBD Consultancy NCB
- SBD Consultancy ICB

International Standards Bid Documents

- There are some standards internationally adopted, especially in English language countries: FIDIC (International Federation of Consulting Engineers), JCT (Joint Contract Tribunal), ICE (Institution of Civil Engineers), NEC/ECC (New Engineering Contract), AIA (American Institute of Architects), AGC (Association of General Contractors), EJCDC (Engineers Joint Contract Documents Committee), World Bank, United Nations, the Government Prime Contracting time and so on.

International ...

- The Conditions of Contract (International) for Works of Civil Engineering Construction, known as the *FIDIC* (International Conditions of Contract) contract are recommended for use for works of civil engineering construction which are the subject of international tender.
- It has evolved from the *ICE* Conditions of Contract and is used in many countries throughout the world.
- There is provision for the insertion of the ruling language in which the contract is to be construed and interpreted.

FIDIC

- *CONS* – Conditions of Contract for Construction (*'The Red Book'*),
- *P & DB* – Conditions of Contract for Plant and Design-Build (*'The Yellow Book'*)
- *EPCT* – Conditions of Contract for *EPC/Turnkey* Projects (*'The Silver Book'*)
- *Conditions of Contract for Design, Build and Operate Projects* (*'The Gold Book'*)
- *Public-private partnership procurement (PPPP) method*