SS ZG622:
Software Project Management
(Lecture #14)

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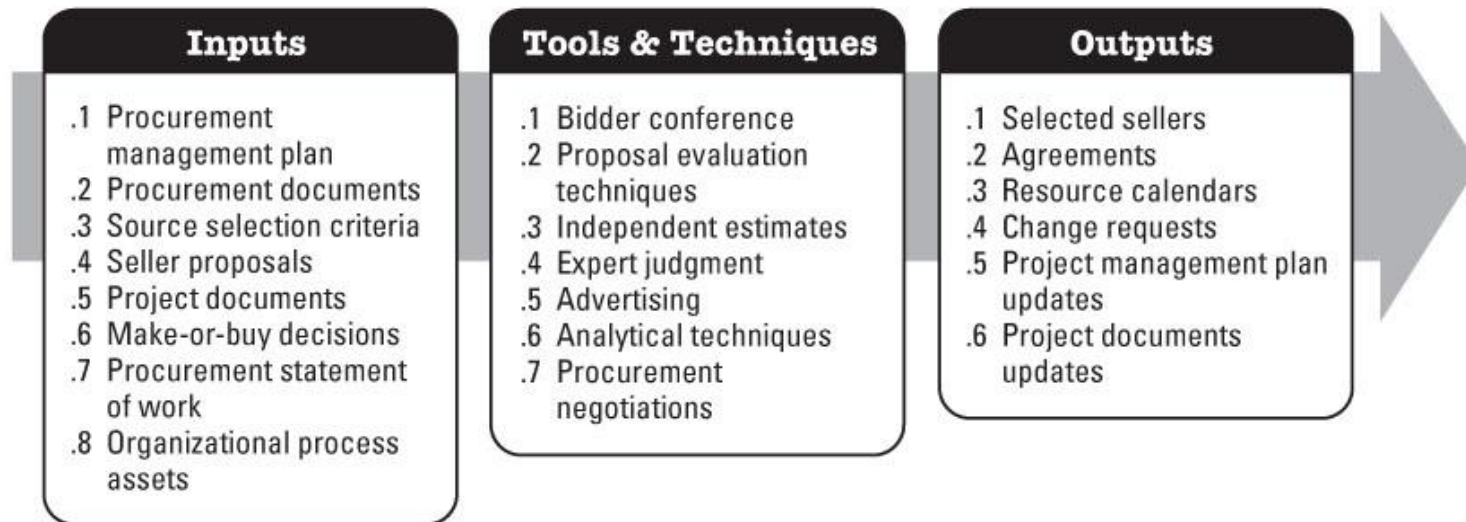**BITS** Pilani

L14: Sotware Project Contracts –

Software project contracts, Contracting process,

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Project Procurement Management - PMBOK

- **Plan Procurement Management** The process of documenting project procurement decisions, specifying the approach, and identifying potential sellers

- **Conduct Procurements** The process of obtaining seller responses, selecting a seller, and awarding a contract.

- **Control Procurements** The process of managing procurement relationships, monitoring contract performance, and making changes and corrections as appropriate.

- **Close Procurements** The process of completing each project procurement

Conduct Procurements - PMBOK

Inputs	Tools & Techniques	Outputs
.1 Procurement management plan .2 Procurement documents .3 Source selection criteria .4 Seller proposals .5 Project documents .6 Make-or-buy decisions .7 Procurement statement of work .8 Organizational process assets	.1 Bidder conference .2 Proposal evaluation techniques .3 Independent estimates .4 Expert judgment .5 Advertising .6 Analytical techniques .7 Procurement negotiations	.1 Selected sellers .2 Agreements .3 Resource calendars .4 Change requests .5 Project management plan updates .6 Project documents updates

Acquiring software from external supplier

This could be:

- a *bespoke system -* created specially for the customer

- *off-the-shelf -* bought 'as is'

- *customised off-the-shelf* (COTS) - a core system is customised to meet needs of a particular customer

Acquiring software from external supplier

When software is provided by supplier, what are they providing:

- *Goods ?* or

- *Service ?*

Globally these two entities are treated differently for the purpose of legal obligations and taxation

Goods vs. Services

Classical view is that

- Goods are items that can be seen and touched, such as books, pens, television etc.

- Services are provided by other people, such as doctors, barbers and waiters

Many nations treat goods and services separately with respect to rights and liabilities.

Software is treated differently by different countries based on several factors in transaction

Stages in contract placement

requirements analysis → evaluation plan → invitation to tender → evaluation of proposals
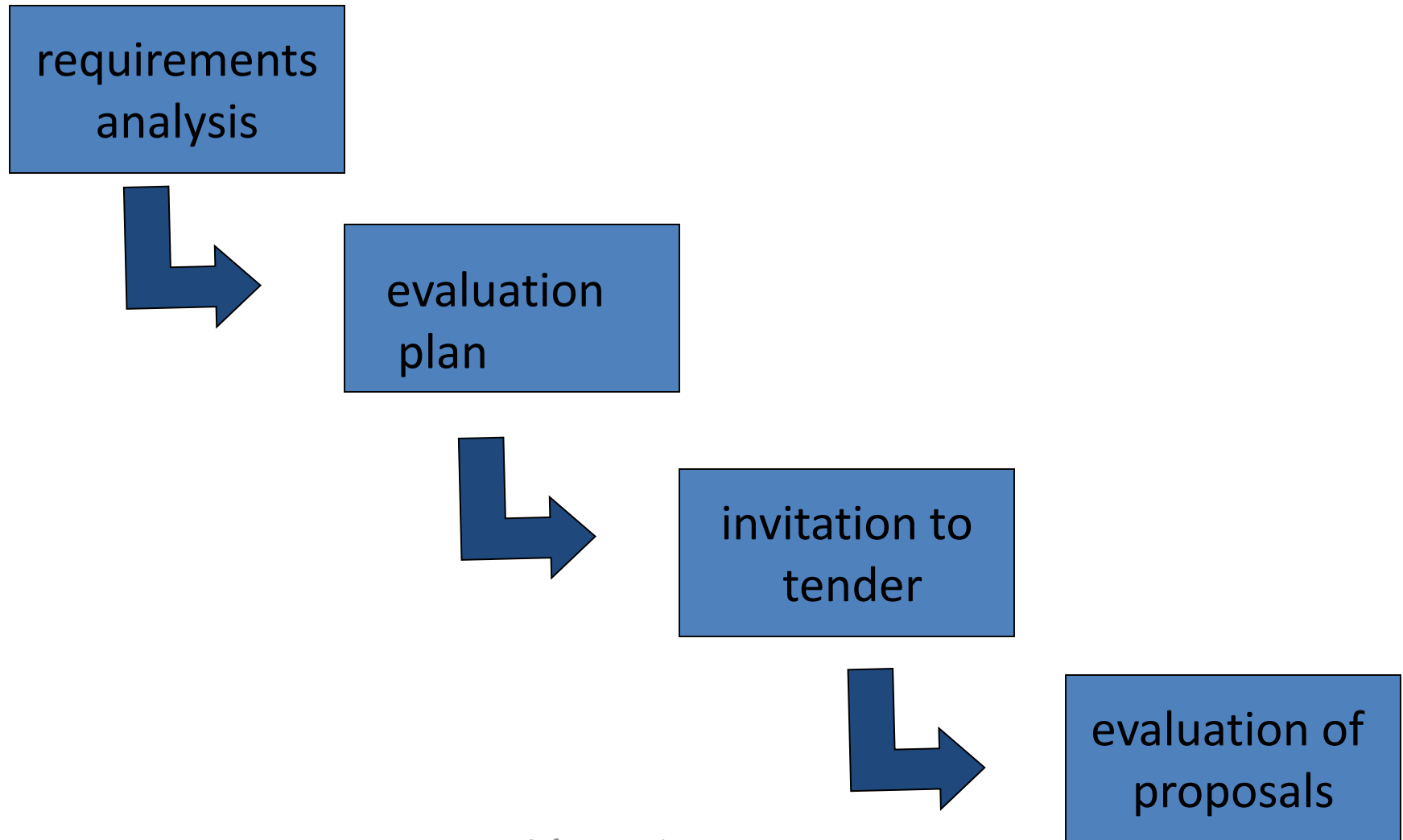
Tendering Process

- Open tendering
  - any supplier can bid in response to the *invitation to tender*
  - all tenders must be evaluated in the same way
  - government bodies may have to do this by local/international law (WTO World Trade Organization, EU European Union requirements)

Tendering Process

- Restricted tendering process
  - bids only from those specifically invited
  - can reduce suppliers being considered at any stage

- Negotiated procedure
  - negotiate with one supplier e.g. for extensions to software already supplied

Requirements document: sections

- introduction

- description of existing system and current environment

- future strategy or plans

- system requirements -
  - mandatory/desirable features

- deadlines

- additional information required from bidders

Requirements

- These will include
  - functions in software, with necessary inputs and outputs
  - standards to be adhered to
  - other applications with which software is to be compatible
  - quality requirements e.g. response times

Bidder Conferences

- Bidder conferences (sometimes called contractor conferences, vendor conferences, and pre-bid conferences) are meetings between the buyer and all prospective sellers prior to submittal of a bid or proposal.

- Used to ensure that all prospective sellers have a clear and common understanding of the procurement requirements), and that no bidders receive preferential treatment.

- Buyers ensure that all prospective sellers hear every question from any individual prospective seller and every answer from the buyer. Typically fairness is addressed by techniques such as collecting questions from bidders or arranging visits in advance of the bidder conference.

- Responses to questions can be incorporated into the procurement documents as amendments.

Evaluation plan

- How are proposals to be evaluated?

- Methods could include:
  - reading proposals
  - interviews
  - demonstrations
  - site visits
  - practical tests

Off the shelf software clearly has an advantage here as there is actually product that can be evaluated in existence.

Evaluation plan -contd.

- Need to assess value for money (VFM) for each desirable feature

- VFM approach an improvement on previous emphasis on accepting lowest bid

- Example:
  - feeder file saves data input
  - 4 hours work a month saved at £20 an hour
  - system to be used for 4 years
  - if cost of feature £1000, would it be worth it?

Invitation to tender (ITT)

- Note that bidder is making an *offer* in response to ITT

- *acceptance* of offer creates a *contract*

- Customer may need further information

- Problem of different technical solutions to the same problem

ISO 12207 refers to an ITT as a Request for Proposal or RFP.

Memoranda of agreement (MoA)

- Customer asks for technical proposals (for complex projects)
- Technical proposals are examined and discussed
- Leads to MoA between customer and prospective suppliers
- Agreed technical solution incorporated in MoA
- Tenders are then requested from prospective suppliers based on MoA
- Tenders judged on price
- Fee could be paid for technical proposals to suppliers by customer

Types of contract

- fixed price contracts

- time and materials contracts

- fixed price per delivered unit

Note difference between goods and services

Often licence to use software is bought rather than the software itself

Fixed Price Contracts

- This category of contracts involves setting a fixed total price for a defined product, service, or result to be provided.

- Fixed-price contracts may also incorporate financial incentives for achieving or exceeding selected project objectives, such as schedule delivery dates, cost and technical performance, or anything that can be quantified and subsequently measured.

- Sellers under fixed-price contracts are legally obligated to complete such contracts, with possible financial damages if they do not.

- Under the fixed-price arrangement, buyers need to precisely specify the product or services being procured. Changes in scope may be accommodated, but generally with an increase in contract price

Fixed Price Contracts

Variants of Fixed Price Contracts are

- *Firm Fixed Price Contracts (FFP)*. The most commonly used contract type is the FFP. Any cost increase due to adverse performance is the responsibility of the seller, who is obligated to complete the effort. Under the FFP contract, the buyer should precisely specify the product or services to be procured, and any changes to the procurement specification can increase the costs to the buyer.

- *Fixed Price Incentive Fee Contracts (FPIF)*. This fixed-price arrangement gives the buyer and seller some flexibility, with financial incentives tied to achieving agreed upon metrics. Typically such financial incentives are related to cost, schedule, or technical performance of the seller. Performance targets are established at the outset, and the final contract price is determined after completion of all work based on the seller's performance. Under FPIF contracts, a price ceiling is set, and all costs above the price ceiling are the responsibility of the seller, who is obligated to complete the work.

- *Fixed Price with Economic Price Adjustment Contracts (FP-EPA)*. This contract type is used whenever the seller's performance period spans a considerable period of years, as is desired with many long-term relationships. It is a fixed-price contract, but with a special provision allowing for pre defined final adjustments to the contract price due to changed conditions, such as inflation changes, or cost increases (or decreases) for specific commodities. The EPA clause needs to relate to some reliable financial index, which is used to precisely adjust the final price.

Fixed price contracts

Advantages to customer

- known expenditure

- supplier motivated to be cost-effective

Fixed price contracts

Disadvantages

- supplier will increase price to meet contingencies
- difficult to modify requirements
- cost of changes likely to be higher
- threat to system quality

Time and Material Contracts (T&M)

- Time and material contracts are often used for staff augmentation, acquisition of experts, and any outside support when a precise statement of work cannot be quickly prescribed.

- These types of contracts may be subject to a cost increase for the buyer. The full value of the agreement and the exact quantity of items to be delivered may not be defined by the buyer at the time of the contract award.

- Many organizations require not-to-exceed values and time limits placed in all T&M contracts to prevent unlimited cost growth.

- T&M contracts can also resemble fixed unit price arrangements when certain parameters are specified in the contract. Unit labor or material rates can be preset by the buyer and seller, including seller profit, when both parties agree on the values for specific resource categories, such as senior engineers at specified rates per hour, or categories of materials at specified rates per unit.

Time and materials

Advantages to customer

- easy to change requirements
- lack of price pressure can assist product quality

Time and materials

Disadvantages

- Customer liability - the customer absorbs all the risk associated with poorly defined or changing requirements

- Lack of incentive for supplier to be cost-effective

Cost-reimbursable contracts.

This category of contract involves payments (cost reimbursements) to the seller for all legitimate actual costs incurred for completed work, plus a fee representing seller profit. Cost-reimbursable contracts may also include financial incentive clauses whenever the seller exceeds, or falls below, defined objectives such as costs, schedule, or technical performance targets. Three of the more common types of cost-reimbursable contracts in use are Cost Plus Fixed Fee (CPFF), Cost Plus Incentive Fee (CPIF), and Cost Plus Award Fee (CPAF).

A cost-reimbursable contract provides the project flexibility to redirect a seller whenever the scope of work cannot be precisely defined at the start and needs to be altered, or when high risks may exist in the effort.

- *Cost Plus Fixed Fee Contracts (CPFF).* The seller is reimbursed for all allowable costs for performing the contract work, and receives a fixed-fee payment calculated as a percentage of the initial estimated project costs. A fee is paid only for completed work and does not change due to seller performance. Fee amounts do not change unless the project scope changes.

- *Cost Plus Incentive Fee Contracts (CPIF).* The seller is reimbursed for all allowable costs for performing the contract work and receives a predetermined incentive fee based upon achieving certain performance objectives as set forth in the contract. In CPIF contracts, if the final costs are less or greater than the original estimated costs, then both the buyer and seller share costs from the departures based upon a prenegotiated cost-sharing formula, for example, an 80/20 split over/under target costs based on the actual performance of the seller.

- *Cost Plus Award Fee Contracts (CPAF).* The seller is reimbursed for all legitimate costs, but the majority of the fee is earned only based on the satisfaction of certain broad subjective performance criteria defined and incorporated into the contract. The determination of fee is based solely on the subjective determination of seller performance by the buyer, and is generally not subject to appeals.

Fixed Price per unit delivered

FP Count	Design Cost/FP	Implementation Cost/FP	Total Cost/FP
Up to 2000	$242	$725	$967
2001-2500	$255	$764	$1019
2501-3000	$265	$793	$1058
3001-3500	$274	$820	$1094
3501-4000	$284	$850	$1134

Fixed price/unit example

- Estimated system size 2,600 FPs
- Price
  - 2000 FPs x $967 *plus*
  - 500 FPs x $1,019 *plus*
  - 100 FPs x $1,058
  - i.e. $2,549,300
- What would be charge for 3,200 FPs?

Fixed price/unit

Advantages for customer

- customer understanding of how price is calculated

- comparability between different pricing schedules

- emerging functionality can be accounted for

- supplier incentive to be cost-effective

Fixed price/unit

Disadvantages

- difficulties with software size measurement - may need independent FP counter

- changing (as opposed to new) requirements: how do you charge?

Procurement Negotiations

- Procurement negotiations clarify the structure, requirements, and other terms of the purchases so that mutual agreement can be reached prior to signing the contract. Final contract language reflects all agreements reached. Subjects covered should include responsibilities, authority to make changes, applicable terms and governing law, technical and business management approaches, proprietary rights, contract financing, technical solutions, overall schedule, payments, and price. Negotiations conclude with a contract document that can be executed by both buyer and seller.

- For complex procurement items, contract negotiation can be an independent process with inputs (e.g., issues or an open items listing) and outputs (e.g., documented decisions) of its own. For simple procurement items, the terms and conditions of the contract can be previously set and nonnegotiable, and only need to be accepted by the seller.

- The project manager may not be the lead negotiator on procurements. The project manager and other members of the project management team may be present during negotiations to provide assistance, and, if needed, to add clarification of the project's technical, quality, and management requirements

Stages in contract placement

requirements analysis

evaluation plan

invitation to tender

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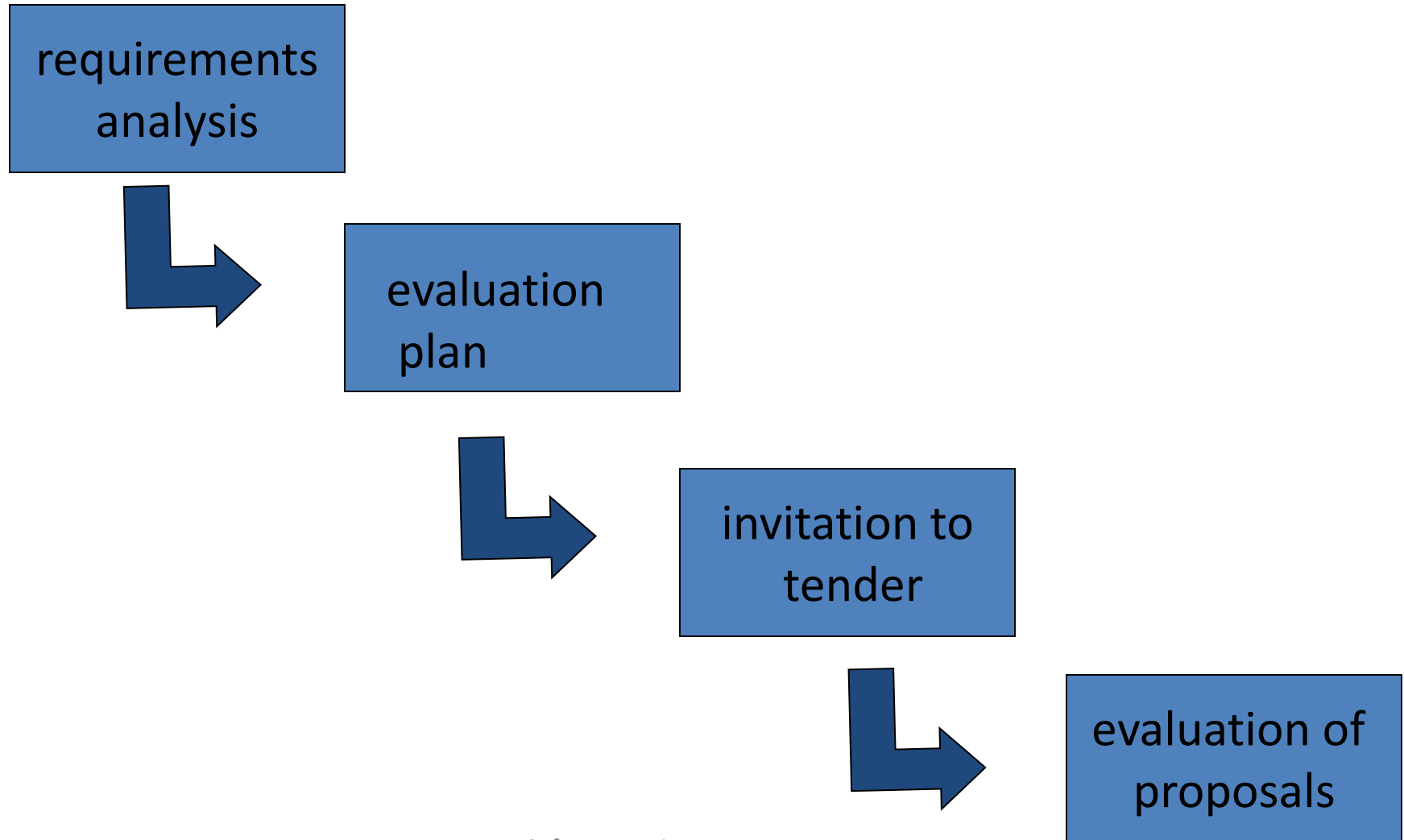
Contracts

- A contract is a mutually binding legal agreement that obligates the seller to provide the specified products, services, or results, and obligates the buyer to compensate the seller. A contract is a legal relationship subject to remedy in the courts.

- A project manager cannot be expected to be a legal expert – needs advice

- BUT must ensure contract reflect true requirements and expectations of supplier and client

Contract Elements

The major components in an agreement document will vary, but may include the following:
- Statement of work or deliverables,
- Schedule baseline,
- Performance reporting,
- Period of performance,
- Roles and responsibilities,
- Seller's place of performance,
- Pricing,
- Payment terms,
- Place of delivery,
- Inspection and acceptance criteria,
- Warranty,
- Product support,
- Limitation of liability,
- Fees and retainer (a fee paid in advance to secure services for use when required)
- Penalties,
- Incentives,
- Insurance and performance bonds,
- Subordinate subcontractor approvals,
- Change request handling, and
- Termination clause and alternative dispute resolution (ADR) mechanisms. The ADR method can be decided in advance as a part of the procurement award.

Contract checklist

- Definitions – what words mean precisely e.g. 'supplier', 'user', 'application'

- Form of agreement. For example, is this a contract for a sale or a lease, or a license to use a software application? Can the license be transferred?

- Goods and services to be supplied – this could include lengthy specifications

- Timetable of activities

- Payment arrangements – payments may be tied to completion of specific tasks

Contract checklist - continued

- Ownership of software
  - Can client sell software to others?
  - Can supplier sell software to others? Could specify that customer has 'exclusive use'
  - Does supplier retain the copyright?
  - Where supplier retains source code, may be a problem if supplier goes out of business; to circumvent a copy of code could be deposited with an **escrow** service

Contract checklist - continued

- Environment – for example, where equipment is to be installed, who is responsible for various aspects of site preparation e.g. electricity supply?

- Customer commitments – for example providing access, supplying information

- Standards to be met

Nondisclosure Agreements

- Nondisclosure agreements (aka confidentiality agreements) are used to protect information exchanged by the parties to a transaction.

- NDAs are generally used at the inception of a proposed business relationship to ensure that confidential information disclosed by the parties prior to executing a definitive agreement is protected from unauthorized disclosure.

- If the parties decide to enter into a definitive agreement (for example, a professional services or software licensing agreement) following their initial discussions, the NDA would commonly be replaced by the confidentiality provisions of the final definitive agreement.

- NDAs are helpful in protecting and maintaining the trade secret rights

Professional Services Agreements

- Professional services agreements are used for a wide range of service engagements, including software development. They may be standalone or part of larger engagement (e.g. software license agreement, hardware procurement also require professional services.)

- Professional services contract is composed of two parts:

  - the main agreement, containing the legal terms and conditions, and
  - one or more statement of work (SOW) describing the specific services to be rendered by the contactor.

Contract management

Some terms of contract will relate to management of contract, for example,

- Progress reporting

- Decision points – could be linked to release of payments to the contractor

- Variations to the contract, i.e. how are changes to requirements dealt with?

- Acceptance criteria

How to evaluate the following?

- usability of an existing package

- usability of an application yet to be built

- maintenance costs of hardware

- time taken to respond to requests for software support

- training

Contract management

- Contracts should include agreement about how customer/supplier relationship is to be managed e.g.
  - *decision points* - could be linked to payment
  - *quality reviews*
  - *changes to requirements*

Sotware Maintenance & Reengineering –

Software Evolution

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Software Evolution

Software Story

- Software is released to end-users, and
  - within days, bug reports filter back to the software engineering organization.
  - within weeks, one class of users indicates that the software must be changed so that it can accommodate the special needs of their environment.
  - within months, another corporate group who wanted nothing to do with the software when it was released, now recognizes that it may provide them with unexpected benefit. They'll need a few enhancements to make it work in their world.

- All of this work is *software maintenance*

Software change

- Software change is inevitable
  - New requirements emerge when the software is used;
  - The business environment changes;
  - Errors must be repaired;
  - New computers and equipment is added to the system;
  - The performance or reliability of the system may have to be improved.

- A key problem for all organizations is implementing and managing change to their existing software systems.

Maintainable Software

- Maintainable software exhibits effective modularity

- It makes use of design patterns that allow ease of understanding.

- It has been constructed using well-defined coding standards and conventions, leading to source code that is self-documenting and understandable.

- It has undergone a variety of quality assurance techniques that have uncovered potential maintenance problems before the software is released.

- It has been created by software engineers who recognize that they may not be around when changes must be made.
  - *Therefore, the design and implementation of the software must "assist" the person who is making the change*

Software Supportability

- According to software-supportability.org, supportability of software is

    "the capability of supporting a software system over its whole product life. This implies satisfying any necessary needs or requirements, but also the provision of equipment, support infrastructure, additional software, facilities, manpower, or any other resource required to maintain the software operational and capable of satisfying its function."

- The software should contain facilities to assist support personnel when a defect is encountered in the operational environment (and make no mistake, defects *will* be encountered).

- Support personnel should have access to a database that contains records of all defects that have already been encountered—their characteristics, cause, and cure.

Importance of evolution

- Organizations have huge investments in their software systems - they are critical ***business assets***.

- To maintain the value of these assets to the business, they must be changed and updated.

- The majority of the software budget in large companies is devoted to changing and evolving existing software rather than developing new software.

Program evolution dynamics

- *Program evolution dynamics* is the study of the processes of system change.

- After several major empirical studies, Lehman and Belady proposed that there were a number of 'laws' which applied to all systems as they evolved.

- There are sensible observations rather than laws. They are applicable to large systems developed by large organisations.
  - It is not clear if these are applicable to other types of software system.

Change is inevitable

- The system requirements are likely to change while the system is being developed because the environment is changing. Therefore a delivered system won't meet its requirements!

- Systems are tightly coupled with their environment. When a system is installed in an environment it changes that environment and therefore changes the system requirements.

- Systems MUST be changed if they are to remain useful in an environment.

Lehman's laws

Law	Description
Continuing change	A program that is used in a real-world environment must necessarily change, or else become progressively less useful in that environment.
Increasing complexity	As an evolving program changes, its structure tends to become more complex. Extra resources must be devoted to preserving and simplifying the structure.
Large program evolution	Program evolution is a self-regulating process. System attributes such as size, time between releases, and the number of reported errors is approximately invariant for each system release.
Organizational stability	Over a program's lifetime, its rate of development is approximately constant and independent of the resources devoted to system development.

Lehman's laws

Law	Description
Conservation of familiarity	Over the lifetime of a system, the incremental change in each release is approximately constant.
Continuing growth	The functionality offered by systems has to continually increase to maintain user satisfaction.
Declining quality	The quality of systems will decline unless they are modified to reflect changes in their operational environment.
Feedback system	Evolution processes incorporate multiagent, multiloop feedback systems and you have to treat them as feedback systems to achieve significant product improvement.

Applicability of Lehman's laws

- Lehman's laws seem to be generally applicable to large, tailored systems developed by large organisations.
  - Confirmed in early 2000's by work by Lehman on the FEAST project.
- It is not clear how they should be modified for
  - Shrink-wrapped software products;
  - Systems that incorporate a significant number of COTS components;
  - Small organisations;
  - Medium sized systems.

Software Evolution

- Software development and evolution can be thought of as an integrated, iterative process that can be represented using a spiral model.

- For custom systems, the costs of software maintenance usually exceed the software development costs.

- The process of software evolution is driven by requests for changes and includes change impact analysis, release planning and change implementation.

- Lehman's laws, such as the notion that change is continuous, describe a number of insights derived from long-term studies of system evolution.

Software maintenance

- Modifying a program after it has been put into use.

- The term is mostly used for changing custom software. Generic software products are said to evolve to create new versions.

- Maintenance does not normally involve major changes to the system's architecture.

- Changes are implemented by modifying existing components and adding new components to the system.

Types of maintenance

- Maintenance to repair software faults
  - Changing a system to correct deficiencies in the way meets its requirements.

- Maintenance to adapt software to a different operating environment
  - Changing a system so that it operates in a different environment (computer, OS, etc.) from its initial implementation.

- Maintenance to add to or modify the system's functionality
  - Modifying the system to satisfy new requirements.

Maintenance effort distribution
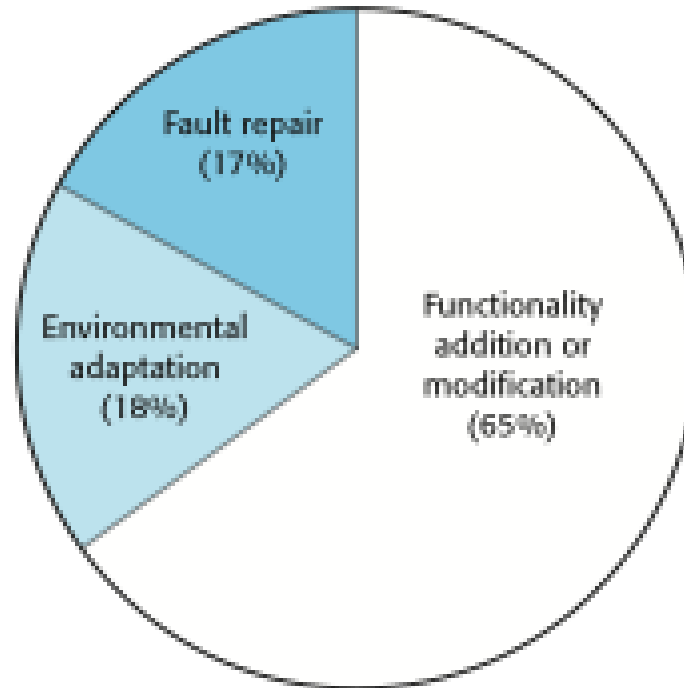
The chart is based on information from several surveys as collated by Sommerville.
Some authors categorize maintenance as corrective, adaptive, perfective forms.
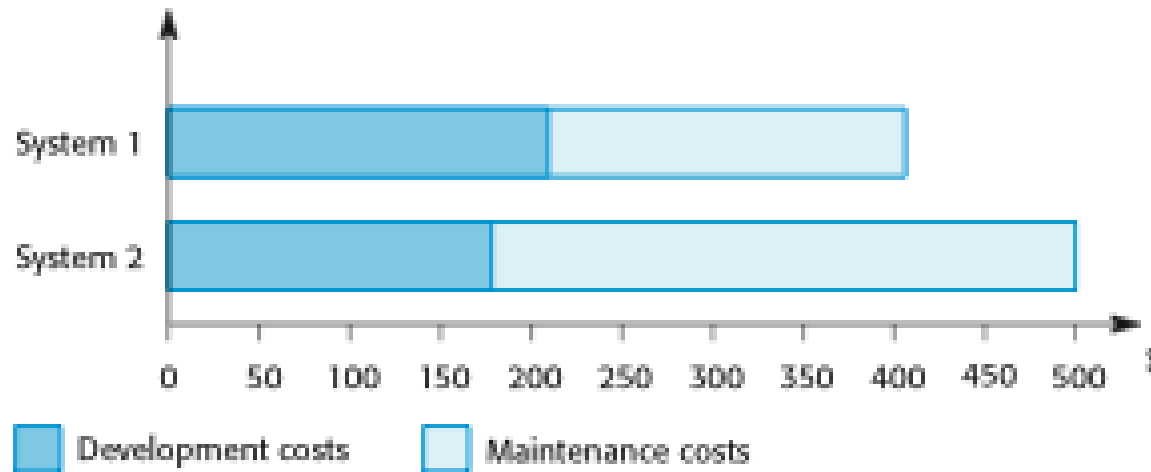
Maintenance costs

- Usually greater than development costs (2* to 100* depending on the application).

- Affected by both technical and non-technical factors.

- Increases as software is maintained. Maintenance corrupts the software structure so makes further maintenance more difficult.

- Ageing software can have high support costs (e.g. old languages, compilers etc.).

Preventative maintenance by refactoring

- Refactoring is the process of making improvements to a program to slow down degradation through change.

- You can think of refactoring as 'preventative maintenance' that reduces the problems of future change.

- Refactoring involves modifying a program to improve its structure, reduce its complexity or make it easier to understand.

- When you refactor a program, you should not add functionality but rather concentrate on program improvement.

Development and maintenance costs

Good management practices recommend considering lifetime costs rather than development costs.

Maintenance cost factors

- Team stability
  - Maintenance costs are reduced if the same staff are involved with them for some time.

- Contractual responsibility
  - The developers of a system may have no contractual responsibility for maintenance so there is no incentive to design for future change.

- Staff skills
  - Maintenance staff are often inexperienced and have limited domain knowledge.

- Program age and structure
  - As programs age, their structure is degraded and they become harder to understand and change.

Maintenance prediction

- Maintenance prediction is concerned with assessing which parts of the system may cause problems and have high maintenance costs

  - Change acceptance depends on the maintainability of the components affected by the change;

  - Implementing changes degrades the system and reduces its maintainability;

  - Maintenance costs depend on the number of changes and costs of change depend on maintainability.

Maintenance prediction
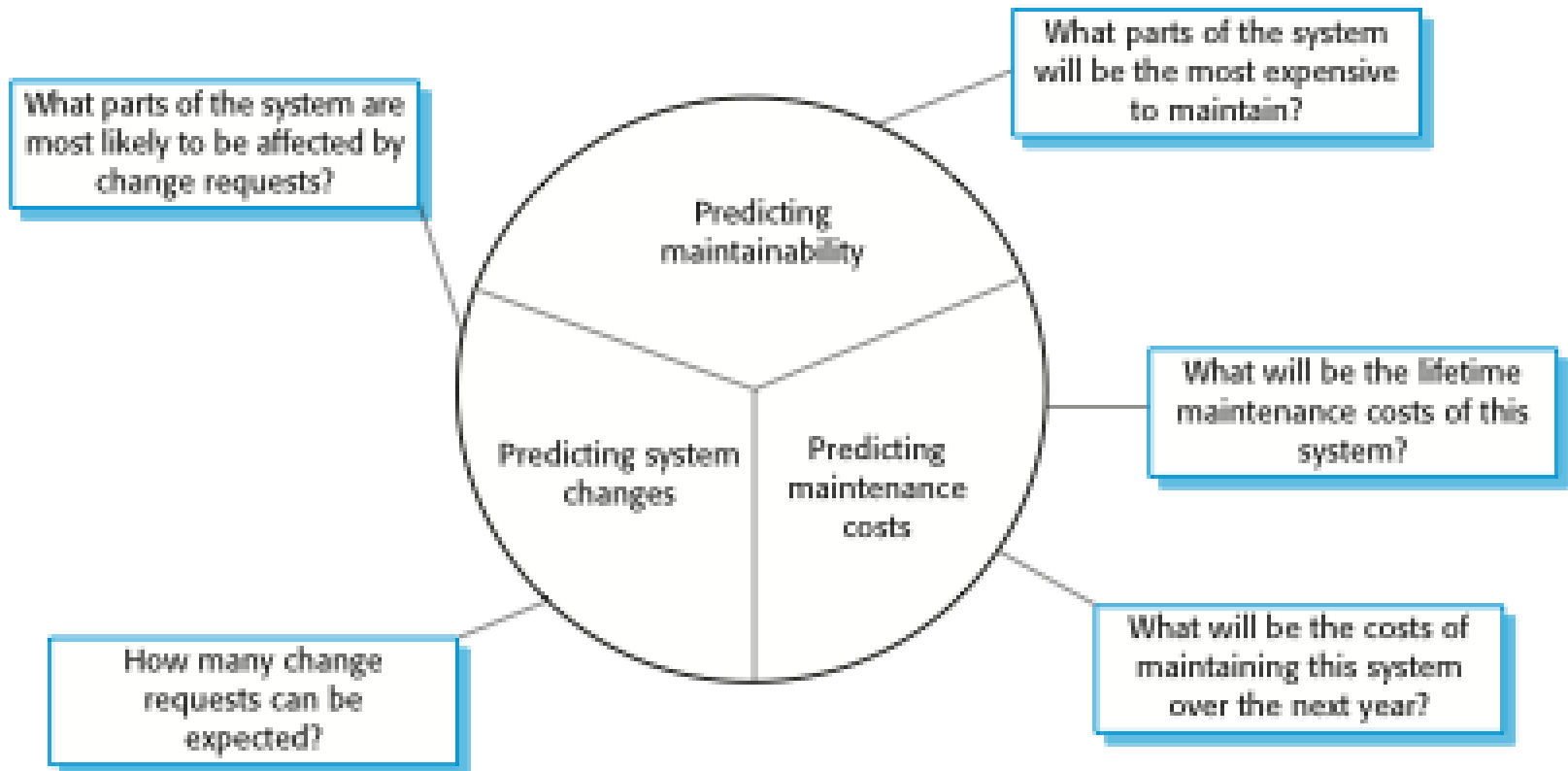
Change prediction

- Predicting the number of changes requires and understanding of the relationships between a system and its environment.

- Tightly coupled systems require changes whenever the environment is changed.

- Factors influencing this relationship are

  - Number and complexity of system interfaces;

  - Number of inherently volatile system requirements;

  - The business processes where the system is used.

Complexity metrics

- Predictions of maintainability can be made by assessing the complexity of system components.

- Studies have shown that most maintenance effort is spent on a relatively small number of system components.

- Complexity depends on

  - Complexity of control structures;

  - Complexity of data structures;

  - Object, method (procedure) and module size.

Process metrics

- Process metrics may be used to assess maintainability

  - Number of requests for corrective maintenance;

  - Average time required for impact analysis;

  - Average time taken to implement a change request;

  - Number of outstanding change requests.

- If any or all of these is increasing, this may indicate a decline in maintainability.

Thank You

Any Questions?