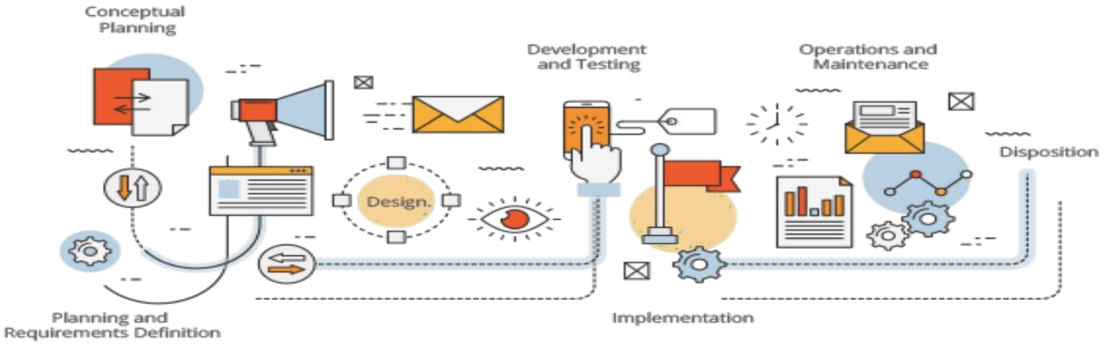
Software Engineering

Requirement Engineering



Functional requirements of Facebook

- Functional requirements are the abilities, behaviors, or traits that **a system must have** in order to perform a certain function or achieve a specific goal.
- **Facebook is a social networking site where members may communicate with one another and exchange content such as photographs, videos, and messages.**

Facebook’s functional requirements

1. Users must have the ability to search the platform for other users, groups, and pages.
2. The platform must be accessible on mobile devices via a dedicated app or mobile website.
3. Users must be able to find and connect with other platform users, either by searching for them by name or by being recommended as friends based on mutual connections.
4. Users must be able to control who can view their content and contact them through the platform.
5. Users must be notified when a new message comes or when someone interacts with their content.
6. Users must be able to create and distribute a wide range of content, such as text-based postings, photos, and videos
7. To use the site, users must first create an account.
8. Users must be able to create and manage personal profiles, which include information such as their name, profile photo, and contact information.
9. Users must be able to interact with other users’ material by posting comments or answering with emoticons.

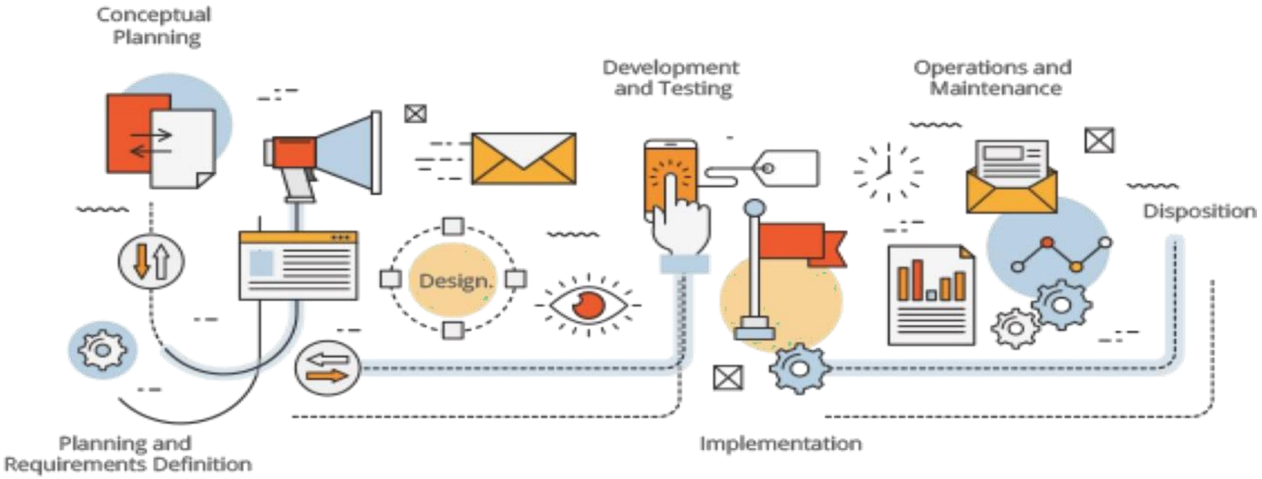
Non Functional requirements of Facebook

Non-functional requirements are system or product qualities that do not relate to a specific function or behavior, but rather to the system’s overall quality or performance.

Non-functional Requirements for Facebook

1. The system should be swift and responsive, with little delays or problems.
2. The system should be compatible with a wide range of devices and browsers.
3. The system should be able to support a wide range of languages and cultural norms.
4. The system should be straightforward to use and navigate, with a basic interface.
5. Scalability refers to the system's ability to handle a large number of users and a high volume of traffic without deteriorating performance.
6. The system should always be available and operating.
7. The system must protect user data and privacy while preventing unauthorized access or tampering.

Requirement Elicitation



Requirements Elicitation

1. Requirements elicitation is the process of gathering and defining the requirements for a software system.

2. Elicitation is the process of discovering, understanding and documenting the stakeholder needs and expectations.

3. It is a crucial step in business analysis, as it helps to define the scope, objectives and deliverables of the project.

Requirement Sources

- Stakeholders
- Document
- System in operation

Influencing factors

- **Type of requirement** (funtional vs. non-functional requirements)
- **Constraints** (cost, time)
- **Experience of requirement engineer** (ask right questions, team management etc)
- **Chances and risk of the project** (High-risk projects (e.g., complex software, regulatory compliance) require detailed and accurate requirements to mitigate failure).

Requirements engineering processes

- The processes used for RE vary widely depending on the application domain, the people involved and the organization developing the requirements.

- However, there are a number of generic activities common to all processes
  - Requirements elicitation
  - Requirements analysis
  - Requirements validation
  - Requirements management

- In practice, RE is an iterative activity in which these processes are interleaved

Requirements Elicitation

- **Definition**: The process of collecting requirements from stakeholders, users, and other sources.

- **Activities**:
    - Stakeholder interviews
    - Surveys & questionnaires
    - Workshops & brainstorming sessions
    - Document analysis
    - Prototyping & observation

Requirements Analysis

- **Definition**: Organizing, refining, and prioritizing requirements to ensure clarity, feasibility, and alignment with business objectives.

- **Activities**:
  - Categorizing requirements (Functional, Non-functional, Business, Technical).
  - Checking feasibility and technical constraints.
  - Resolving conflicts between stakeholders.
  - Prioritizing based on business needs and risks.

Requirements Validation

Definition: Verifying that requirements are accurate, complete, and meet stakeholder needs before development starts.

Activities:

- Reviewing requirements with stakeholders.
- Prototyping and simulation for feedback.
- Using formal validation techniques (walkthroughs, inspections, requirement modeling).
- Checking for consistency, completeness, and testability.

Requirements management

- **Definition**: Continuously monitoring, updating, and maintaining requirements throughout the project lifecycle.

- **Activities**:
  - Version control and requirement traceability.
  - Managing requirement changes systematically.
  - Ensuring alignment with evolving business goals.
  - Communicating updates to all stakeholders.

Problems of Requirements analysis

1. Stakeholders don’t know what they really want

2. Stakeholders express requirements in their own terms

3. Different stakeholders may have conflicting requirements

4. Organizational and political factors may influence the system requirements

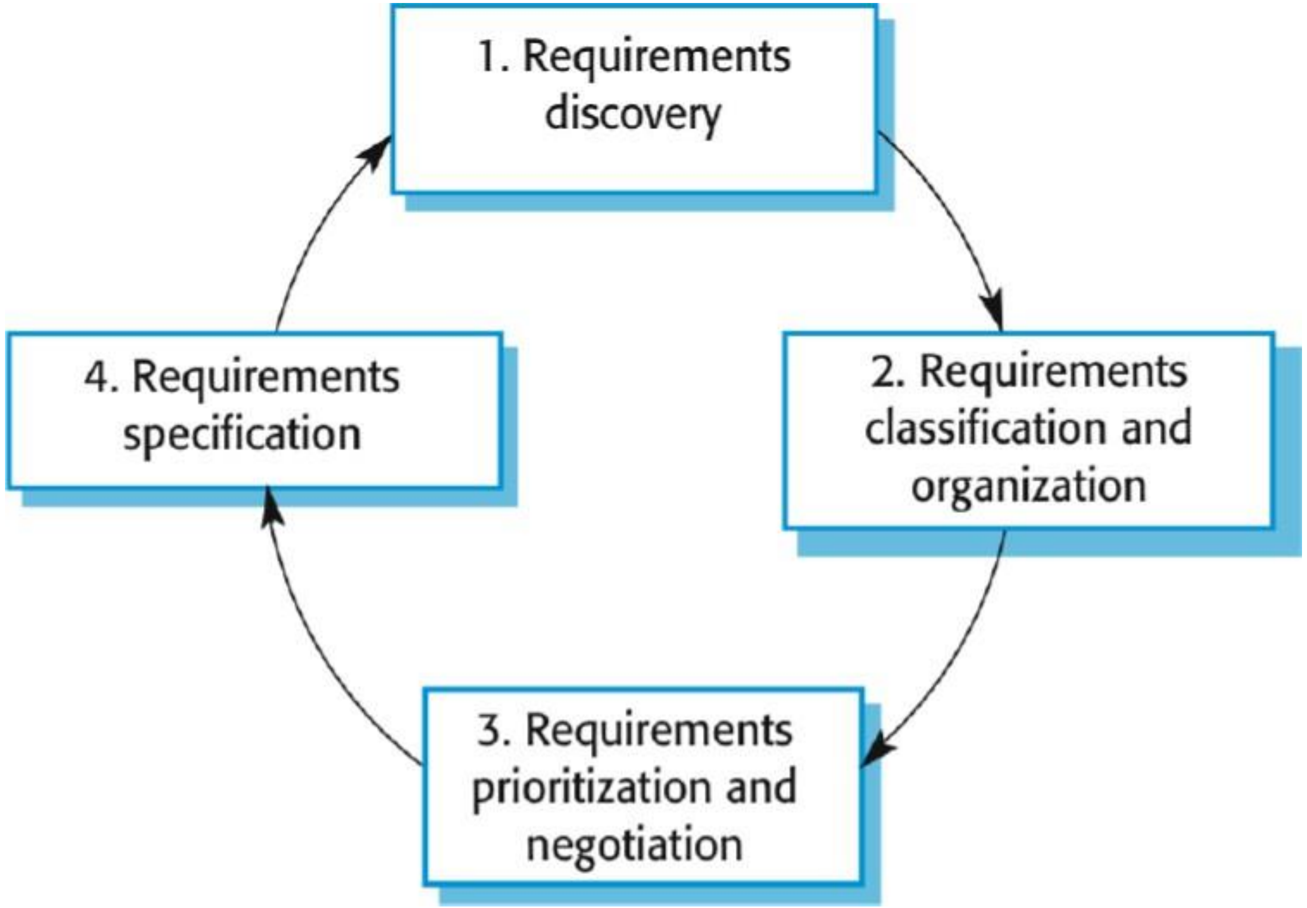
5. The requirements change during the analysis process. New stakeholders may emerge and the business environment may change

Requirements elicitation and analysis

Software engineers work with a range of system stakeholders to find out about the application domain, the services that the system should provide, the required system performance, hardware constraints, other systems, etc.

- Stages include:
  - ➢ Requirements discovery
  - ➢ Requirements classification and organization
  - ➢ Requirements prioritization and negotiation
  - ➢ Requirements specification

The requirements elicitation and analysis process



1. Requirements discovery

2. Requirements classification and organization

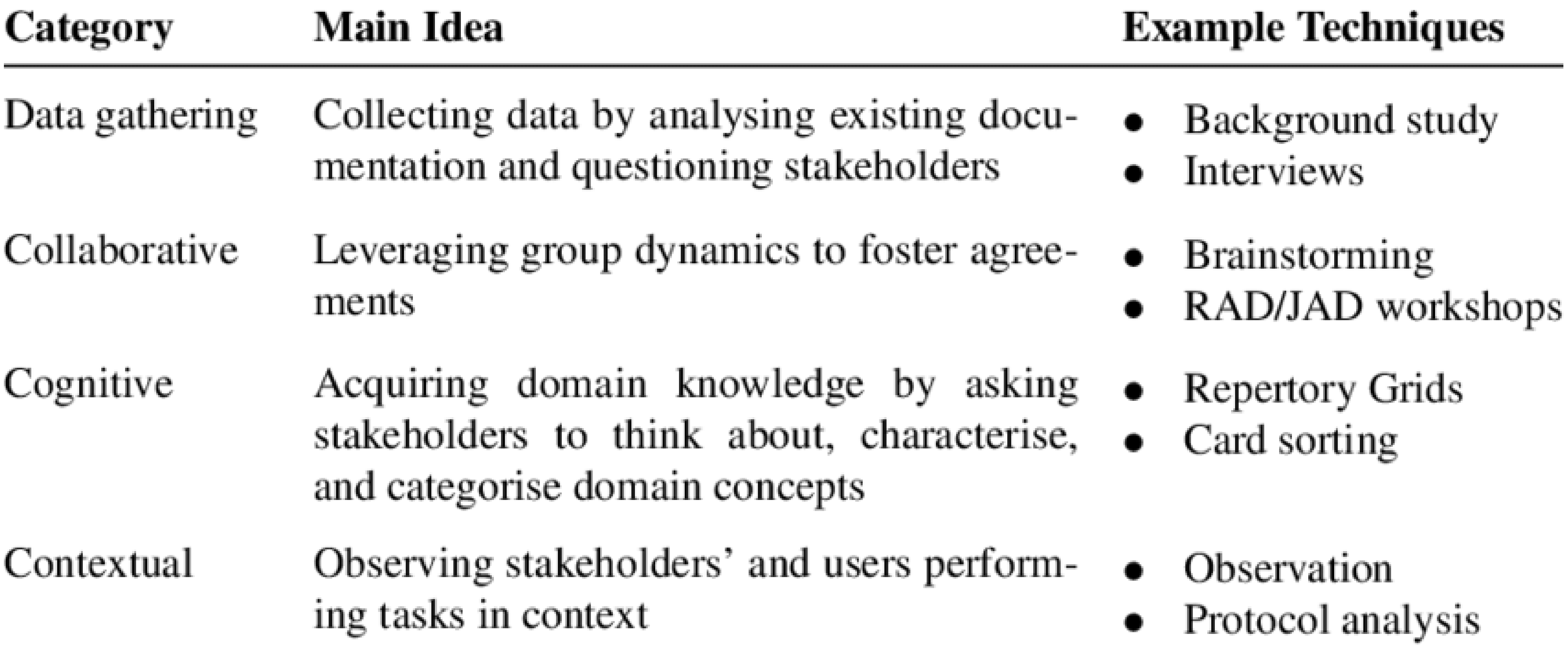
3. Requirements prioritization and negotiation

4. Requirements specification

Process activities

1. **Requirements discovery**
   - Interacting with stakeholders to discover their requirements. Domain requirements are also discovered at this stage
2. **Requirements classification and organization**
   - Groups related requirements and organizes them into coherent clusters
3. **Prioritization and negotiation**
   - Prioritizing requirements and resolving requirements conflicts
4. **Requirements specification**
   - Requirements are documented and input into the next round of the spiral

REQUIREMENTS ELICITATION



Category	Main Idea	Example Techniques
Data gathering	Collecting data by analysing existing documentation and questioning stakeholders	• Background study • Interviews
Collaborative	Leveraging group dynamics to foster agreements	• Brainstorming • RAD/JAD workshops
Cognitive	Acquiring domain knowledge by asking stakeholders to think about, characterise, and categorise domain concepts	• Repertory Grids • Card sorting
Contextual	Observing stakeholders' and users performing tasks in context	• Observation • Protocol analysis

Elicitation Techniques

→ Traditional techniques

- Introspection
- Reading existing documents
- Analyzing hard data
- Interviews
  - Open-ended
  - Structured
- Surveys / Questionnaires
- Meetings

→ Collaborative techniques

- Group techniques
  - Focus Groups
  - Brainstorming
- JAD/RAD workshops
- Prototyping
- Participatory Design

→ Cognitive techniques

- Task analysis
- Protocol analysis
- Knowledge Acquisition Techniques
  - Card Sorting
  - Laddering
  - Repertory Grids
  - Proximity Scaling Techniques

→ Contextual approaches

- Ethnographic techniques
  - Participant Observation
  - Enthnomethodology
- Discourse Analysis
  - Conversation Analysis
  - Speech Act Analysis
- Sociotechnical Methods
  - Soft Systems Analysis

2. Collaborative requirements elicitation

- Collaborative requirements elicitation refers to techniques that **bring stakeholders together to work as a group to identify, discuss, and agree on system requirements**.

Key aspects of collaborative requirements elicitation include:

1. **Group participation**: Involves multiple stakeholders working together simultaneously rather than individually
2. **Facilitated sessions**: Usually led by a facilitator who guides the process and ensures productive discussion
3. **Consensus building**: Focuses on reaching shared understanding and agreement on requirements
4. **Knowledge sharing**: Allows different perspectives and expertise to be shared across organizational boundaries
5. **Conflict resolution**: Provides a structured environment to address conflicting requirements immediately

Commonly used techniques

- **Brainstorming**: An open-ended, creative technique where participants generate as many ideas as possible without immediate criticism, followed by evaluation and refinement.

- **RAD/JAD workshops:**
  - → RAD (Rapid Application Development) workshops: Intensive sessions focused on rapid development of system prototypes
  - → JAD (Joint Application Development) workshops: Structured workshop sessions where users and developers work together to define requirements, often following a specific methodology

Requirements Elicitation techs…

Cognitive techniques *protocol analysis* (in which an expert thinks aloud while performing a task, to provide the observer with insights into the cognitive processes used to perform the task):

- ***laddering***(using probes to elicit structure and content of stakeholder knowledge),
- ***card sorting*** (sorting requirements obtained from stakeholders or users by allowing them to rank them from most important to least important. This will allow the analyst to prioritize requirements during the development process.)

Ethnography

- A social scientist spends a considerable time observing and analyzing how people actually work
- People do not have to explain or articulate their work
- Social and organizational factors of importance may be observed
- Ethnographic studies have shown that work is usually richer and more complex than suggested by simple system models

Scope of ethnography

- Requirements that are derived from the way that people actually work rather than the way I which process definitions suggest that they ought to work.

- Requirements that are derived from cooperation and awareness of other people’s activities

- Awareness of what other people are doing leads to changes in the ways in which we do things.

- Ethnography is effective for understanding existing processes but cannot identify new features that should be added to a system

Focused ethnography

- Developed in a project studying the air traffic control process

- Combines ethnography with prototyping

- Prototype development results in unanswered questions which focus the ethnographic analysis

- The problem with ethnography is that it studies existing practices which may have some historical basis which is no longer relevant

Requirements Prioritization and Triage

- Requirements prioritization is also referred to as triage
- Need to decide which requirements really matter or on those that need to be implemented in the current release
- Need for compromise, negotiation, priorities
- Prioritization is needed because there will almost always be the need for trade-offs (e.g., required functionality vs. time and resources)

- Must help:
  - Make acceptable tradeoffs among goals of value, cost, time-to-market
  - Allocate resources based on importance of requirements to the project as a whole (project planning)
  - Determine when a requirements should become part of the product
  - Offer the right product!

1st Technique – Prioritization Scales

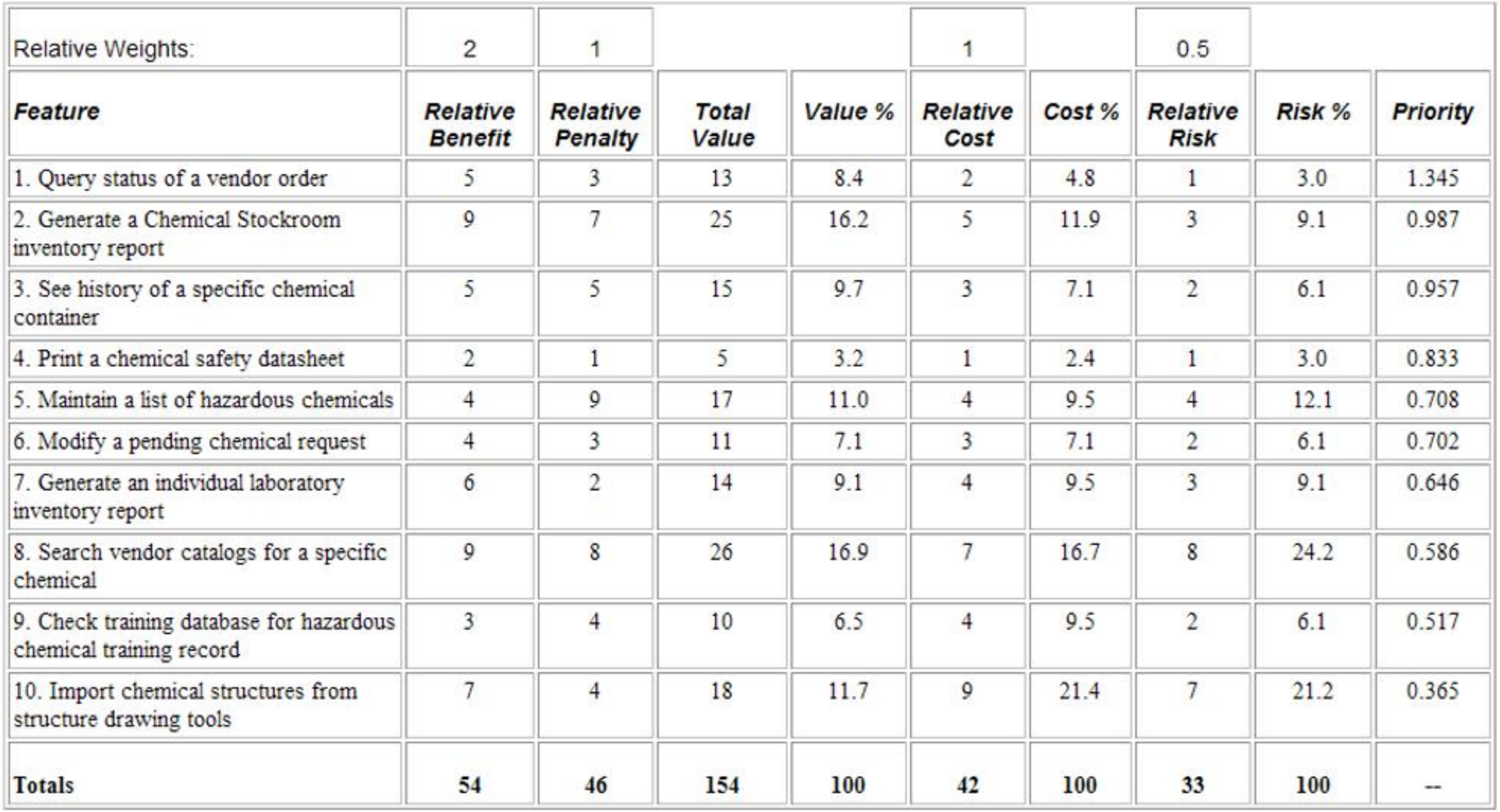
- Determine criteria, granularity, scale dimensions
- Frequently used:
  - Urgency
    - High (mission critical requirement; required for next release)
    - Medium (supports necessary system operations; required eventually but could wait until a later release if necessary)
    - Low (a functional or quality enhancement; would be nice to have someday if resources permit)
  - Importance
    - Essential (product unacceptable unless these requirements are satisfied)
    - Conditional (would enhance the product, but the product is acceptable if absent)
    - Optional (functions that may or may not be worthwhile)

2nd Technique – Wiegers' Prioritization

- Semi-quantitative analytical approach to requirements prioritization based on value, cost, and risk
- Relies on estimation of relative priorities of requirements
  - Dimensions
    - Relative benefit (for having requirement)
    - Relative penalty to stakeholder (if requirement is not included)
    - Relative cost (to implement requirement)
    - Relative risk (technical and other risks)
  - Each dimension is given a value on a given scale (e.g., 0..9)
  - Dimensions have relative weights
- Formula used to derive overall priority
  - priority = (value%) / ((cost% * cost weight) + (risk% * risk weight))
- Still limited by ability to properly estimate
  - Requires adaptation and calibration

Wiegers' Prioritization Example

- Chemical tracking system



Relative Weights:	2	1			1		0.5		
Feature	***Relative Benefit***	***Relative Penalty***	***Total Value***	***Value %***	***Relative Cost***	***Cost %***	***Relative Risk***	***Risk %***	***Priority***
1. Query status of a vendor order	5	3	13	8.4	2	4.8	1	3.0	1.345
2. Generate a Chemical Stockroom inventory report	9	7	25	16.2	5	11.9	3	9.1	0.987
3. See history of a specific chemical container	5	5	15	9.7	3	7.1	2	6.1	0.957
4. Print a chemical safety datasheet	2	1	5	3.2	1	2.4	1	3.0	0.833
5. Maintain a list of hazardous chemicals	4	9	17	11.0	4	9.5	4	12.1	0.708
6. Modify a pending chemical request	4	3	11	7.1	3	7.1	2	6.1	0.702
7. Generate an individual laboratory inventory report	6	2	14	9.1	4	9.5	3	9.1	0.646
8. Search vendor catalogs for a specific chemical	9	8	26	16.9	7	16.7	8	24.2	0.586
9. Check training database for hazardous chemical training record	3	4	10	6.5	4	9.5	2	6.1	0.517
10. Import chemical structures from structure drawing tools	7	4	18	11.7	9	21.4	7	21.2	0.365
Totals	**54**	**46**	**154**	**100**	**42**	**100**	**33**	**100**	**--**

Requirements Prioritization using Weigers Prioritization technique

- Allows you to prioritize requirements based on benefits, detriment (penalty) and risk involved
- Helps in resolving conflicts and prioritize requirements

Relative Weight	2	0.5			1		1			
Requirements	**Relative Benefit**	**Relative Detriment**	**Value Total**	**Value%**	**Relative Cost**	**Cost%**	**Relative Risk**	**Risk%**	**Priority**	**Rank**
R1	6	3			2		1			
R2	9	7			4		2			
R3	4	7			4		2			
R4	2	1			1		1			
R5	4	9			4		4			
R6	4	8			3		3			
Total	29	35			15		11			

Weigers Prioritization technique Steps

Step 1: Find Value total

Value Total = Relative Benefit x Weight + Relative Determent x Weight

Step 2: Sum Value Total

Step 3: Find Value%

$$\text{Value \%} = \frac{Value\ total\ (Requirement)}{Sum\ value\ total} \text{ x } 100$$

Step 4: Find Cost%

$$\text{Cost \%} = \frac{Cost\ of\ Requirement}{Total\ Cost} \text{ x } 100$$

Step 5: Find Risk%

$$\text{Risk \%} = \frac{Relative\ Risk\ of\ Requirement}{Total\ Relative\ Risk} \text{ x } 100$$

Relative Weight	2	0.5			1		1			
Requirements	**Relative Benefit**	**Relative Detriment**	**Value Total**	**Value%**	**Relative Cost**	**Cost%**	**Relative Risk**	**Risk%**	**Priority**	**Rank**
R1	6	3	13.5	17.88079	2	11.11111	1	7.692308		
R2	9	7	21.5	28.47682	4	22.22222	2	15.38462		
R3	4	7	11.5	15.23179	4	22.22222	2	15.38462		
R4	2	1	4.5	5.960265	1	5.555556	1	7.692308		
R5	4	9	12.5	16.55629	4	22.22222	4	30.76923		
R6	4	8	12	15.89404	3	16.66667	3	23.07692		
Total	**29**	**35**	**75.5**		**18**		**13**			

Weigers Prioritization technique Steps

Step 6: Find Priority

$$\text{Priority} = \frac{(\text{Value\%})}{\text{Cost\%} * \text{Relative Cost Weight} + \text{Risk\%} * \text{Reltive Risk Weight}}$$

Step 7: Rank

Based on the priority, rank the requirements where 1 demotes the highest priority

Weigers Prioritization technique Solution

Relative Weight	2	0.5			1		1			
R1	6	3	13.5	17.88079	2	11.11111	1	7.692308	0.950933	1
R2	9	7	21.5	28.47682	4	22.22222	2	15.38462	0.757225	2
R3	4	7	11.5	15.23179	4	22.22222	2	15.38462	0.405027	4
R4	2	1	4.5	5.960265	1	5.555556	1	7.692308	0.449904	3
R5	4	9	12.5	16.55629	4	22.22222	4	30.76923	0.312433	6
R6	4	8	12	15.89404	3	16.66667	3	23.07692	0.399915	5
Total	**29**	**35**	**75.5**		**18**		**13**			

Step-4 Requirements management

- *Requirements management* is the process of managing changing requirements during the requirements engineering process and system development

- New requirements emerge as a system is being developed and after it has gone into use

- You need to keep track of individual requirements and maintain links between dependent requirements so that you can assess the impact of requirements changes. You need to establish a formal process for making change proposals and linking these to system requirements.

Changing requirements

✧**The business and technical environment of the system always changes after installation**

- New hardware may be introduced, it may be necessary to interface the system with other systems, business priorities may change (with consequent changes in the system support required), and new legislation and regulations may be introduced that the system must necessarily abide by

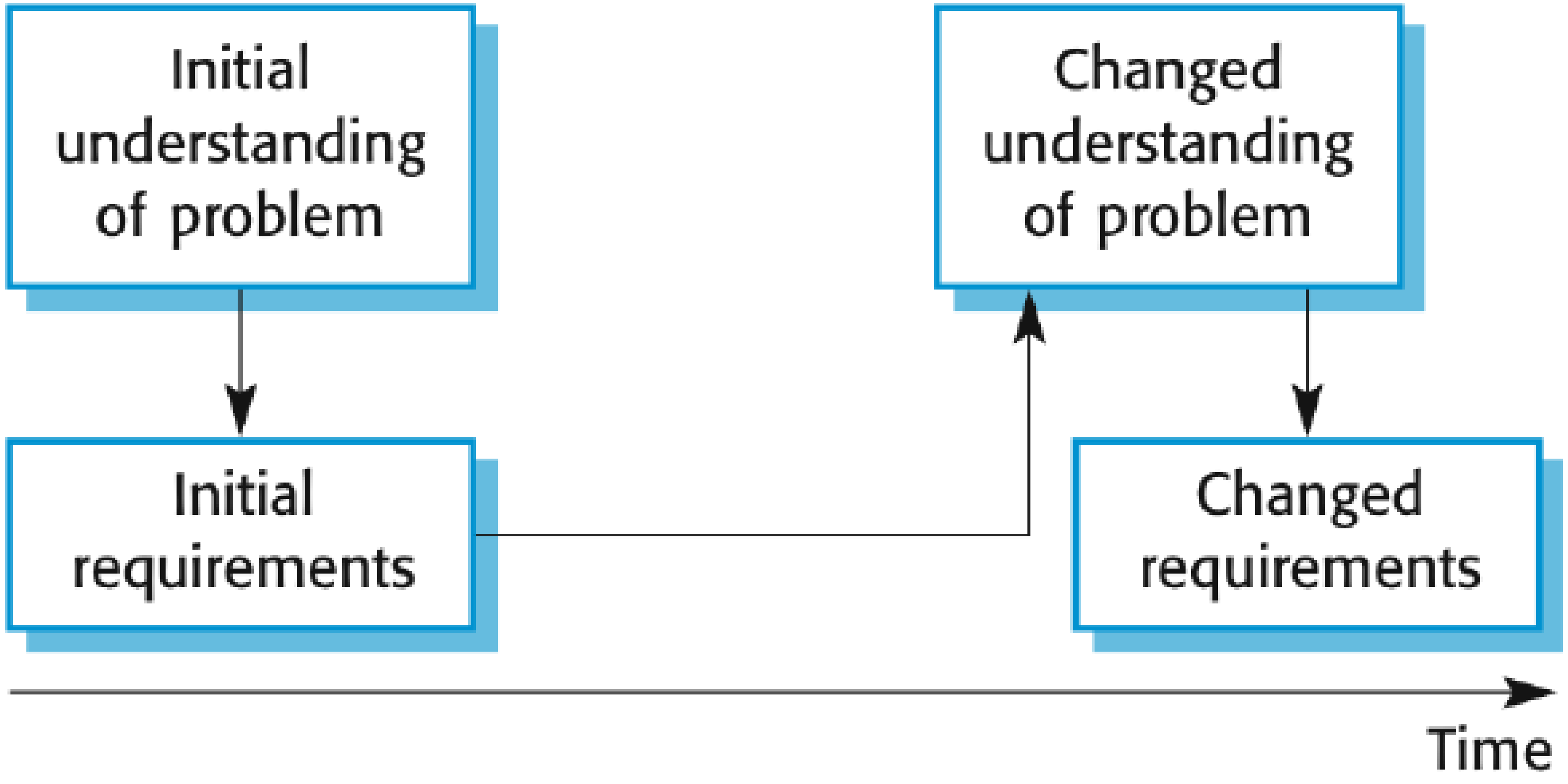
✧**The people who pay for a system and the users of that system are rarely the same people**

- System customers impose requirements because of organizational and budgetary constraints. These may conflict with end-user requirements and, after delivery, new features may have to be added for user support if the system is to meet its goals

Changing requirements

✧Large systems usually have a diverse user community, with many users having different requirements and priorities that may be conflicting or contradictory

- ➢ The final system requirements are inevitably a compromise between them and, with experience, it is often discovered that the balance of support given to different users has to be changed


Initial understanding of problem
Changed understanding of problem
Initial requirements
Changed requirements
Time

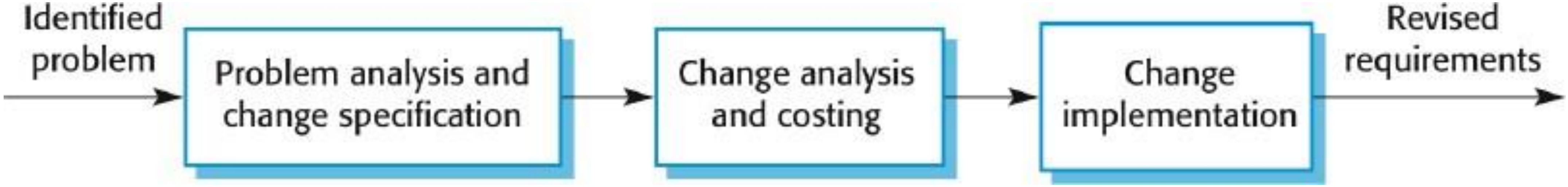
Requirements management planning

✧Establishes the level of requirements management detail that is required.

✧Requirements management decisions:

- **Requirements identification** Each requirement must be uniquely identified so that it can be cross-referenced with other requirements
- **A change management process** This is the set of activities that assess the impact and cost of changes.
- **Traceability policies** These policies define the relationships between each requirement and between the requirements and the system design that should be recorded.
- **Tool support** Tools that may be used range from specialist requirements management systems to spreadsheets and simple database systems

Requirements change management


Identified problem
Problem analysis and change specification
Change analysis and costing
Change implementation
Revised requirements

Key points

- Requirements for a software system set out what the system should do and define constraints on its operation and implementation.
- Functional requirements are statements of the services that the system must provide or are descriptions of how some computations must be carried out.
- Non-functional requirements often constrain the system being developed and the development process being used.
- They often relate to the emergent properties of the system and therefore apply to the system as a whole

Key points

- The software requirements document is an agreed statement of the system requirements. It should be organized so that both system customers and software developers can use it.

- The requirements engineering process is an iterative process including requirements elicitation, specification and validation.

- Requirements elicitation and analysis is an iterative process that can be represented as a spiral of activities –requirements discovery, requirements classification and organization, requirements negotiation and requirements documentation

Key points

- You can use a range of techniques for requirements elicitation including interviews, use-cases and ethnography.

- Requirements validation is the process of checking the requirements for validity, consistency, completeness, realism and verifiability.

- Business, organizational and technical changes inevitably lead to changes to the requirements for a software system. Requirements management is the process of managing and controlling these changes.