Lecture 20:
Requirements Prioritization

→ Why Prioritization is needed
  % Basic Trade-offs
→ Cost-Value Approach
  % Sorting Requirements by cost/value
  % Estimating Relative Costs/Values using AHP
→ What if stakeholders disagree?
  % Visualizing differences in priority
  % Resolving Disagreements

Basics of Prioritization

→ Need to select what to implement
  % Customers (usually) ask for way too much
  % Balance time-to-market with amount of functionality
  % Decide which features go into the next release
→ For each requirement/feature, ask:
  % How important is this to the customer?
  % How much will it cost to implement?
  % How risky will it be to attempt to build it?
→ Perform Triage:
  % Some requirements "must" be included
  % Some requirements should definitely be excluded
  % That leaves a pool of "nice-to-haves", which we must select from.

A Cost-Value Approach

→ Calculate return on investment
  % Assess each requirement’s importance to the project as a whole
  % Assess the relative cost of each requirement
  % Compute the cost-value trade-off:

Estimating Cost & Value

→ Two approaches:
  % Absolute scale (e.g. dollar values)
  % Requires much domain experience
  % Relative values (e.g. less/more; a little, somewhat, very)
  % Much easier to elicit
  % Prioritization becomes a sorting problem
→ Comparison Process - options
  % Basic sorting - for every pair of requirements (i,j), ask if i>j?
    % E.g. bubblesort - start in random order, and swap each pair if out of order
    % requires n*(n-1)/2 comparisons
  % Construct a Binary Sort Tree
    % Requires O(n log n) comparisons
  % Construct a Minimal Spanning Tree
    % for each pair (Ri, Ri+1) get the distance between them
    % Requires n-1 comparisons
Some complications

- Hard to quantify differences
  - % easier to say “x is more important than y”...
  - % than to estimate by how much.

- Not all requirements comparable
  - % E.g. different level of abstraction
  - % E.g. core functionality vs. customer enhancements

- Requirements may not be independent
  - % No point selecting between X and Y if they are mutually dependent

- Stakeholders may not be consistent
  - % E.g. If X > Y, and Y > Z, then presumably X > Z?

- Stakeholders might not agree
  - % Different cost/value assessments for different types of stakeholder

Hierarchical Prioritization

- Group Requirements into a hierarchy
  - % E.g. A goal tree
  - % E.g. A NFR tree

- Only make comparisons between branches of a single node:
  - Better train system

Analytic Hierarchy Process (AHP)

- Create n x n matrix (for n requirements)
  - % For element (x,y) in the matrix enter:
    - 1 - if x and y are of equal value
    - 3 - if x is slightly more preferred than y
    - 5 - if x is strongly more preferred than y
    - 7 - if x is very strongly more preferred than y
    - 9 - if x is extremely more preferred than y
  - % (use the intermediate values, 2,4,6,8 if compromise needed
  - % and for (y,x) enter the reciprocal.

- Estimate the eigenvalues:
  - % E.g. “averaging over normalized columns”
    - Calculate the sum of each column
    - Divide each element in the matrix by the sum of it’s column
    - Calculate the sum of each row
    - Divide each row sum by the number of rows

- This gives a value for each reqt:
  - % giving the estimated percentage of total value of the project

AHP example - estimating costs

<table>
<thead>
<tr>
<th>Req1</th>
<th>Req2</th>
<th>Req3</th>
<th>Req4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req1</td>
<td>1</td>
<td>1/3</td>
<td>2</td>
</tr>
<tr>
<td>Req2</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Req3</td>
<td>1/2</td>
<td>1/5</td>
<td>1</td>
</tr>
<tr>
<td>Req4</td>
<td>1/4</td>
<td>1/3</td>
<td>3</td>
</tr>
</tbody>
</table>

Normalized columns

Result

<table>
<thead>
<tr>
<th>Req1</th>
<th>Req2</th>
<th>Req3</th>
<th>Req4</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.18</td>
<td>0.18</td>
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<tr>
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<td>0.54</td>
<td>0.45</td>
</tr>
<tr>
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<td>0.11</td>
<td>0.11</td>
<td>0.09</td>
</tr>
<tr>
<td>Req4</td>
<td>0.05</td>
<td>0.18</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Sum

<table>
<thead>
<tr>
<th></th>
<th>sum</th>
<th>sum/ 4</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req1</td>
<td>1.05</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>Req2</td>
<td>1.98</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Req3</td>
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</tr>
<tr>
<td>Req4</td>
<td>0.62</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>
Plot ROI graph

→ Repeat AHP process twice:
  % Once to estimate relative value
  % Once to estimate relative cost
→ Use results to calculate ROI ratio:

Other selection criteria

→ ROI ratio is not the only way to group requirements

Visualizing “Value by stakeholder”

Visualizing stakeholder satisfaction

→ Graph showing correlation between stakeholder’s priorities and the group’s priorities
  % Can also be thought of as “influence of each stakeholder on the group”

Other selection criteria

→ ROI ratio is not the only way to group requirements
Can also weight each stakeholder

- Weight each stakeholder
  - E.g. to reflect credibility?
  - E.g. to reflect size of constituency represented?

Example:

Result: (The priorities have changed)

P Z M C H B K E J A D L O I N G Q F

Resolving Stakeholder Conflict

→ Causes of Conflict

- Deutsch (1973):
  - control over resources
  - preferences and nuisances (tastes or activities of one party impinge upon another)
  - values (e.g. claim that a value or set of values should dominate)
  - beliefs (dispute over facts, information, reality, etc.)
  - the nature of the relationship between the parties.
- Robbins (1989):
  - communicational (insufficient exchange of information, noise, selective perception)
  - structural (goal compatibility, jurisdictional clarity, leadership style)
  - personal factors, (individual value systems, personality characteristics).

→ Interesting Results

- Deviant behaviour & conflict are normal in small group decision making
- More aggression and less co-operation when communication is restricted
- A decrease in communication tends to intensify a conflict (the contact hypothesis)
- Heterogeneous teams experience more conflict;
- Homogeneous groups are more likely to make high risk decisions (groupthink)
- Effect of personality is overshadowed by situational and perceptual factors

Conflicts Resolution - Basics

→ Defining Conflict

- In Social psychology, focus is on interdependence and perception:
  - "the interaction of interdependent people who perceive the goals, aims, and values, and who see the other party as potentially interfering with the realization of these goals" (Putnam & Poole, 1987)
- In RE, focus typically is on logical inconsistency:
  - E.g. conflict is a divergence between goals - there is a feasible boundary condition that makes the goals inconsistent (von Lonsweerde et al. 1998)
- Note: Conflict may occur between individuals, groups, organizations, or different roles played by one person

→ Resolution Method:

- The approach used to settle a conflict
  - Methods include negotiation, competition, arbitration, coercion, and education
  - Not all conflicts need a resolution method: not all conflicts need to be resolved.
- Three broad types of resolution method can be distinguished:
  - Co-operative (or collaborative) methods, which include negotiation and education;
  - Competitive methods, which include combat, coercion and competition;
  - Third Party methods, which include arbitration and appeals to authority.

Basic approaches to conflict resolution

→ Negotiation

- A collaborative exploration:
  - Participants attempt to find a settlement that satisfies all parties as much as possible.
- Also known as:
  - Integrative behaviour
  - Constructive negotiation
- Distinct from:
  - Distributive/competitive negotiation

→ Competition

- Is maximizing your own gain:
  - No regard for the degree of satisfaction of other parties;
  - But not necessarily hostile.
- Extreme form:
  - When all gains by one party are at the expense of others.
  - I.e. a zero-sum game.

→ Third Party Resolution

- Participants appeal to outside source
  - The rule-book, a figure of authority,
  - Or the toss of a coin.
- Can occur with the breakdown of either negotiation or competition as resolution methods.
- Types of third party resolution
  - Judicial: cases presented by each participant are taken into account
  - Extrajudicial: a decision is determined by factors other than the cases presented (e.g. relative status of participants);
  - Arbitrary: e.g. toss of a coin.