Requirements Prioritisation
Basics of Prioritisation

- **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:

![Diagram illustrating cost-value trade-off with three priority levels: Low, Medium, High. The graph shows a linear relationship between cost (percent) and value (percent) for each priority level.](image-url)
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:

<table>
<thead>
<tr>
<th>Cost (percent)</th>
<th>Value (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low priority</td>
<td>5</td>
</tr>
<tr>
<td>Medium priority</td>
<td>10</td>
</tr>
<tr>
<td>High priority</td>
<td>15</td>
</tr>
</tbody>
</table>

- **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
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 Prioritisation

- Group Requirements into a hierarchy
  - e.g. A goal tree
- Only make comparisons between branches of a single node:
Analytic Hierarchy Process (AHP)

Source: Adapted from Karlsson & Ryan 1997

- **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 its column
    - Calculate the sum of each row
    - Divide each row sum by the number of rows

- **This gives a value for each requirement:**
  - ...giving the estimated percentage of total value of the project
### AHP example - estimating costs

#### Normalise columns

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

#### Sum the rows

<table>
<thead>
<tr>
<th></th>
<th>sum</th>
<th>sum/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req1</td>
<td>1.05</td>
<td>0.26</td>
</tr>
<tr>
<td>Req2</td>
<td>1.98</td>
<td>0.50</td>
</tr>
<tr>
<td>Req3</td>
<td>0.34</td>
<td>0.09</td>
</tr>
<tr>
<td>Req4</td>
<td>0.62</td>
<td>0.16</td>
</tr>
</tbody>
</table>

#### Result

- Req1 - 26% of the cost
- Req2 - 50% of the cost
- Req3 - 9% of the cost
- Req4 - 16% of the cost
Plot ROI graph

- Repeat AHP process twice:
  - Once to estimate relative value
  - Once to estimate relative cost
Other selection criteria

![Graph showing selection criteria based on cost and value.](image)

- Above average value
- Below average cost
- Above average cost
- Below average value
- Above average in both cost and value
Security Risk Management in Airline Turnaround Sector

- **Check-in passenger information**
  - **Risk1**: Blacklisted passenger presents fake document, gets checked-in because personnel could be bribed
  - **Risk2**: Attacker uses phishing email to extract passenger booking number and uses it to check-in to the flight

- **Luggage information**
  - **Risk3**: The personnel records values lower than actual weight of luggage and ground operations uses the information in the loading of the aircraft
  - **Risk4**: The personnel accepts luggage and adds contraband items to a passenger’s luggage

- **Fuel slip**
  - **Risk5**: A malicious insider with access to the computer that stores the fuel slip performs changes to the data contained in the fuel slip
  - **Risk6**: The attacker intercepts the fuel slip, changes the data contained and sends it to the supplier

- **Cargo assignment**
  - **Risk7**: A malicious insider with access rights performs changes to the cargo assignment document before it is sent to a service provider
  - **Risk8**: An attacker hacks the airline mailing list, receives the cargo assignment, changes the data contained and sends the cargo assignment to a service provider

[Matulevičius et al., 2016]
FDSE 2016
Security Risk Management in Airline Turnaround Sector

- Check-in passenger information
  - Risk1: Blacklisted passenger presents fake document, gets checked-in because personnel could be bribed
  - Risk2: Attacker uses phishing email to extract passenger booking number and uses it to check-in to the flight

- Luggage information
  - Risk3: The personnel records values lower than actual weight of luggage and ground operations uses the information in the loading of the aircraft
  - Risk4: The personnel accepts luggage and adds contraband items to a passenger’s luggage

- Fuel slip
  - Risk5: A malicious insider with access to the computer that stores the fuel slip performs changes to the data contained
  - Risk6: The attacker intercepts the fuel slip, changes the data contained and sends it to the supplier

- Cargo assignment
  - Risk7: A malicious insider with access rights performs changes to the cargo assignment document before it is sent to a service provider
  - Risk8: An attacker hacks the airline mailing list, receives the cargo assignment, changes the data contained and sends the cargo assignment to a service provider

[Matulevičius et al., 2016]
FDSE 2016
Security Risk Management in Airline Turnaround Sector

- Check-in passenger information
  - Risk1: Blacklisted passenger presents fake document, gets checked-in because personnel could be bribed
  - Risk2: Attacker uses phishing email to extract passenger booking number and uses it to check-in to the flight
- Luggage information
  - Risk3: Personnel records values lower than actual weight of luggage and ground operations uses the information in the loading of the aircraft
  - Risk4: Personnel accepts luggage and adds contraband items to a passenger’s luggage
- Fuel slip
  - Risk5: A malicious insider with access to the computer that stores the fuel slip performs changes to the data contained in the fuel slip
  - Risk6: The attacker intercepts the fuel slip, changes the data contained and sends it to the supplier

<table>
<thead>
<tr>
<th>Risk</th>
<th>Value-RRL</th>
<th>RRL-cost</th>
<th>value-cost</th>
<th>Graph 1</th>
<th>Graph 2</th>
<th>Graph 3</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk6</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk7</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk8</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Take Home

- Why Prioritization is needed
  - Basic Trade-offs

- Cost-Value Approach
  - Sorting Requirements by cost/value
  - Estimating Relative Costs/Values using AHP