SEG3101 (Fall 2010)

Requirements Triage and Negotiation

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Based on Powerpoint slides by Gunter Mussbacher
with material from:
K.E. Wiegers, D. Leffingwell & D. Widrig, M. Jackson, I.K. Bray, B. Selic,
Volere, Telelogic, D. Damian, S. Somé 2008, and D. Amyot 2008-2009

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Requirements Negotiation (1)

- Possible conflicts to be resolved among stakeholders
  - Between supplier and customers about costs, benefits, risks
  - Power struggle within customer organization
  - Conflicts with other projects about resources
  - Conflicting goals, features, requirements
  - ...

- Conflict resolution involves negotiation
  - Negotiating a coherent set of requirements is not easy
  - But it is one task of the requirements analyst
  - Difficult to satisfy everyone, to achieve all goals, make good decisions!
  - Involves a lot of (group) discussions

Requirements Negotiation (2)

- First, detect when requirements are inconsistent
- Then, convince all stakeholders to understand the essential point of view of each other
  - Have each party explain what they believe the other party wants and why
- Finally, reach an agreement on a coherent set of requirements that meets the needs of as many stakeholders as possible
  - Analyze each party's goals, find solutions that do not conflict but ideally support everybody's goals

Let Schedule Drive Requirements (Not the Reverse)

"It Will Take Us 9 Months"

"Okay, Here Are Our Requirements By When Can You Build Them?"

"Sorry, They Must Be Completed in 6 Months"

Typical Scenario

NOW WHAT?

Source: Davis, A.: "Just Enough Requirements Management", Dorset House, 2005; "The art of requirements triage", IEEE Computer, 03/2003

Let Schedule Drive Requirements (Better Scenario)

"Okay, we're going to build in a series of 3 month increments. Here are all the requirements."

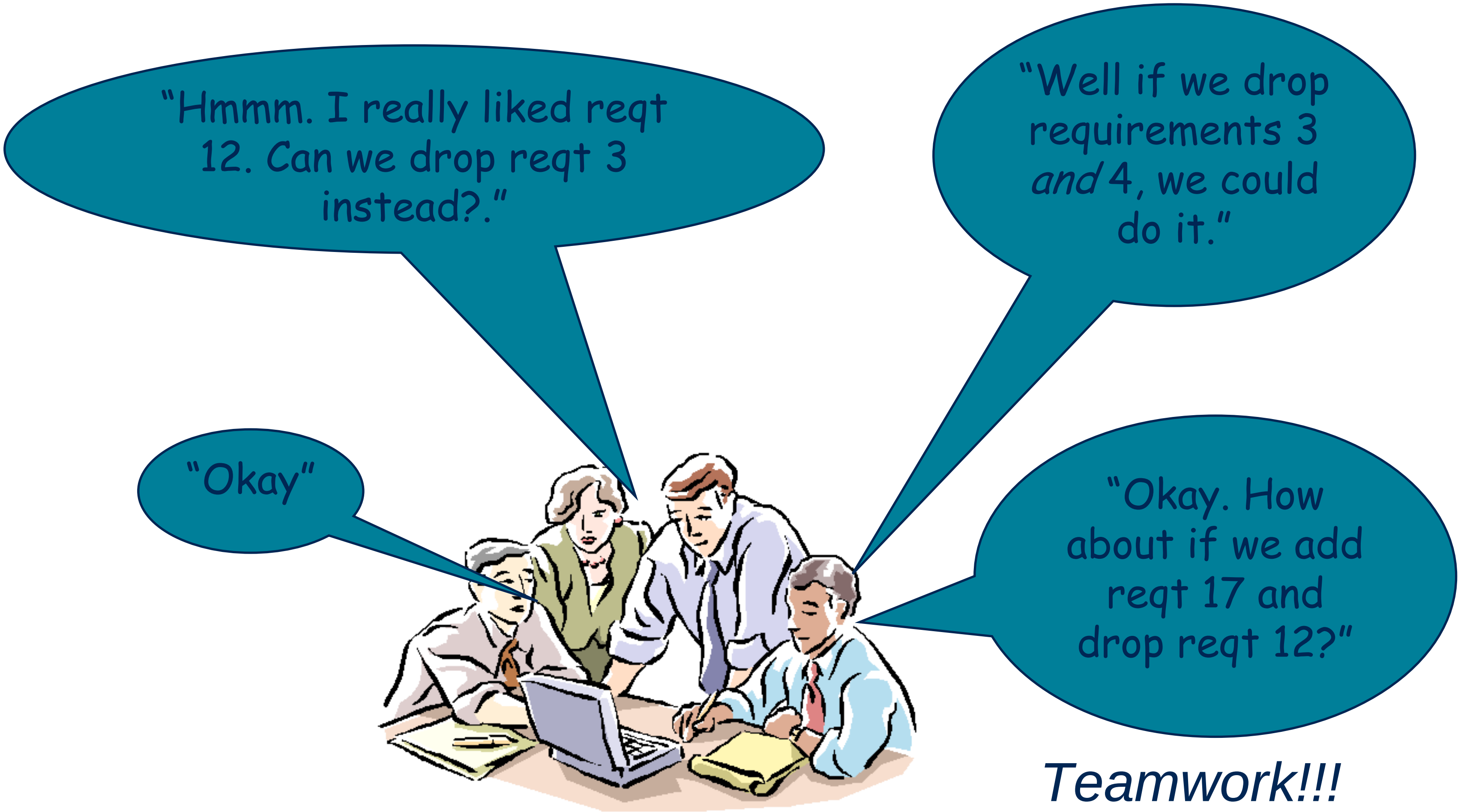
"Let's see. If we build reqts 1 through 9 and 12, we'll be able to do them in 3 months"

"But we really need reqt 17 in that first release."

"Okay. How about if we add reqt 17 and drop reqt 12?"

Source: Davis, A.: "Just Enough Requirements Management", Dorset House, 2005; "The art of requirements triage", IEEE Computer, 03/2003

Let Schedule Drive Requirements (Better Scenario)


"Hmmm. I really liked reqt 12. Can we drop reqt 3 instead?."
"Well if we drop requirements 3 *and* 4, we could do it."
"Okay"
"Okay. How about if we add reqt 17 and drop reqt 12?"

Teamwork!!!

Source: Davis, A.: "Just Enough Requirements Management", Dorset House, 2005; "The art of requirements triage", IEEE Computer, 03/2003

Requirements Negotiation – Key Aspects (1)

(by analogy with land negotiations)

- Territory: desired requirements
  - The real requirements are those in the head of each stakeholder
- Map: requirements document
  - An abstract model of intentions/requirements, imperfect and incomplete
- Interpretation of the map: included requirements
  - May vary from one session to the next → need to be clear, precise, and unambiguous
- Looking at the map through the magnifying glass: importance
  - Each stakeholder has such a view about its requirements in the project
  - For each stakeholder, see if a documented requirement is important, conflicting, or optional

Requirements Negotiation – Key Aspects (2)

- Negotiating boundaries: counterproposals of stakeholders
  - Reaction of a stakeholder (open, opposed, cooperative...) to a documented requirement may indicate how far it is open for compromise
  - Helps optimize the requirements of all stakeholders

- Can we be consistent? See techniques later on!

Difficulties (1)

- There are too many requirements!
- From many different sources
- Resources are limited (budget, time…)
- Establishing priorities is important, but
  - Which requirements are important, and to whom?
  - How to prioritize them? On what basis? What to minimize/maximize?
  - In which iteration should the requirement be considered?
- Developers may not know the business value of some requirements, and clients may not know the implementation complexity of some requirements

Difficulties (2)

- Different stakeholders have different goals and different priorities
- Some stakeholders’ decisions carry more weight than others
- Companies often lack systematic data, metrics, and technologies to support the prioritization process
  - Often done manually, informally, on an ad-hoc basis
  - Difficult to establish and communicate
- Attitude!
  - "No need for priorities, we can do everything in the specification!“
    - Yes, but when and at what cost?
  - Suddenly, when the deadline is fast approaching, some requirements are put aside in order to deliver something on time...

Requirements Prioritization and Triage

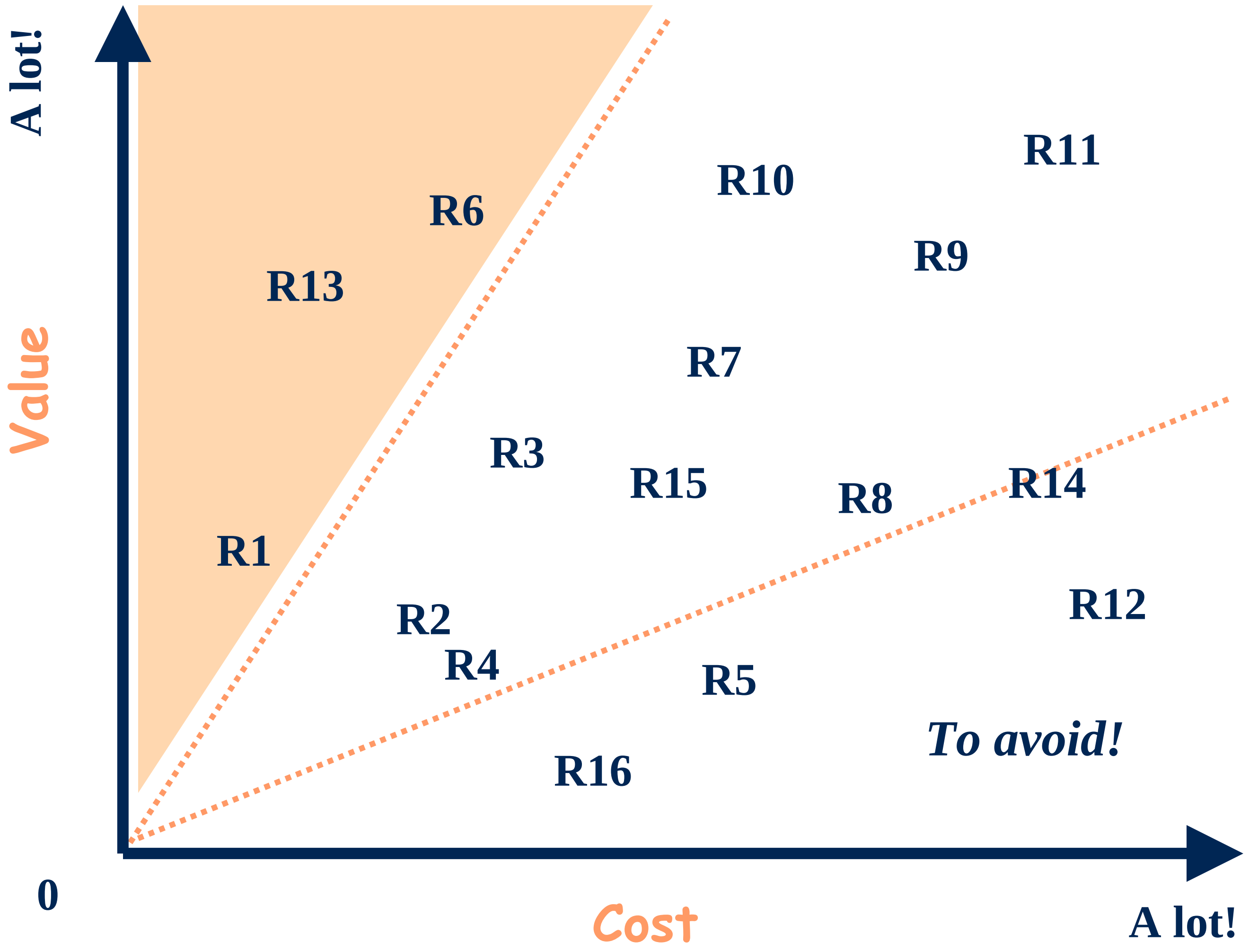
- Requirements prioritization is also referred to as triage
- Need to decide which requirements really matter or on those that need to be implemented in the current release
- Need for compromise, negotiation, priorities
- Prioritization is needed because there will almost always be the need for trade-offs (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!

80-20 Rule

- 20% of functionalities provide 80% of revenues
  - Think of MS Word…
- The remaining 80% of functionalities offer a lower return on investment while adding delays, development costs, maintenance costs...
- How to find the most useful and beneficial 20% of functionalities?

Which Sector Should We Focus On?

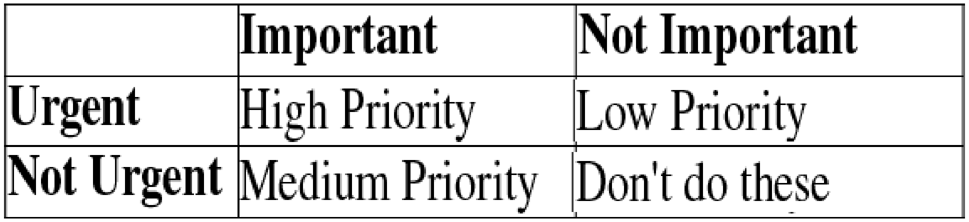


Requirements Triage Process

- Must be simple and fast, for industry adoption
- Must yield accurate and trustworthy results
- Must consider issues such as
  - The value of requirements to stakeholder (maximize)
    The cost of implementation (minimize)
    Time to market (to minimize)
- Important to agree on requirements granularity
  - E.g., use cases, features, detailed functional requirements

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)



	Important	**Not Important**
Urgent	High Priority	Low Priority
Not Urgent	Medium Priority	Don't do these

Prioritization Based on Cost and Value

- Calculate return on investment by
  - Assessing the value of each requirement
  - Assessing the cost of each requirement
  - Calculating the cost-value trade-offs

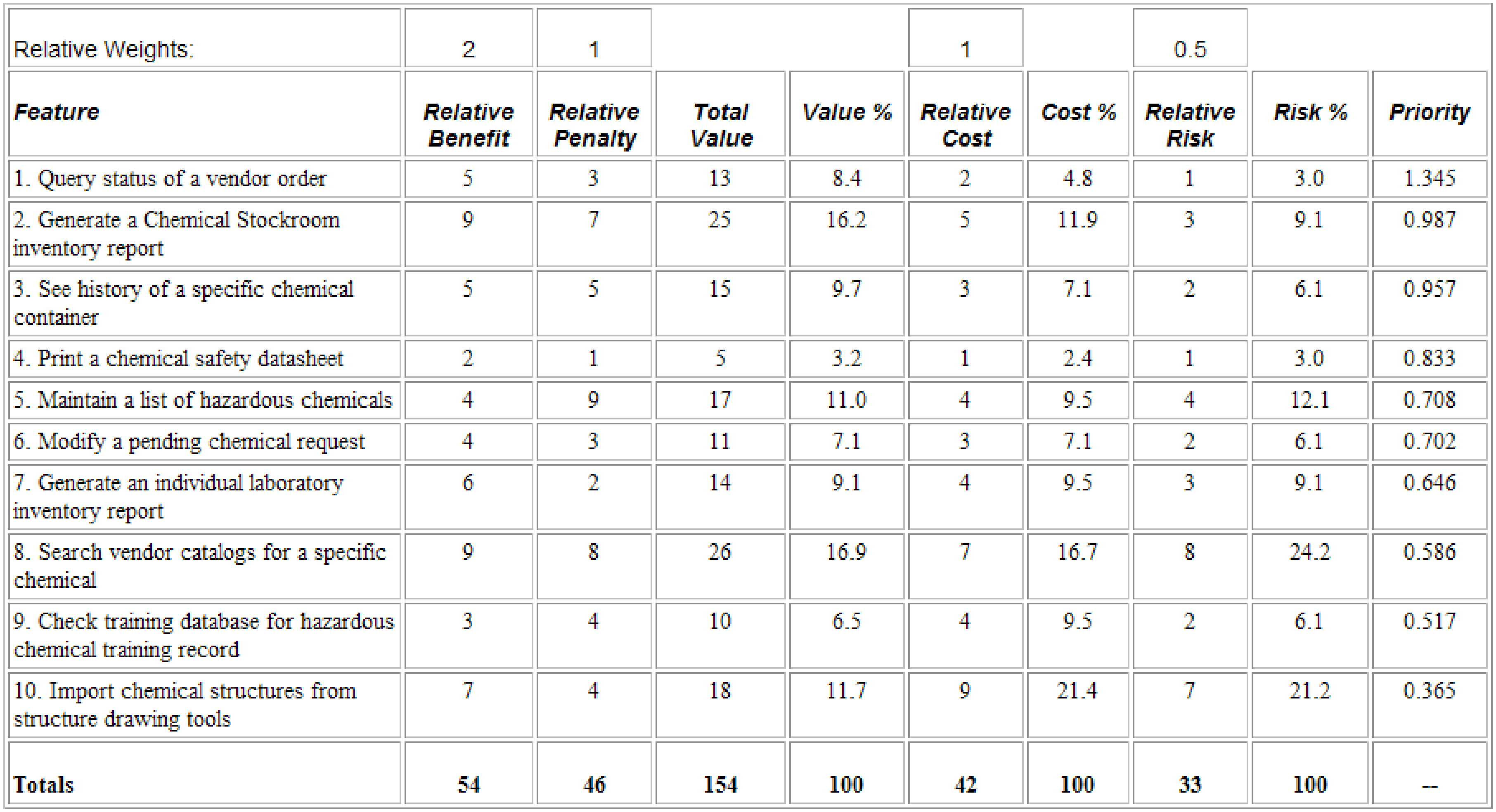
- Difficulties:
  - Hard to calculate absolute value/cost
  - Relative value/cost figures are easier to obtain
  - Interdependent requirements difficult to treat individually
  - Inconsistencies or conflicts in priorities assigned by individual stakeholders

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



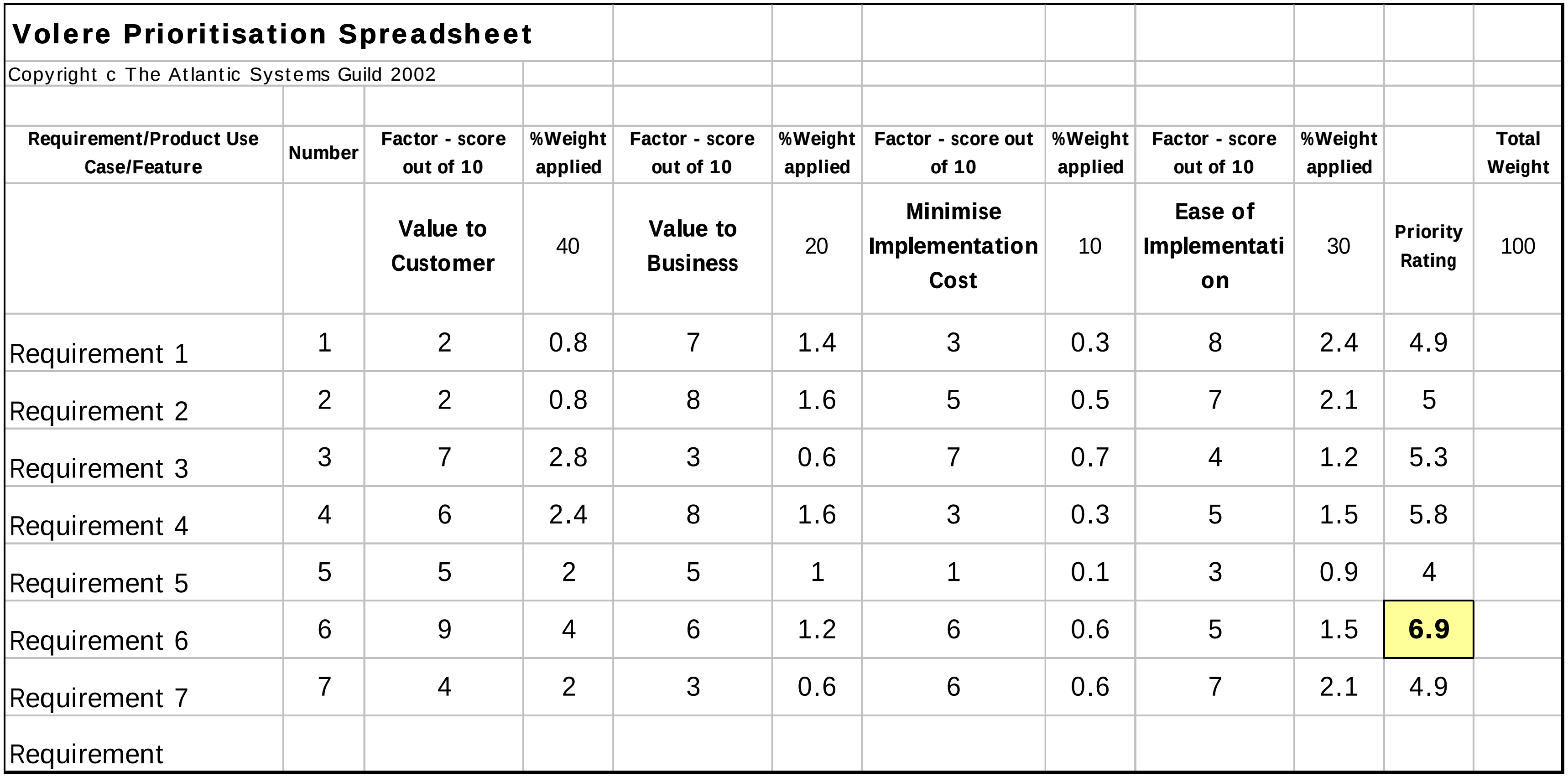
Relative Weights:	2	1			1		0.5		
Feature	***Relative Benefit***	***Relative Penalty***	***Total Value***	***Value %***	***Relative Cost***	***Cost %***	***Relative Risk***	***Risk %***	***Priority***
1. Query status of a vendor order	5	3	13	8.4	2	4.8	1	3.0	1.345
2. Generate a Chemical Stockroom inventory 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**	**--**

Source: Wiegers, Karl E., First Things First: Prioritizing Requirements, http://www.processimpact.com/articles/prioritizing.html

Other Criteria to Consider

- Costs/benefits approach is good but sometimes insufficient
- The following criteria are not all applicable to all projects, but they are there to be considered:
  - Cost of implementation (how much does it cost to develop?)
  - Value to customer (how much does the customer want it?)
  - Time to implement (how much time does it take to deliver?)
  - Ease of implementation at technical level
  - Ease of implementation at the organizational level (business process)
  - Value to company (how much will the business benefit?)
  - Obligation to some external authority (laws, standards, patents…)

3rd Technique – Volere Prioritisation



Volere Prioritisation Spreadsheet

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Requirement/Product Use Case/Feature	Number	Factor - score out of 10	%Weight applied	Factor - score out of 10	%Weight applied	Factor - score out of 10	%Weight applied	Factor - score out of 10	%Weight applied		Total Weight
		Value to Customer	40	Value to Business	20	Minimise Implementation Cost	10	Ease of Implementation	30	Priority Rating	100
Requirement 1	1	2	0.8	7	1.4	3	0.3	8	2.4	4.9	
Requirement 2	2	2	0.8	8	1.6	5	0.5	7	2.1	5	
Requirement 3	3	7	2.8	3	0.6	7	0.7	4	1.2	5.3	
Requirement 4	4	6	2.4	8	1.6	3	0.3	5	1.5	5.8	
Requirement 5	5	5	2	5	1	1	0.1	3	0.9	4	
Requirement 6	6	9	4	6	1.2	6	0.6	5	1.5	**6.9**	
Requirement 7	7	4	2	3	0.6	6	0.6	7	2.1	4.9	
Requirement											

- *Editable Excel document*

Source: Volere Prioritisation Analysis, http://www.volere.co.uk/prioritisationdownload.htm

Pairwise Comparisons (1)

- Finding scores and weights is difficult and subjective
- Potential solution: pairwise comparison
  - Which requirements (A or B) is more important:
    A << < = > >> B
- Benefits
  - Indicates what is important to the client
  - Identifies requirements of high value and low cost (priority!)
  - Identifies requirements of low value and high cost (likely to be removed)
  - Has already been used to assist numerous corporate and government decision makers
    - Choosing a telecommunication system, formulating a drug policy, choosing a product marketing strategy

Pairwise Comparisons (2)

- New problems
  - Large number of pairs – pairwise comparison can be tedious
    - Solved using transitivity and other tricks!
    - Mathematical optimization of the number of pairs to be considered (no need to cover all)
  - Many dependencies between requirements
    - Can actually be used to further reduce the # of pairs
    - E.g., group many requirements as features, use cases, services…
- Example approach
  - Analytic Hierarchy Process[1]

[1] Karlsson, J. and Ryan, K. A cost-value approach for prioritizing requirements, IEEE Software, Sept/Oct 1997

4th Technique – Analytic Hierarchy Process (AHP)

- Developed by Karlsson and Ryan (1997) based on work by Saaty (early 1970)
  - see also http://en.wikipedia.org/wiki/Analytic_Hierarchy_Process
- Use cost-value diagrams to analyze and discuss candidate requirements
- Useful for requirements triage and release planning (but also applicable in many other situations where complex decisions are to be made)
- Basic procedure for rating a set of criteria
  - Develop pairwise comparison matrix of each criterion
  - Normalize the matrix
  - Average the value of each row to get corresponding rating
- Criterion ratings are then used to evaluate different potential decisions

Basic Rating Procedure (1)

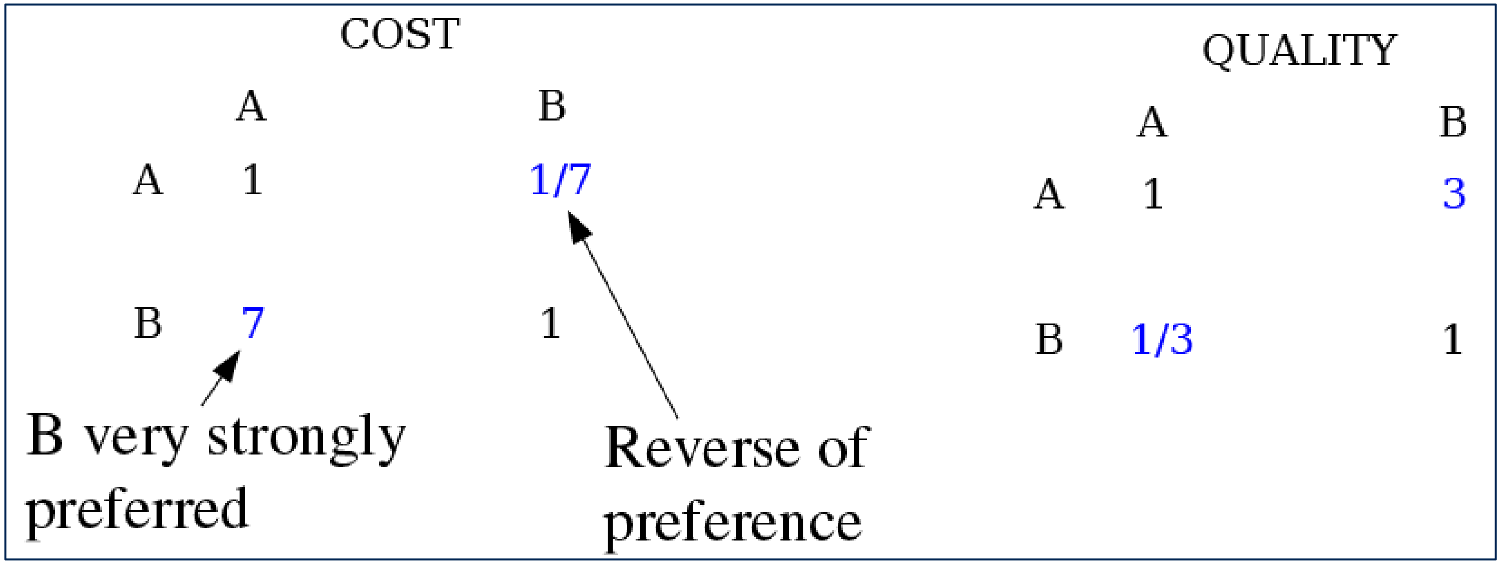
- Pairwise comparison rating scale

RATING	DESCRIPTION
1	Equally preferred
3	Moderately preferred
5	Strongly preferred
7	Very strongly preferred
9	Extremely strongly preferred

- Values 2, 4, 6, or 8 represent preferences halfway between the integers on either side

Basic Rating Procedure (2)

- Suppose two criteria, cost and quality, for product A & B
  - The cost for A is $60 and the quality is above average.
  - The cost for B is $15 and the quality is right at average.
- Which product do you choose?



COST

$$\begin{array}{ccc} & A & B \\ A & 1 & 1/7 \\ B & 7 & 1 \end{array}$$

QUALITY

$$\begin{array}{ccc} & A & B \\ A & 1 & 3 \\ B & 1/3 & 1 \end{array}$$

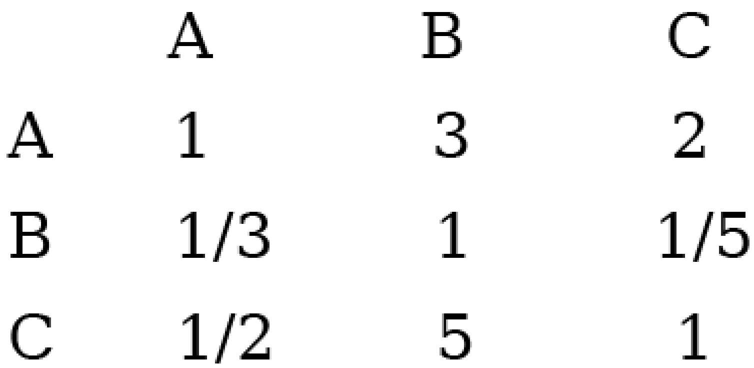
B very strongly preferred

Reverse of preference

- The matrix describes that the price of B is very strongly preferred over A and A is only moderately preferred over B

Basic Rating Procedure (3)

- Suppose three products with the following pairwise comparison (for one given criteria)



	A	B	C
A	1	3	2
B	1/3	1	1/5
C	1/2	5	1

Basic Rating Procedure (4)

- Normalize the matrix
  - First add up all the values in each column

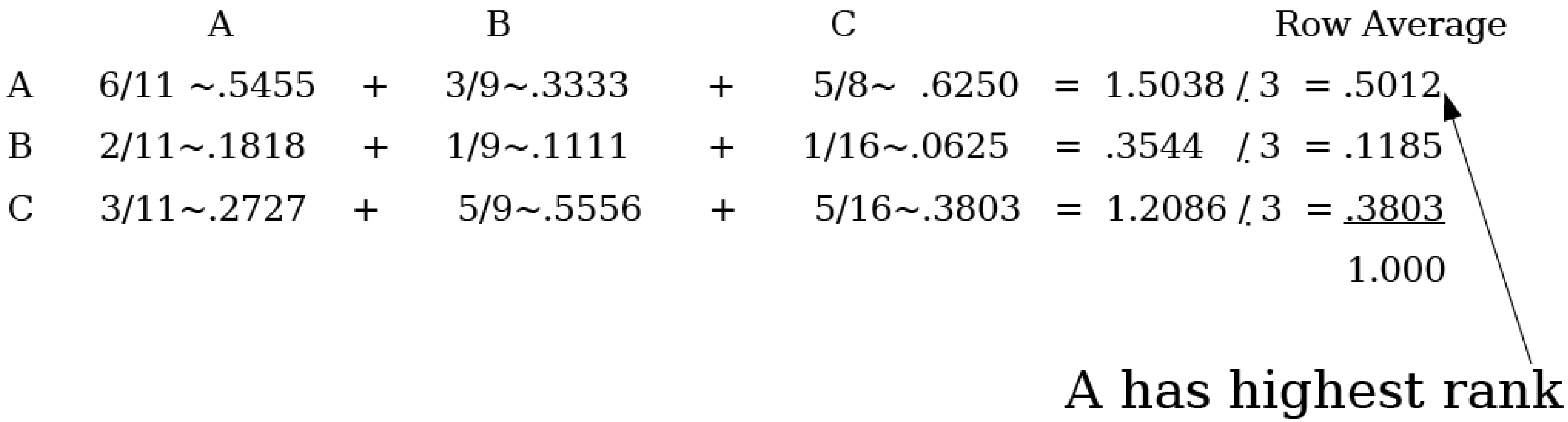
$$\begin{array}{cccc} & A & B & C \\ A & 1 & 3 & 2 \\ & + & + & + \\ B & 1/3 & 1 & 1/5 \\ & + & + & + \\ C & \underline{1/2} & \underline{5} & \underline{1} \\ = & 11/6 & 9 & 16/5 \end{array}$$

  - Next the values in each column are divided by the corresponding column sums
  - Note: the values in each column add up to 1

$$\begin{array}{cccc} & A & B & C \\ A & 1/(11/6) = 6/11 & 3/9 = 3/9 & 2/(16/5) = 5/8 \\ & + & + & + \\ B & (1/3)/(11/6) = 2/11 & 1/9 = 1/9 & (1/5)/(16/5) = 1/16 \\ & + & + & + \\ C & (1/2)/(11/6) = \underline{3/11} & 5/9 = \underline{5/9} & (11/6)/5 = \underline{5/16} \\ & = 1 & 1 & 1 \end{array}$$

Basic Rating Procedure (5)

- Average the value of each row to get corresponding rating



	A		B		C	Row Average
A	6/11 ~.5455	+	3/9~.3333	+	5/8~ .6250	= 1.5038 / 3 = .5012
B	2/11~.1818	+	1/9~.1111	+	1/16~.0625	= .3544 / 3 = .1185
C	3/11~.2727	+	5/9~.5556	+	5/16~.3803	= 1.2086 / 3 = .3803
						1.000

A has highest rank

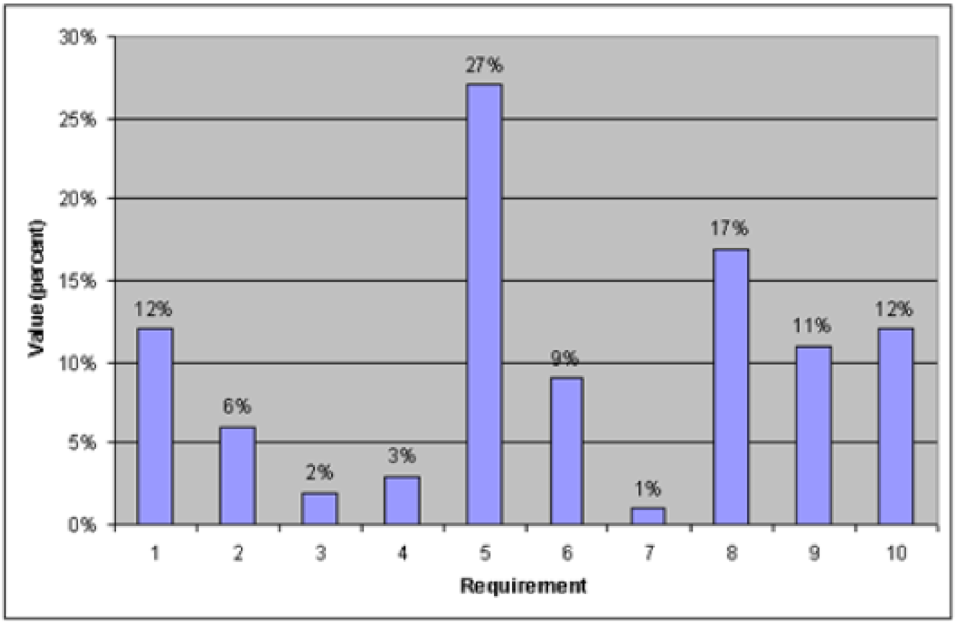
Analytic Hierarchy Process – Steps

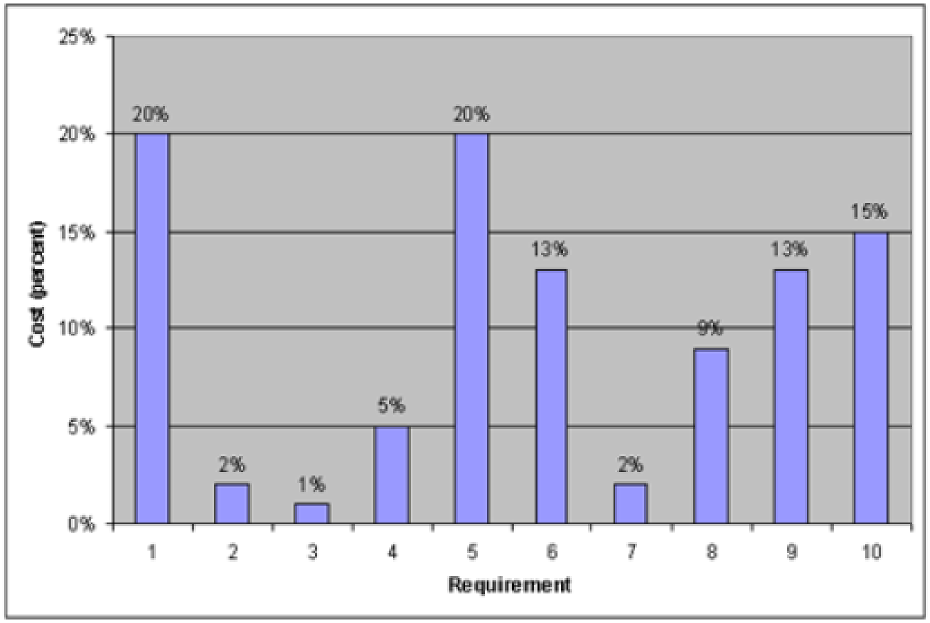
- Requirements engineers check individual requirements for ambiguities, completeness…
- Apply AHP's pairwise comparison to estimate the relative value of candidate requirements
- Experienced software engineers use AHP's pairwise comparison to estimate the cost of candidate requirements
- Plot these values on a cost-value diagram
- Stakeholders use this diagram for analysis and to make trade-offs

Analytic Hierarchy Process – Example (1)

Value/Cost obtained by AHP

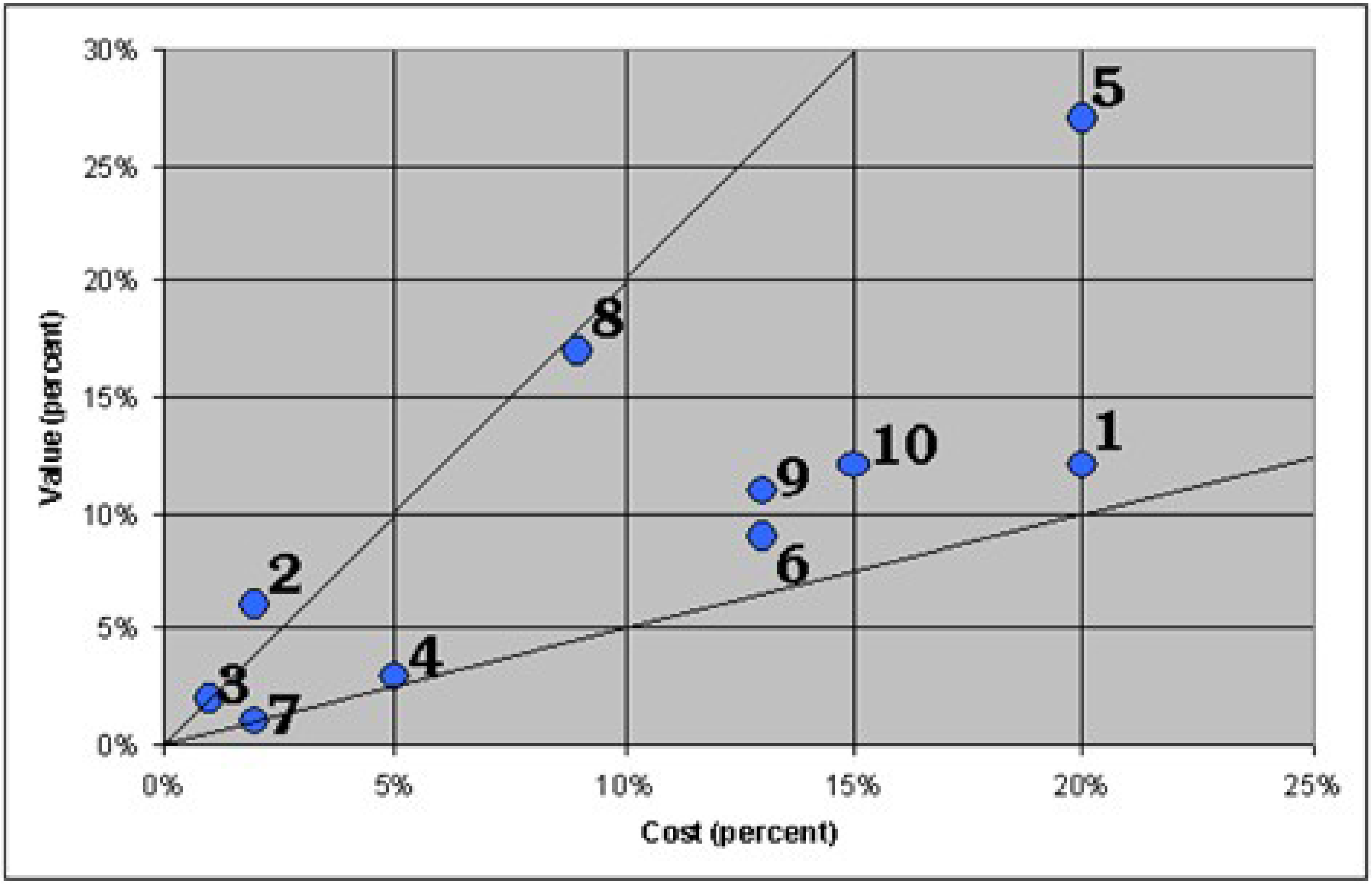
Req	1	2	3	4	5	6	7	8	9	10
Value	12%	6%	2%	3%	27%	9%	1%	17%	11%	12%
Cost	20%	2%	1%	5%	20%	13%	2%	9%	13%	15%





Analytic Hierarchy Process – Example (2)

- Cost-value diagram

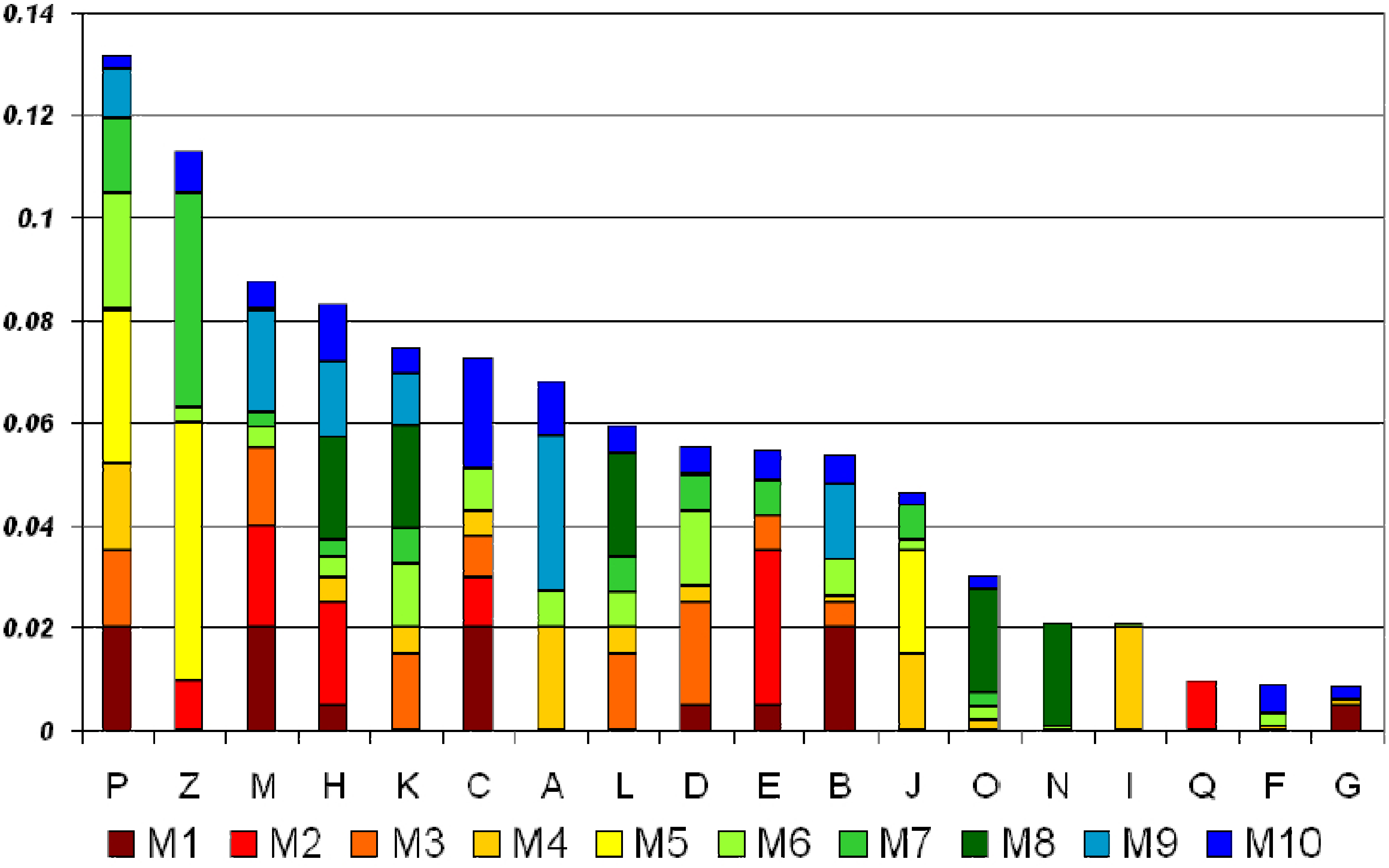


Analytic Hierarchy Process – Stakeholders (1)

- Each client is unique!
- Each stakeholder group may have a different weight
  - Process uses a weighting criteria to consider each individual stakeholder group
- Example (stakeholders M1 to M10 are different markets)
  - Revenue last release
  - Profit last release
  - Number of sold licenses last release
  - Predictions of the above criteria for the coming release
  - Number of contracts lost to competitors
  - Number of potential customer with nil licenses to date
  - Size of total market segment
  - Growth potential

Analytic Hierarchy Process – Stakeholders (2)

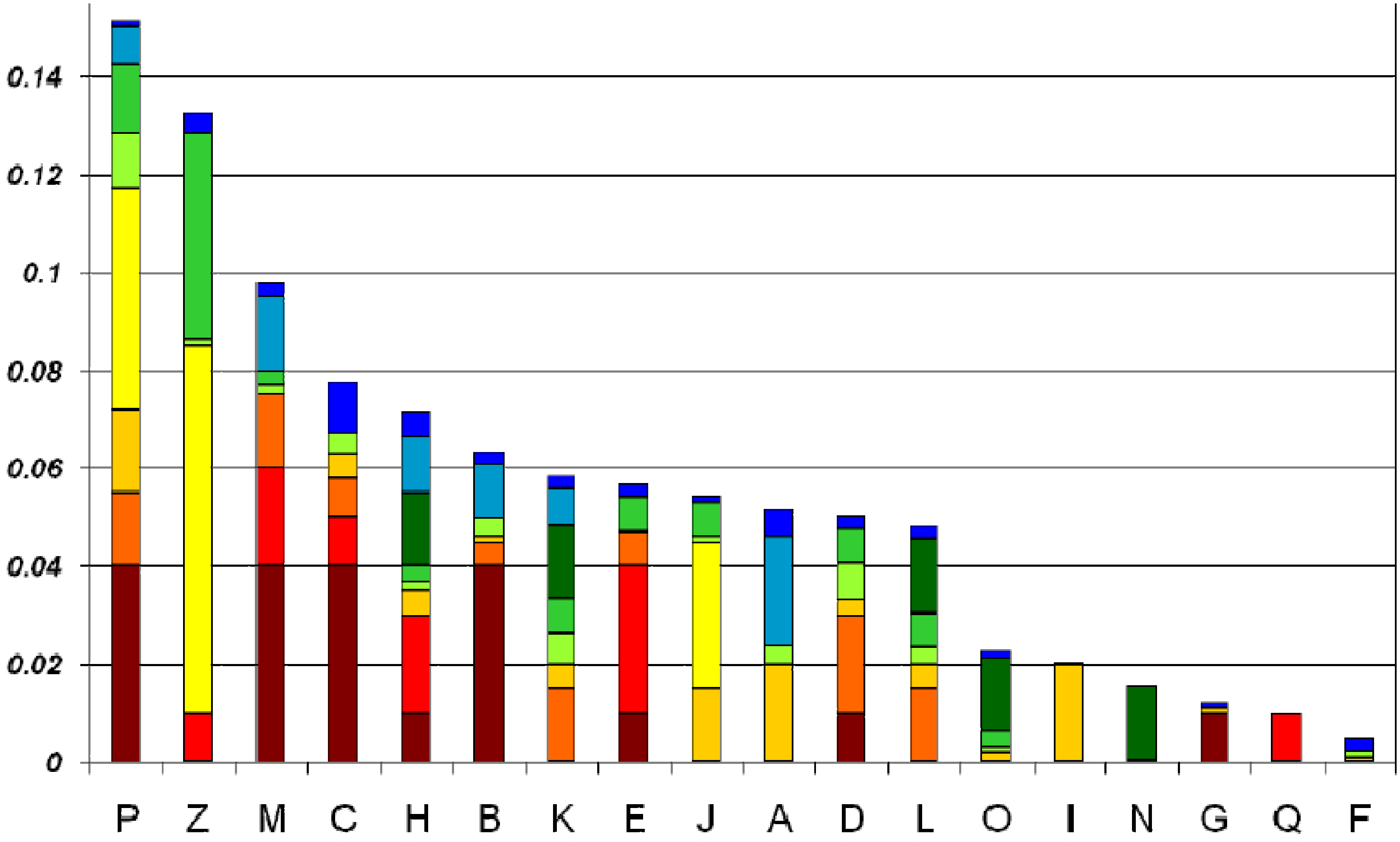
- Before adjustment based on stakeholders importance



Source: Damian, 2005

Analytic Hierarchy Process – Stakeholders (3)

- After adjustment based on stakeholders importance



Source: Damian, 2005

Example of Commercial Tool

- IBM Rational (formerly Telelogic) Focal Point
  - Decision support, portfolio management
  - Pairwise comparisons of features
    - Creation and validation of web questionnaires
  - Dynamic algorithm for reducing the number of pairs, according to the responses
  - Detection of inconsistency between the answers
  - Priorities
    - For different markets
  - Represented in various different ways
  - Integration with DOORS
  - http://www-01.ibm.com/software/awdtools/focalpoint/