Three developments of AHP: Calibrated Fuzzy AHP, AHPSort and GAHPO

Alessio Ishizaka

Full Professor in Decision Analysis

Head of Supply chain, Information Systems, Decision Aid department

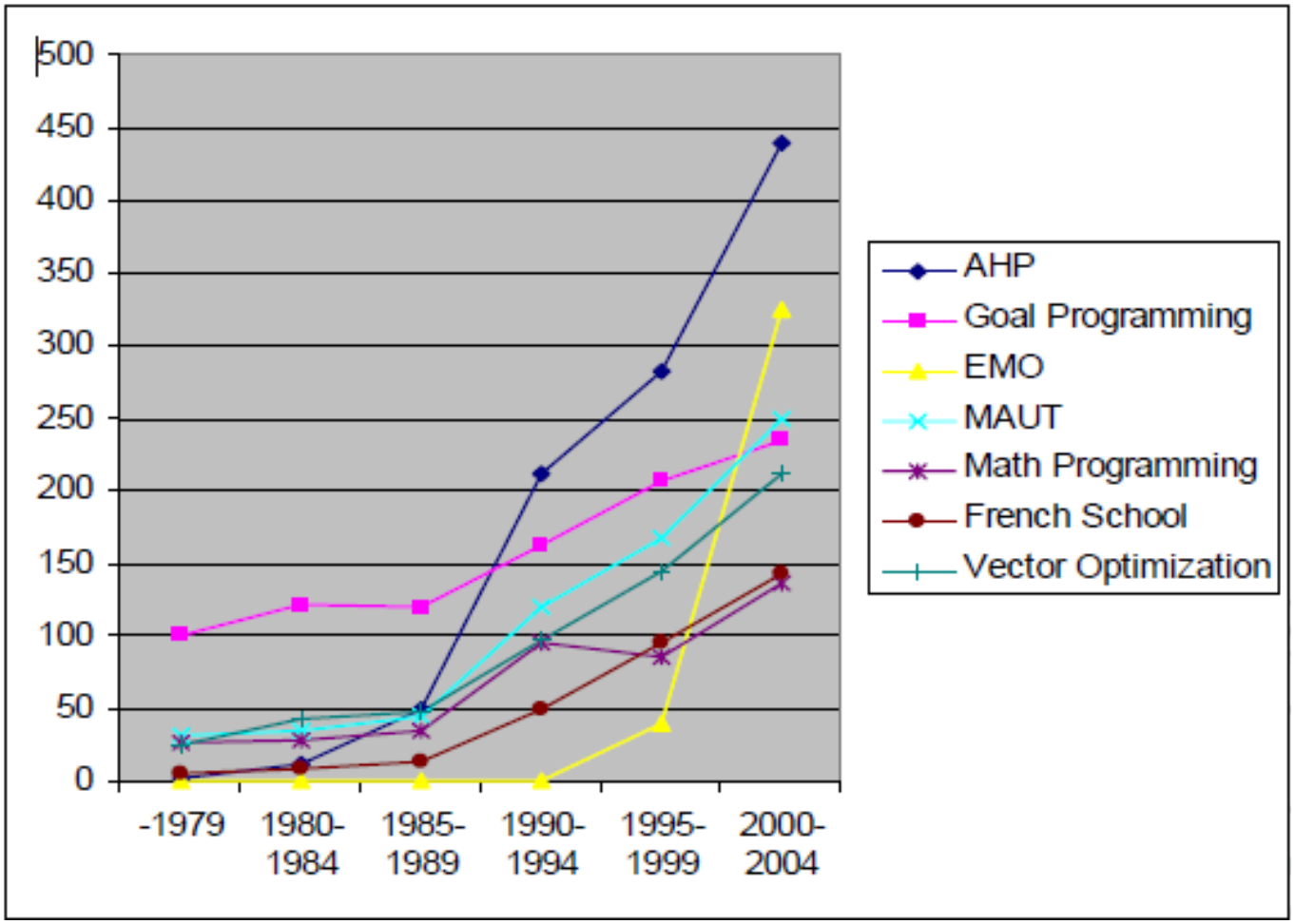
NEOMA Business School

France

Agenda

1. Introduction
2. Calibrated Fuzzy AHP
3. AHPSort
4. GAHPO

MCDA publication: an expanding area



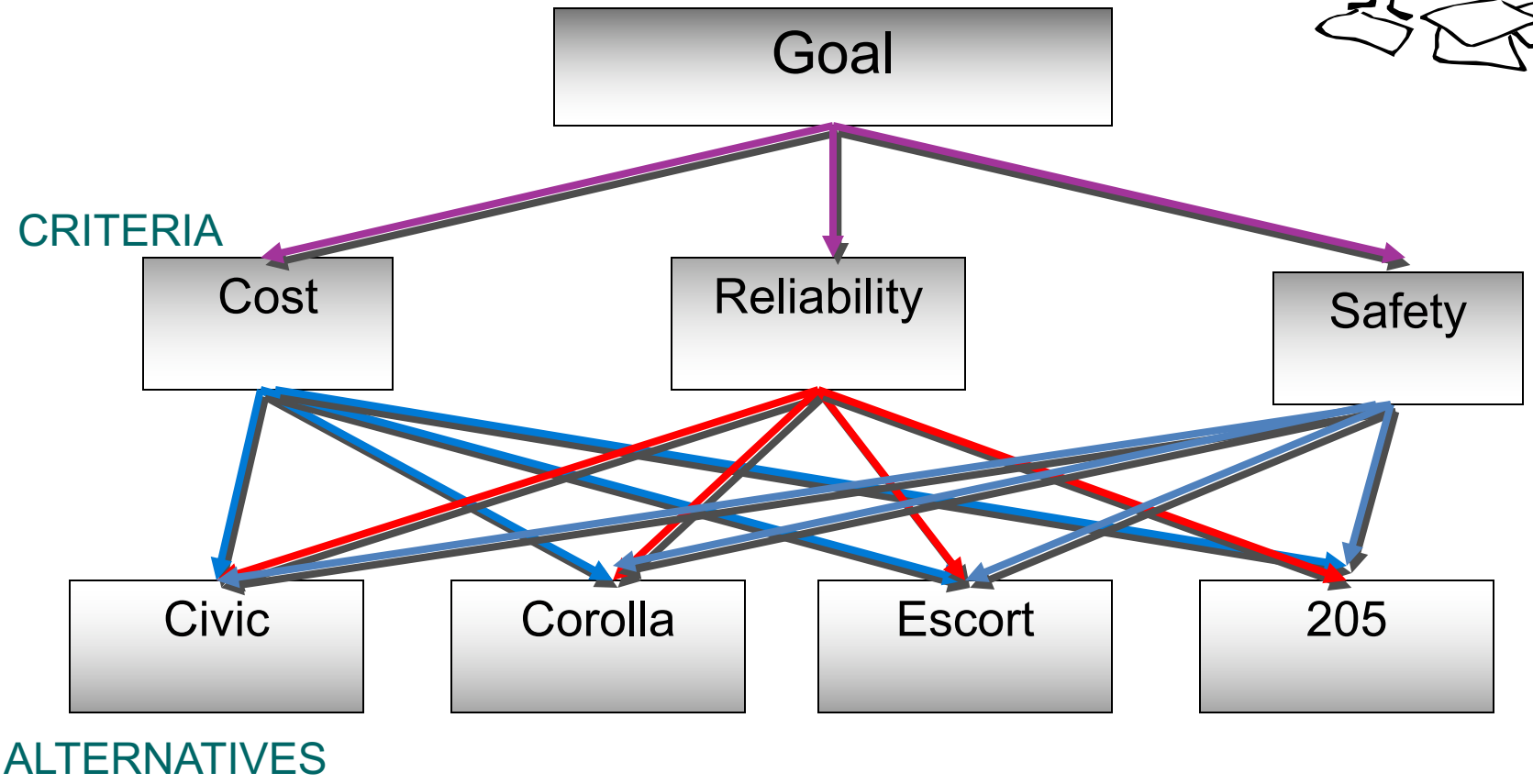
Wallenius J, Dyer J, Fishburn P, Steuer R, Zionts S, and Deb K (2008). *Multiple Criteria Decision Making, Multiattribute Utility Theory: Recent Accomplishments and What Lies Ahead*. Management Science 54(7),1336-1349.

Part A

Calibrated Fuzzy AHP
for current bank account selection

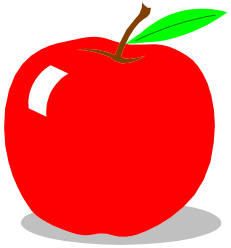
Alessio Ishizaka, Nam Hoang Nguyen, Calibrated fuzzy AHP for current bank selection, Expert Systems with Applications, 40(9), 3775–3783, 2013

Hierarchic Thinking

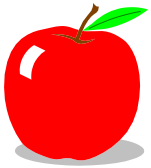


Comparison matrix

Given: Three apples of different sizes.



Apple A



Apple B

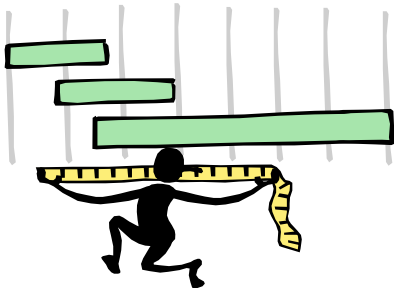
Apple C

We Assess Their Relative Sizes By Forming Ratios

Size Comparison	Apple A	Apple B	Apple C
Apple A	S_1/S_1	S_1/S_2	S_1/S_3
Apple B	S_2 / S_1	S_2 / S_2	S_2 / S_3
Apple C	S_3 / S_1	S_3 / S_2	S_3 / S_3

Ref: Prof Saaty's Notes

Scale of relative importance



Intensity of importance	Definition
1	**Equal importance**
2	Weak
3	**Moderate importance**
4	Moderate plus
5	**Strong importance**
6	Strong plus
7	**Very strong**
8	Very, very strong
9	**Extreme importance**

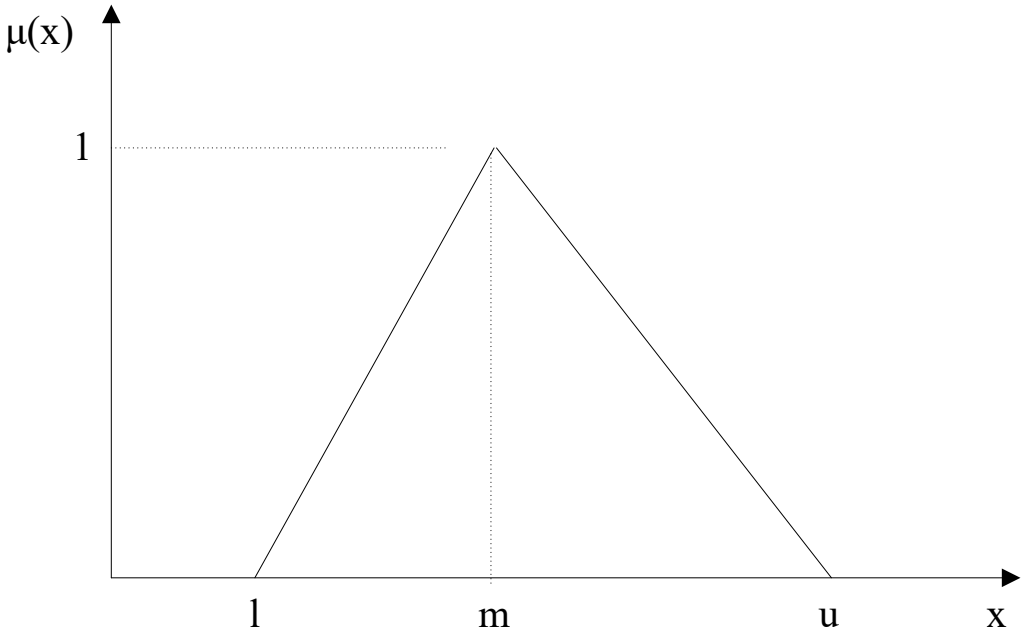
Linguistic assessments are often vague, we cannot represent them with crisp values.

Fuzzy AHP

Fuzzy AHP was first proposed by Van Laarhoven and Pedrycz (1983) and is an extension of AHP combined with fuzzy set theory (Zadeh, 1965)

1. For each linguistic term of the evaluation scale, a **membership function** is constructed.
2. Criteria/alternatives are **pair-wise compared** in comparison matrix Ã.
3. Fuzzy priorities are derived from comparison matrix Ã. This is done using the **eigenvalue method** or any other method used in traditional AHP.
4. Fuzzy priorities are translated into real numbers. Several methods exist including the **weighted average approach**, **the centre of area**, **the mean-max membership** and the **first (or last) of maxima**.

Fuzzy AHP



$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{x-l}{m-l}, & l \le x \le m \\ 1, & x = m \\ \dfrac{u-x}{u-m}, & m < x < u \\ 0, & otherwise \end{cases}$$

Membership functions

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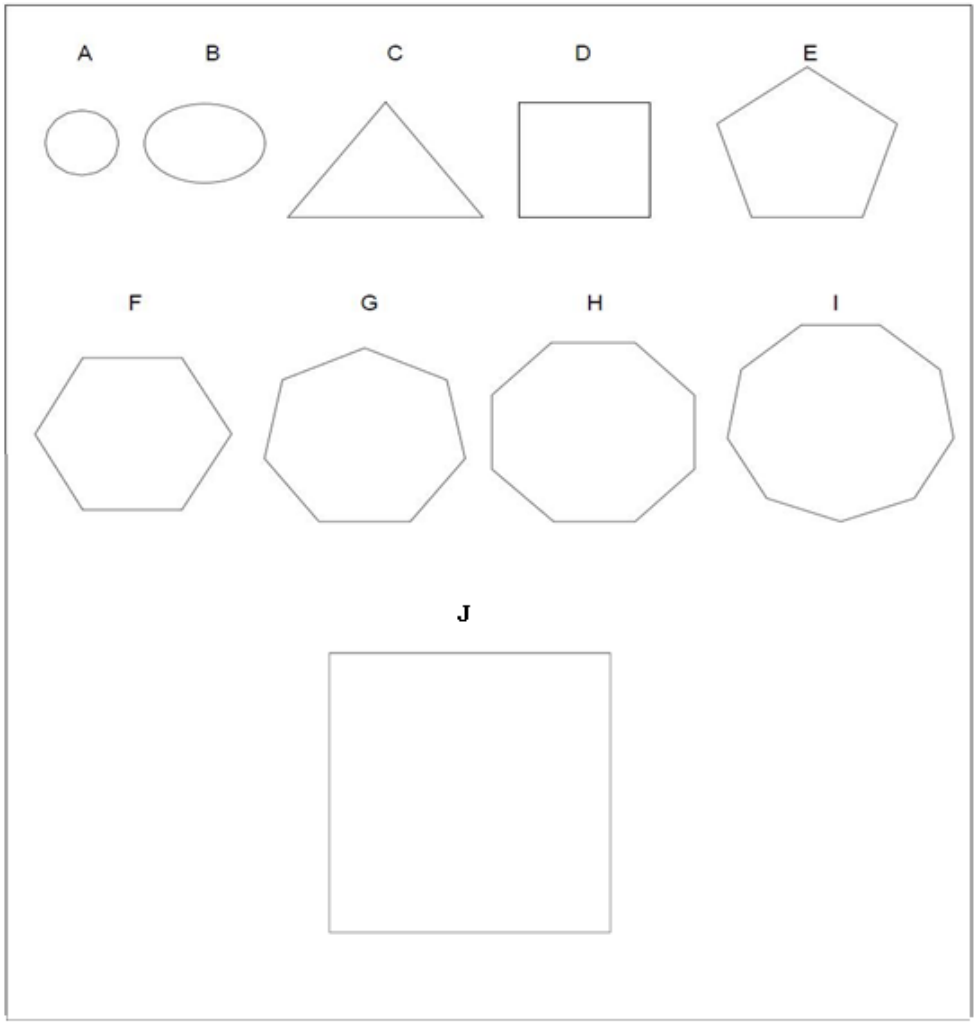
(A. Lee, Chen, & Chang, 2008; Paksoy, Pehlivan, & Kahraman, 2012; Şen & Çınar, 2010; Zeydan, Çolpan, & Çobanoğlu, 2011)	(Y.-L. Hsu, Lee, & Kreng, 2010; Yuen & Lau, 2011)	(Alev Taskin, 2009; M.-K. Chen & Wang, 2010; Chia-Chi, 2010; S. H. Hsu, Kao, & Wu, 2009; Wu, Lo, & Hsu, 2008)	(Büyüközkan & Çifçi, 2012; Lo & Wen, 2010)	(H. Chen, Lee, & Tong, 2007; Lu & Wang, 2011)
(1,1,1) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (9,9,9)	(1,1,1) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,9)	(1,1,1) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,10)	(1,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,10)	(1,1,3) (1,2,4) (1,3,5) (2,4,6) (3,5,7) (4,6,8) (5,7,9) (6,8,9) (7,9,9)
(Cho & Lee, 2011)	(Javanbarg, Scawthorn, Kiyono, & Shahbodaghkhan, 2012)	(L.-C. Chen & Chu, 2012)	(Özkır & Demirel, 2012)	(Önüt, Efendigil, & Soner Kara, 2010)
(0,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,9)	(0.5,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,10)	(1,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8) (7,8,9) (8,9,9)	(1,1,1) or (1,1,2) (2,3,4) (4,5,6) (6,7,8) (8,9,9) (1,1,1) only if an element is compared with itself, otherwise (1,1,2) if the user thinks they are equal	(1,1,1) or (1,1,3) (1,3,5) (3,5,7) (5,7,9) (7,9,9) (1,1,1) only if an element is compared with itself, otherwise (1,1,3) if the user thinks they are equal
(Mentes & Helvacioglu, 2012)	(Bulut, Duru, Keçeci, & Yoshida, 2012; Cebeci, 2009; Duru, Bulut, & Yoshida)	(Haghighi, Divandari, & Keimasi, 2010; S.-H. Lee, 2010)	(Bozbura, Beskese, & Kahraman, 2007; Isaai, Kanani, Tootoonchi, & Afzali, 2011; T.-C. Wang & Chen, 2011)	(Che, Wang, & Chuang, 2010)
(1.00,1.00,1.25) (1.25,1.50, 1.75) (1.75,2.00, 2.25) (2.25,2.50,2.75) (2.75,3.00,3.00)	(1,1,1) (1,3,5) (3,5,7) (5,7,9) (7,9,9)	(1,1,1) (1/2,1,3/2) (1,3/2,2) (3/2,2,5/2) (2,5/2,3) (5/2,3,7/2)	(1.0,1.0,1.0) (0.5,1.0,1.5) (1.0,1.5,2.0) (1.5,2.0,2.5) (2.0,2.5,3.0) (2.5,3.0,3.5)	(1,1,1) (1,2,3) (2,3,4) (3,4,5) (4,5,6) (5,6,7) (6,7,8)

Membership functions

(Iç & Yurdakul, 2009)	(Hosang, 2011)	(Seçme, Bayrakdaroğlu, & Kahraman, 2009)	(Hadi-Vencheh & Mohamadghasemi, 2011)	(Nepal, Yadav, & Murat, 2010)
(1,1,1) (2,3,4) (4,5,6) (6,7,8) (8,9,10)	(1,1,2) (1,3,5) (3,5,7) (5,7,9) (8,9,9)	(1,1,1) (2/3,1,3/2) (1,3/2,2) (3/2,2,5/2) (5/2,3,7/2)	(1,1,2) (1,2,3) (2,3,4) (3,4,5) (4,5,5)	(1,1,3) (1,3,5) (3,5,7) (5,7,9) (7,9,11)
(Celik, Deha Er, & Ozok, 2009; Kilincci & Onal, 2011; Liu & Chen, 2009; Rostamzadeh & Sofian, 2011)	(Büyüközkan, Çifçi, & Güleryüz, 2011; T.-S. Li & Huang, 2009)	(Cakir & Canbolat, 2008; J. Wang, Fan, & Wang, 2010)	(Kaya & Kahraman, 2011a, 2011c; Kutlu & Ekmekçioğlu, 2012)	(Celik, Kandakoglu, & Er, 2009; Durán & Aguilo, 2008)
(1,1,1) (2/3,1,3/2) (3/2,2,5/2) (5/2,3,7/2) (7/2,4,9/2)	(1,1,2) (2,3,4) (4,5,6) (6,7,8) (8,9,10)	(1,1,2) (2,3,4) (4,5,6) (6,7,8) (8,9,9)	(1,1,1) (1,1,1.5) (1,1.5,2) (1.5,2,2.5) (2,2.5,3)	(1,1,3) (1,3,5) (3,5,7) (5,7,9) (7,9,9)
(Kaya & Kahraman, 2011b)	(Iç & Yurdakul, 2009)	(S. Li & Kuo, 2008)	(Chiang & Che, 2010; Ho, 2012; Ou, Fu, Hu, Chu, & Chiou, 2011)	
(1,1,1,1) (1,3/2,2,5/2) (3/2,2,5/2,3) (2,5/2,3,7/2) (5/2,3,7/2,4)	(1,1,1,1) (2,3,4,5) (4,5,6,7) (6,7,8,9) (8,9,10,10)	Decision-maker constructs their own membership function.	Not mentioned	

Membership function calibration

Calibration of the membership function is performed through a comparison of measurable alternatives



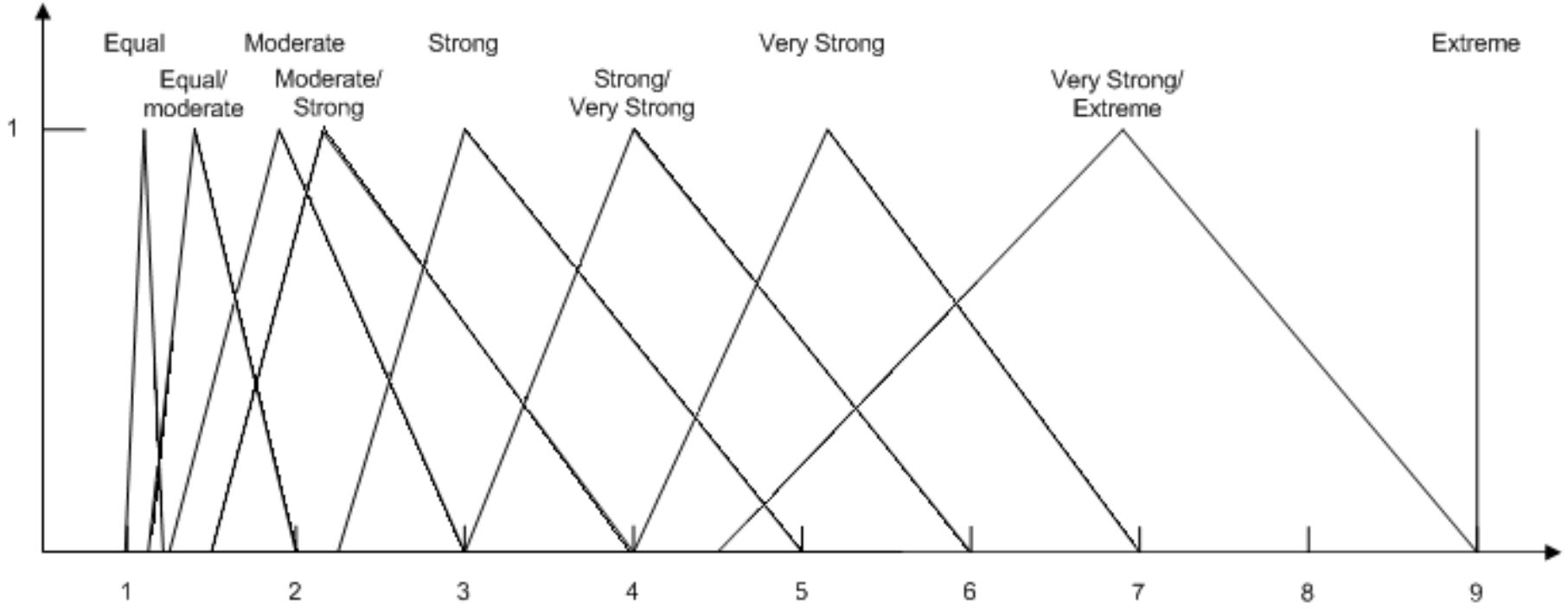
Real measured pairwise comparisons

	A	B	C	D	E	F	G	H	I	J
A										
B	**2**									
C	**3**	**3/2**								
D	**4**	**4/2**	**4/3**							
E	**5**	**5/2**	**5/3**	**5/4**						
F	**6**	**6/2**	**6/3**	**6/4**	**6/5**					
G	**7**	**7/2**	**7/3**	**7/4**	**7/5**	**7/6**				
H	**8**	**8/2**	**8/3**	**8/4**	**8/5**	**8/6**	**8/7**			
I	**9**	**9/2**	**9/3**	**9/4**	**9/5**	**9/6**	**9/7**	**9/8**		
J		**10/2**	**10/3**	**10/4**	**10/5**					

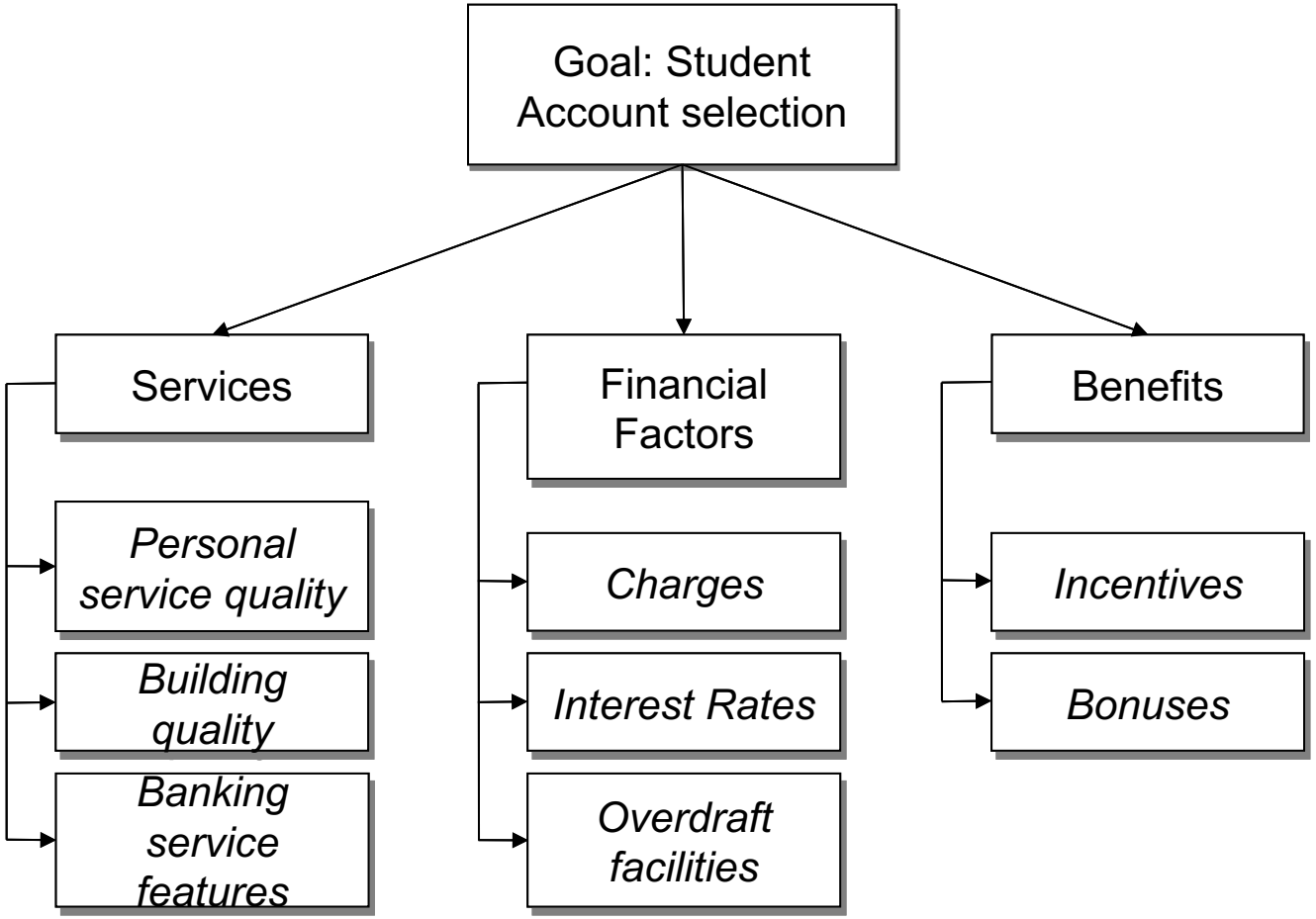
Matching table

Scale	Equal	Eq/ Mod	Moderate	Mod/ Str	Strong	Str/ very Str	Very Strong	Ver str/ extreme	Extreme
Participant judgements	1.20	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
	1.00	1.33	1.50	2.33	2.50	3.00	4.00	4.50	
		1.40	2.00	1.50	2.67	3.50	4.50	9.00	
		1.60	1.67	1.75	2.67	3.60		6.00	
		1.17	2.00	2.00	3.00				
		1.33	1.25	1.50	2.25				
		1.14	1.80						
		1.29							
		1.13							
p(min)	1.00	1.13	1.25	1.50	2.25	3.00	4.00	4.50	9.00
p(mean)	1.10	1.38	1.89	2.18	3.01	4.03	5.17	6.88	9.00
p(max)	1.20	2.00	3.00	4.00	5.00	6.00	7.00	9.00	9.00

Customised membership functions



Case study: bank account selection



Demography of the participants

#	Course	Age	Gender	Nationality
P1	MsC Finance	27	M	British
P2	BA Accounting and Finance	19	F	Vietnamese
P3	MsC Business and Management	24	F	Indian
P4	MA Marketing	24	F	Thailand
P5	MsC Business and Management	23	F	Vietnamese
P6	BsC Business and Economic	20	F	British
P7	MsC Business and Management	25	M	Vietnamese
P8	BsC Biology	21	M	British
P9	BA Accountancy and Financial Management	20	F	British
P10	BA Computing	21	F	British
P11	BsC Crime and Criminology	24	M	British
P12	MsC Financial Decision Analysis	23	M	Vietnamese
P13	BA Digital Marketing	22	F	British
P14	MsC Financial Decision Analysis	25	M	Malaysian
P15	BsC Digital Forensics	22	M	British
P16	MsC Finance	26	M	Chinese
P17	MsC Construction Project Management	27	M	British
P18	BA Education and Training studies	22	F	British
P19	BA English Literature	20	F	Chinese
P20	BA Business Administration	19	M	Malaysian
P21	MsC Forensic Accounting	25	M	Chinese
P22	BA Business Enterprise	20	M	Indian
P23	BA Accounting and Business	21	M	Vietnamese
P24	MsC Finance	23	M	Chinese
P25	MsC Business and Management	25	F	British
P26	BA Business with Business Communication	20	M	Vietnamese
P27	MsC Finance	23	M	British

Modes of data collection

Mode of communication	Questionnaire distributed	Nº of responses	Nº of usable responses	Responses rate	Usable response rate
Email	75	25	14	33%	56%
Face to face	40	30	19	75%	63.33%
Social network	High	20	7	(Very low)	35%
Total	115 to high	75	40	n/a	n/a

	Male	Female
British student	10	10
International student	10	10

Results

Comparisons Criteria	Overall	Comparison I		Comparison II		Comparison III	
		Home	Inte-rnational	Females	Males	Under-graduate	Post-graduate
Number of participants	**40**	**20**	**20**	**20**	**20**	**17**	**23**
Services	***44.5%***	***42.5%***	***46.3%***	***46.5%***	***42.2%***	***40.6%***	***47.1%***
Personal service quality	***19.9%***	***19.3%***	***20.4%***	***20.9%***	***18.7%***	***17.9%***	***21.3%***
Building quality	***11.1%***	***9.5%***	***12.8%***	***10.9%***	***11.2%***	***10.8%***	***11.1%***
Banking service features	***13.5%***	***13.8%***	***13.2%***	***14.8%***	***12.2%***	***11.9%***	***14.7%***
Financial Factors	***22.1%***	***24.0%***	***20.3%***	***24.3%***	***20.0%***	***20.4%***	***23.3%***
Charges	***8.7%***	***9.2%***	***8.3%***	***9.7%***	***7.8%***	***8.8%***	***8.6%***
Interest rates	***6.5%***	***7.6%***	***5.5%***	***7.5%***	***5.6%***	***5.8%***	***6.9%***
Overdraft facilities	***6.9%***	***7.3%***	***6.5%***	***7.2%***	***6.6%***	***5.8%***	***7.7%***
Benefits	***33.4%***	***33.4%***	***33.4%***	***29.3%***	***37.9%***	***39.0%***	***29.6%***
Bonuses	***18.6%***	***17.5%***	***19.7%***	***16.5%***	***20.8%***	***20.9%***	***16.9%***
Incentives	***14.8%***	***16.0%***	***13.6%***	***12.7%***	***17.1%***	***18.0%***	***12.7%***
Inconsistency rate	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

Alessio Ishizaka, Nam Hoang Nguyen, Calibrated fuzzy AHP for current bank selection, Expert Systems with Applications, 40(9), 3775–3783, 2013

Part B

AHPSort
for selecting a supplier

Ishizaka A, Pearman C, Nemery P, *AHPSort: an AHP based method for sorting problems*, International Journal of Production Research , 50(17), 4767-4784, 2012

Problem of AHP

If high number of criteria or alternatives

then

Too many pairwise comparisons!

Number of suppliers

AHP	
Number suppliers	Number articles
n.c.	7
2	2
3	15
4	6
5	4
6	1
7	1
8	1
Likert scale	2

TCO	
Number suppliers	Number articles
n.c.	1
2	2
3	2
6	1
15	1
24	1
25	1
34	1
39	1

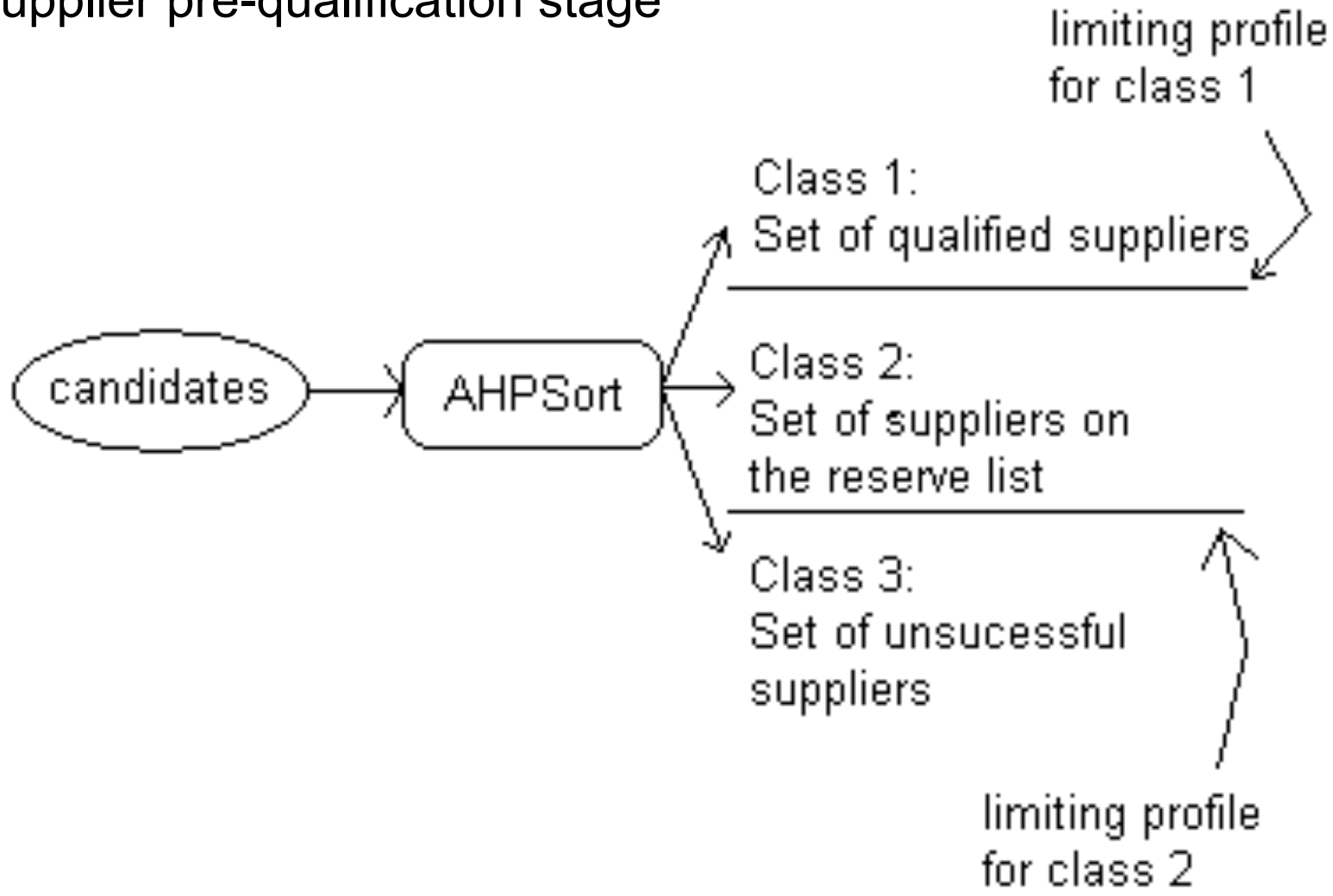
MCDM	
Number suppliers	Number articles
n.c.	3
3	3
5	3
10	2
12	1
22	1

Supplier selection

- Tremendous important
- Wrong supplier has serious consequences
- Multicriteria problem recognised early (Dickson, 1966)
- Support of a multicriteria method is advised
- AHP (Analytic Hierarchy Process) widely used for a small number of alternatives

AHPSort

Supplier pre-qualification stage



AHPSort: Method

A) Problem structuring

- Definition of goal, criteria and alternatives
- Definition of classes
- Definition of limiting profiles or central profiles

B) Evaluations

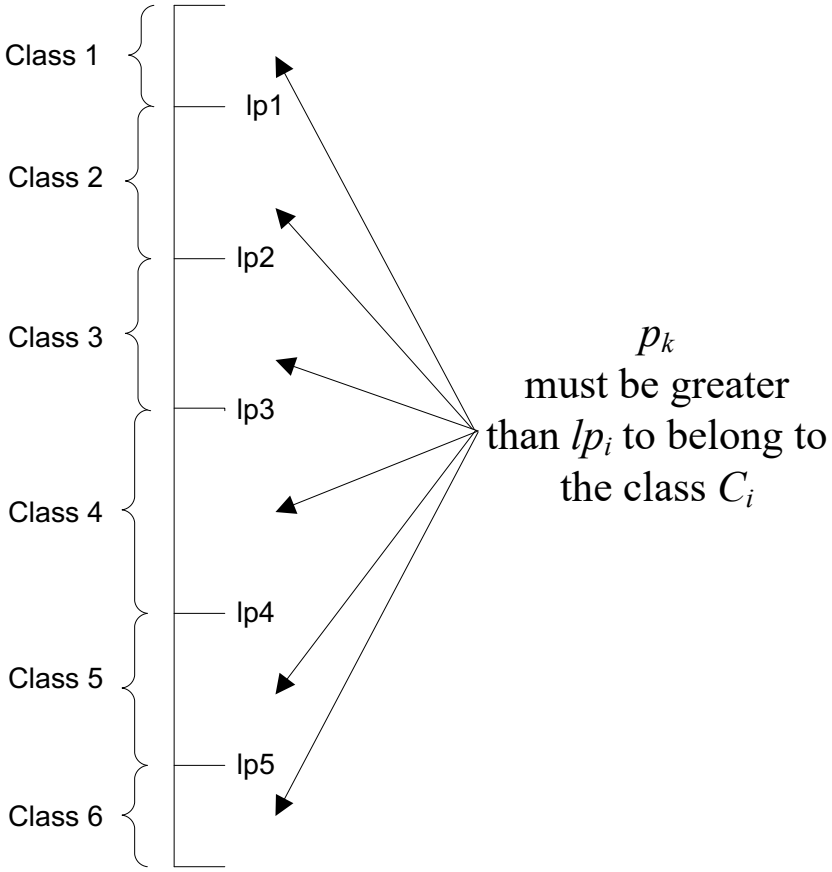
- Pairwise evaluation of criteria
- Pairwise evaluation of one alternative and the profiles

C) Assignements

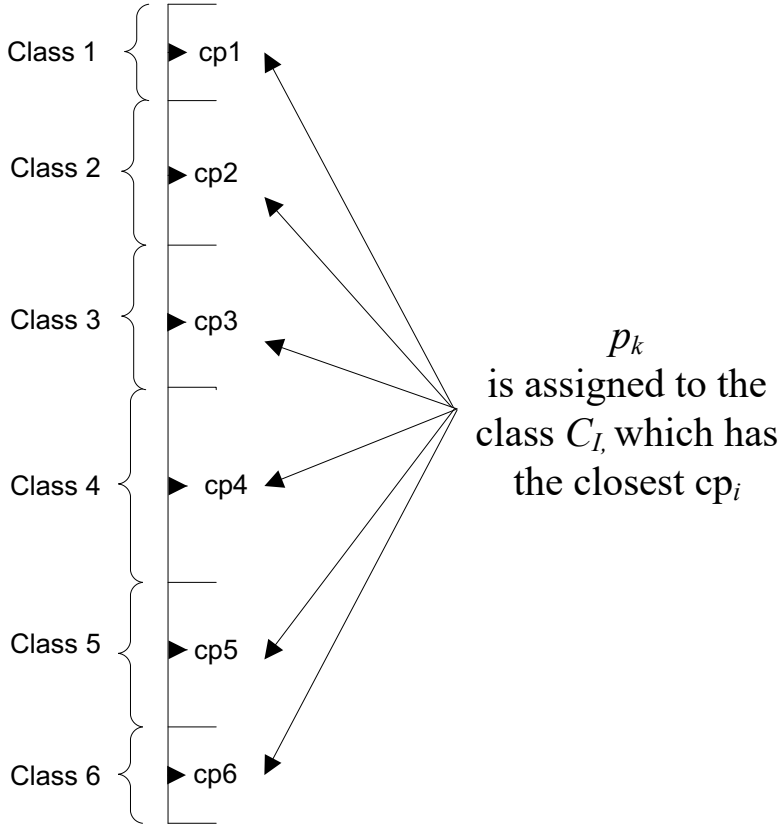
- Aggregation of the local weighted priorities
- Assignement to a class
- Restart the process with the next alternative

Assignement to a class

Limiting profile



Central profile



AHPSort:Pre-qualification stage

Circle one number per row below using the scale:																		
1 = Equal 3 = Moderate 5 = Strong 7 = Very strong 9 = Extreme																		
Experience	9	8	**7**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Flexibility
Experience	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	Security
Experience	9	8	**7**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Resilience
Experience	9	**8**	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Environment
Flexibility	9	8	7	6	5	4	3	2	1	2	3	**4**	5	6	7	8	9	Security
Flexibility	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	Resilience
Flexibility	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	Environment
Security	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	Resilience
Security	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	Environment
Resilience	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	Environment

Criteria weighting

Criterion	Weighting
Experience	0.565
Flexibility	0.081
Security	0.234
Resilience	0.081
Environment	0.040
Inconsistency Ratio	0.05

Local priorities

Circle one number per row below using the scale:
1 = Equal 3 = Moderate 5 = Strong 7 = Very strong 9 = Extreme
2, 4, 6 and 8 are intermediate values

Compare the relative performance of the supplier against the **experience** criteria for the PQQ stage.

Supplier A	**9**	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Limiting profile
Supplier B	**9**	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Limiting profile
Supplier C	9	**8**	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Limiting profile
Supplier D	9	8	**7**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Limiting profile
Supplier E	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	Limiting profile
Supplier F	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	Limiting profile
Supplier G	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	Limiting profile
Supplier H	9	8	7	6	5	4	3	2	1	2	3	4	5	6	**7**	8	9	Limiting profile
Supplier I	9	8	7	6	5	4	3	2	1	2	3	**4**	5	6	7	8	9	Limiting profile
Supplier J	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	**9**	Limiting profile
Supplier K	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	**8**	9	Limiting profile
Supplier L	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	**9**	Limiting profile

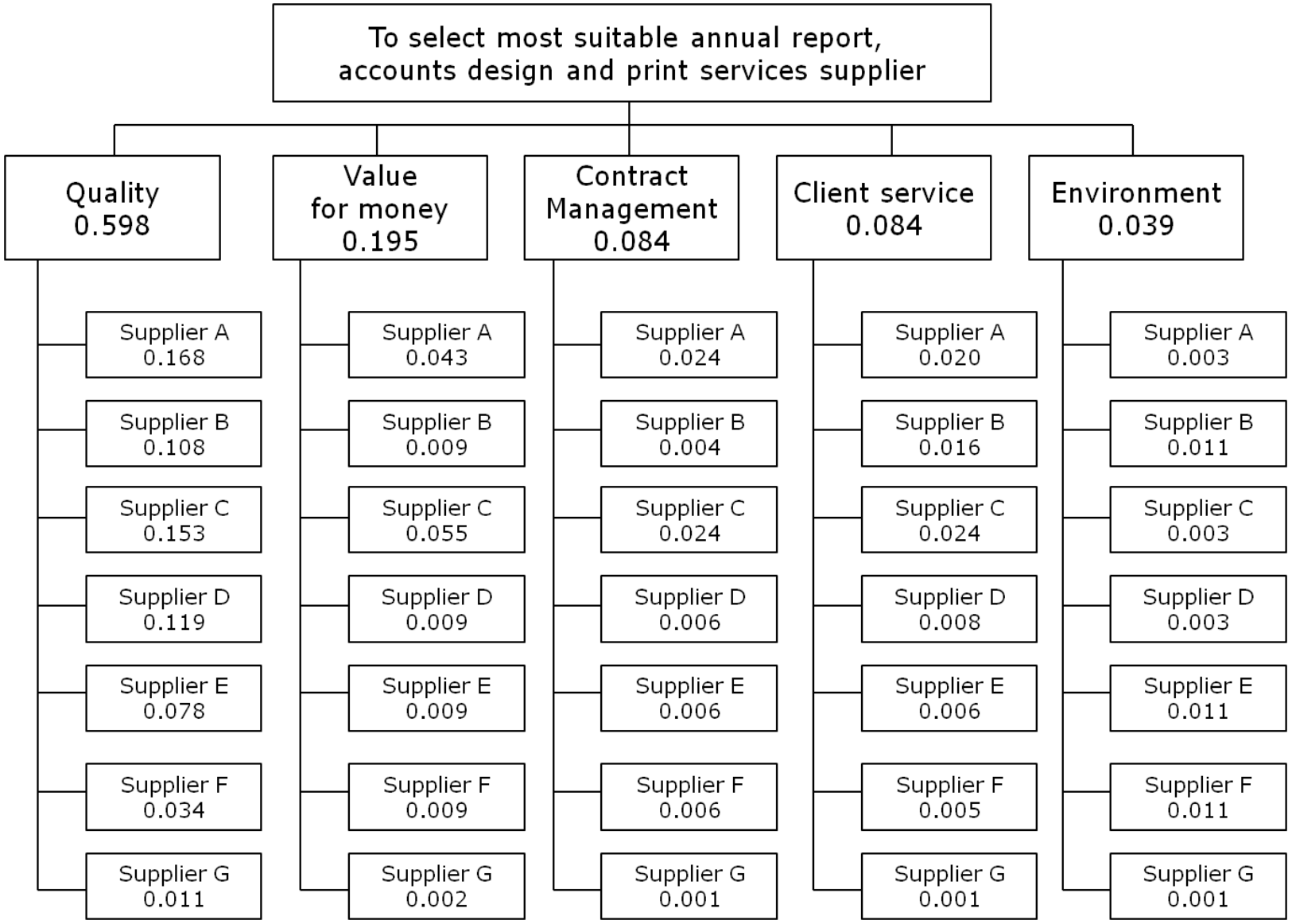
Global priorities

	Experience (0.565)	Flexibility (0.081)	Security (0.234)	Resilience (0.081)	Environment (0.040)	Score limiting profile	Overall priority
Supplier A	0.9	0.9	0.9	0.9	0.9	0.100	.900
Supplier B	0.9	0.9	0.9	0.9	0.9	0.100	.900
Supplier C	0.889	0.9	0.9	0.9	0.9	0.106	.894
Supplier D	0.875	0.9	0.833	0.167	0.9	0.191	.809
Supplier E	0.833	0.875	0.875	0.167	0.833	0.209	.791
Supplier G	0.833	0.750	0.5	0.833	0.833	0.285	.715
Supplier F	0.5	0.143	0.9	0.9	0.9	0.423	.577
Supplier H	0.125	0.9	0.5	0.9	0.9	0.614	.386
Supplier I	0.2	0.125	0.8	0.167	0.167	0.668	.332
Supplier J	0.1	0.125	0.5	0.5	0.5	0.700	.300
Supplier K	0.111	0.1	0.5	0.167	0.167	0.748	.252
Supplier L	0.1	0.1	0.1	0.1	0.1	0.900	.100

Qualified suppliers

Supplier	Score AHPSort
Supplier A	.900
Supplier B	.900
Supplier C	.894
Supplier D	.809
Supplier E	.791
Supplier F	.577
Supplier G	.715
Supplier H	.386
Supplier I	.322
Supplier J	.299
Supplier K	.252
Supplier L	.100

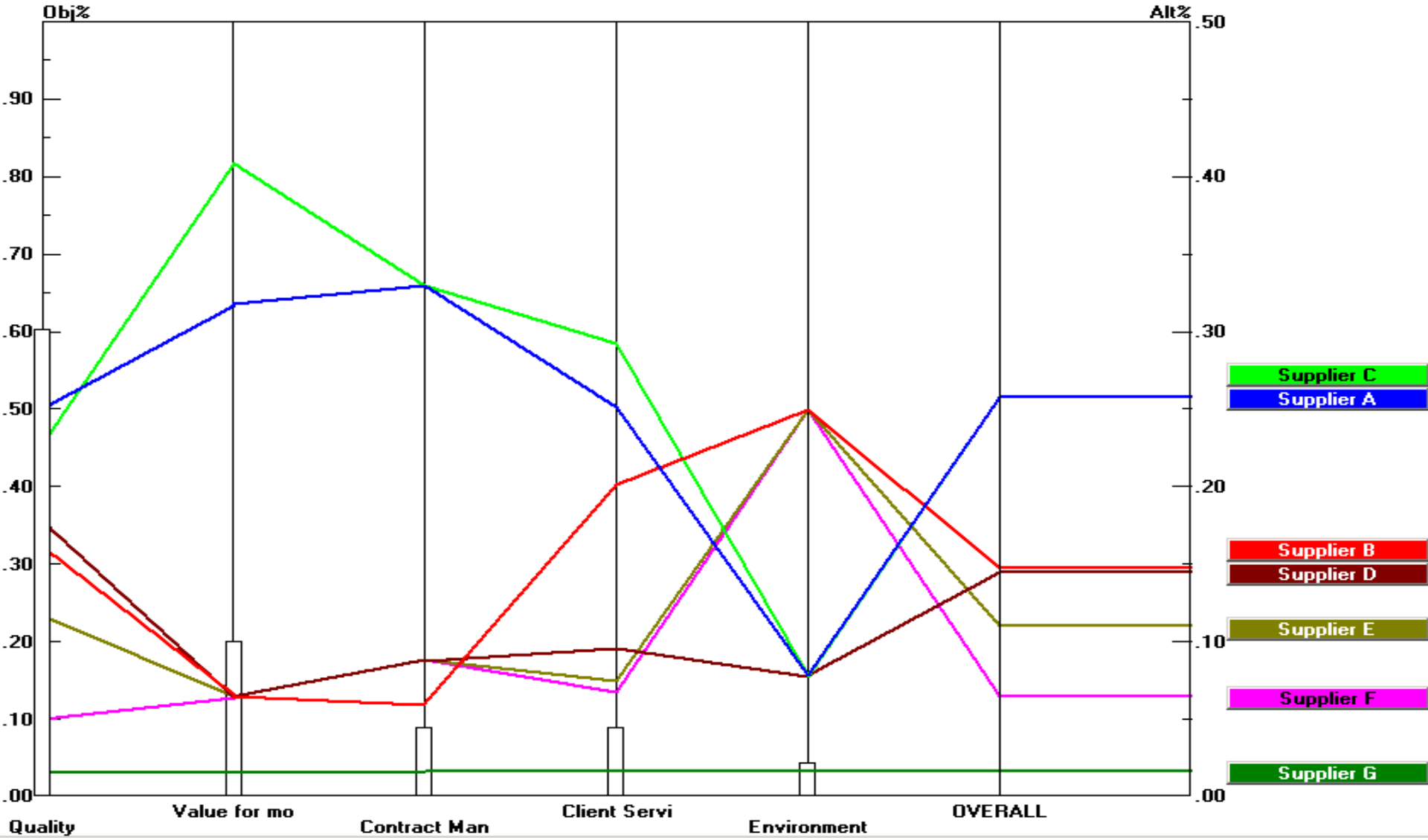
Evaluation stage with AHP



Supplier ranking

Supplier	Score AHP
Supplier C	.258
Supplier A	.258
Supplier B	.148
Supplier E	.110
Supplier D	.145
Supplier F	.065
Supplier G	.017

Sensitivity Analysis



Conclusion AHPSort

- AHP is useful but not applicable for a large number of suppliers
- The two stage approach AHPSort and AHP allow to bypass this problem

However:

- It is not implemented in the information system
- Staff must be trained to use the method

Ishizaka A, Pearman C, Nemery P, *AHPSort: an AHP based method for sorting problems*, International Journal of Production Research , 50(17), 4767-4784, 2012

Partie C

GAHPO

Introduction of incomparabilities in AHP

Ishizaka Alessio, Labib Ashraf, Selection of new production facilities with the Group Analytic Hierarchy Process Ordering Method, Expert Systems With Applications, 38(6),7317–7325, 2011

Agenda

1. Title
2. Agenda
3. Problem description
4. Decision Workflow Management
5. Awarness session on the AHP
6. AHP in group decisions
7. Weight of stakeholders
8. Structure of the hierarchy model
9. Assessment of pairwise comparisons
10. Calculation of priorities
11. Sensitivity analysis
12. Conclusions

Prof Alessio Ishizaka
University of Portsmouth
Portmsouth Business School
Richmond Building
PO1 3DE Portsmouth
United Kingdom

Alessio.Ishizaka@port.ac.uk

Motivation

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3 possible relations between 2 alternatives:

1. Preference: x is preferred to y
   x P y
2. Indifference: x and y are indifferent to him/her
   x I y
3. Incomparable: (s)he unable to compare them
   x J y

The incomparability relation is missing in AHP

Problem description

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Current situation:

Two plants in England:

- the **'Green' plant** producing paper products
- the **'Plasto' plant** producing plastic items

New situation:

Repatriation of another plastic production plant from Scotland

Consequence:

the Plasto plant has to be redesigned

Alternatives

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A. **Redesign of Plasto plant**, hereafter referred to as *Plant Redesign*

B. **Automation of Plasto production processes**, hereafter referred to as *Plant Automation*

C. **Relocation and consolidation of Green plant with Plasto**, hereafter referred to as *Plant Consolidation*

Decision Workflow Management

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A. Awareness session on the AHP

B. Structure of the hierarchy model

C. Assessment of pairwise comparisons

D. Calculation of priorities and sensitivity analysis

Awarness session on the AHP

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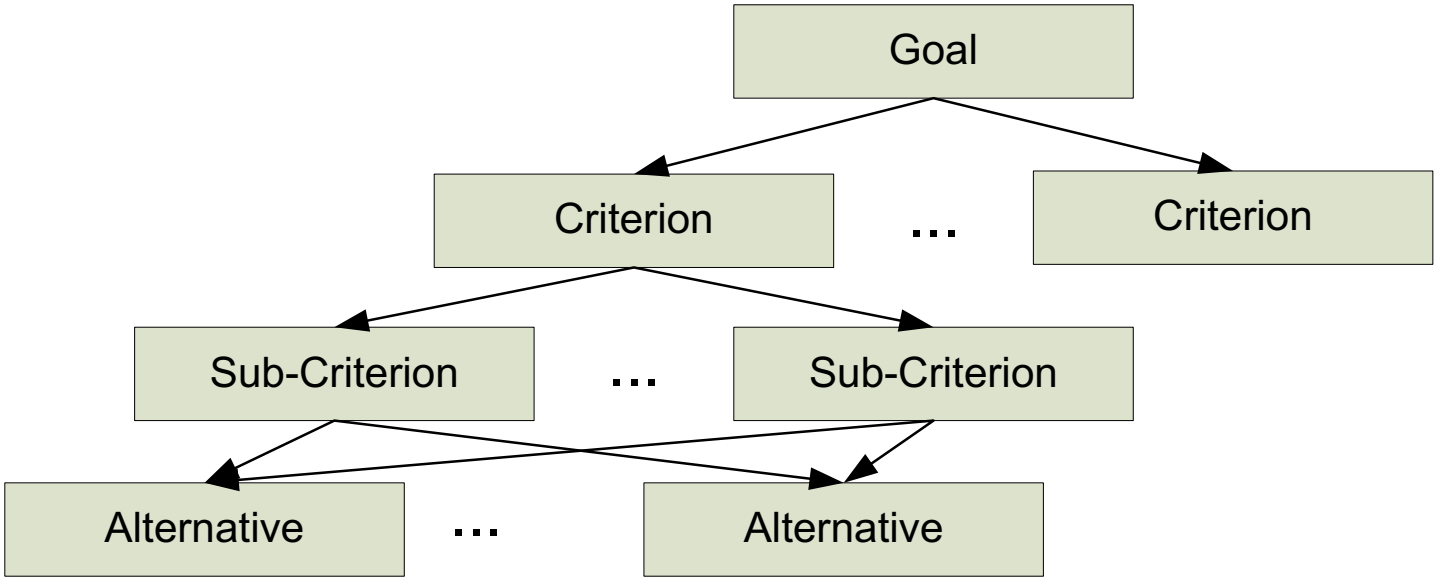

$$Aw = \lambda_{max} w$$

where A: comparison matrix

λ_{max}: principal eigenvalue

w: vector of the priorities

AHP in group decisions

		Mathematical aggregation	
		yes	no
Aggregation on	judgements	Geometric mean on judgements	Consensus vote on judgements
	priorities	Weighted arithmetic mean on priorities	Consensus vote on priorities

Weight of stakeholders (1)

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The weight reflect the expertise of a decision-maker or the importance of the impact of the decision on the actor.

Allocation of weights by:

A. A supra decision-maker or benevolent dictator

B. A participatory approach

Weight of stakeholders (2)

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	Share-holders	Senior managers	Middle managers	Relative importance
Shareholders	1	3	9	0.672
Senior Managers	1/3	1	5	0.265
Middle managers	1/9	1/5	1	0.063

Inconsistency Ratio = 0.03

Structure of the cost hierarchy model

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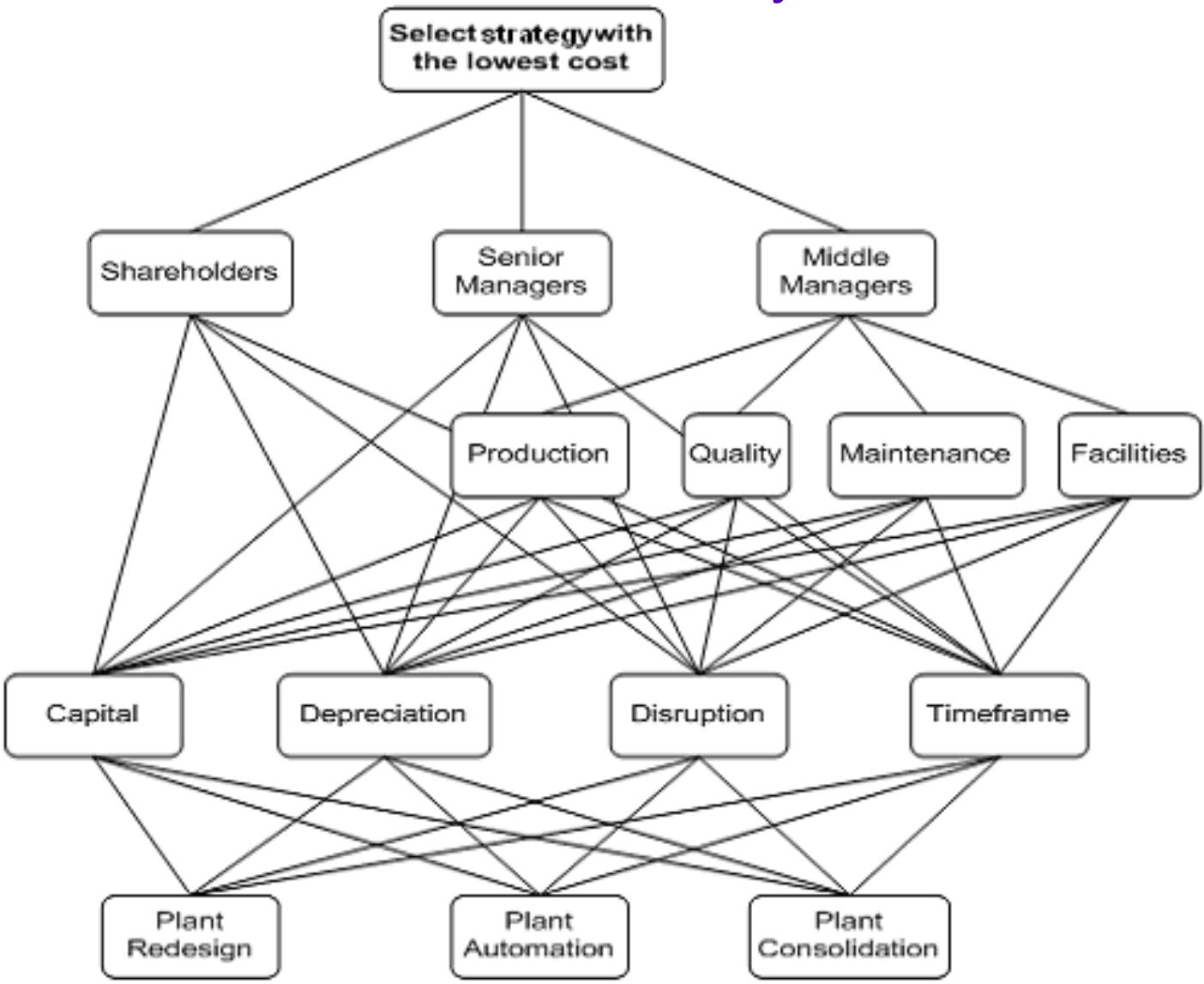

Structure of the benefit hierarchy model

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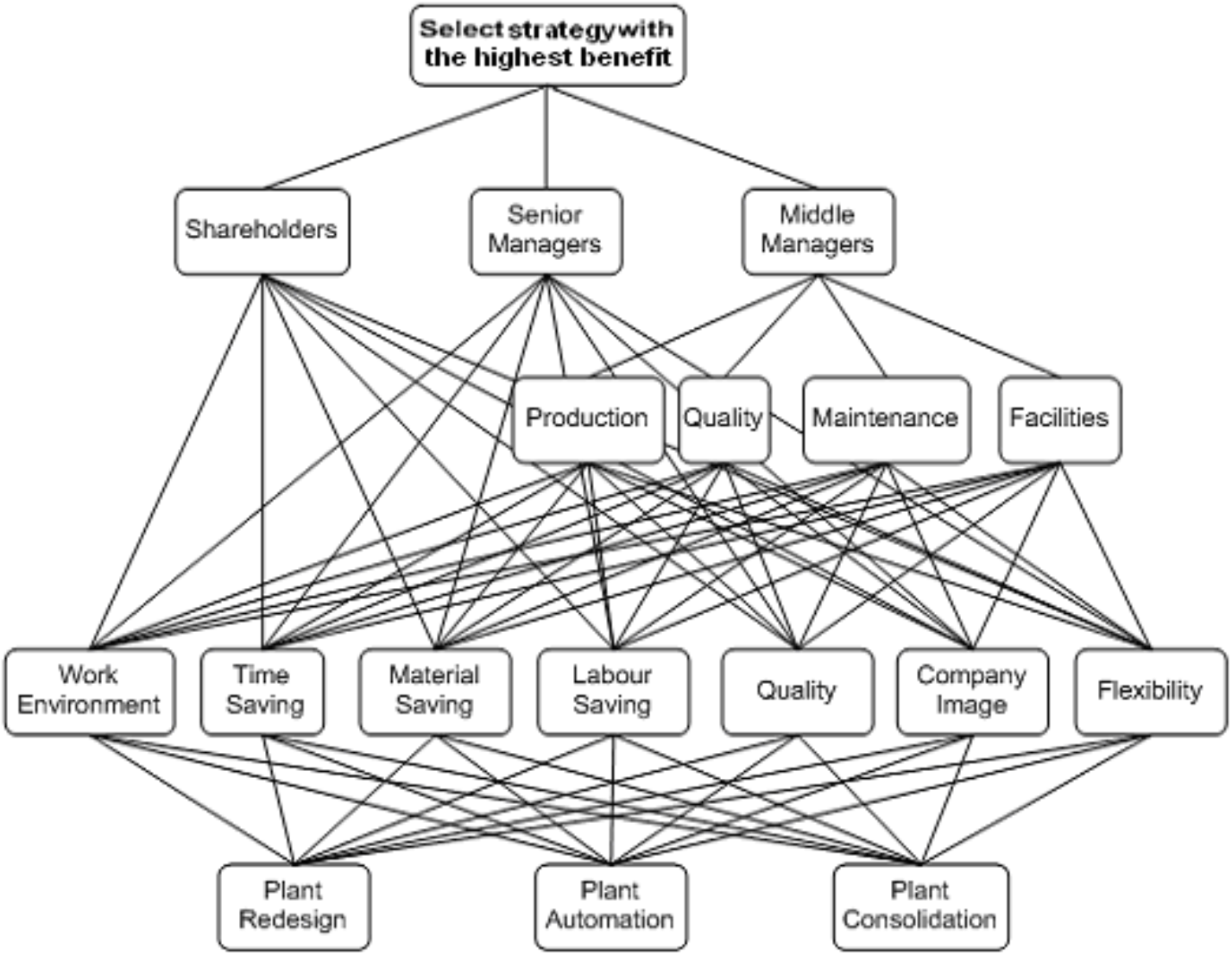

Assessment of pairwise comparisons

	Production	Quality	Maintenance	Facilities	Priorities
Production	1	3	5	5	0.538
Quality	1/3	1	5	5	0.305
Maintenance	1/5	1/5	1	1	0.078
Facilities	1/5	1/5	1	1	0.078

Calculation of priorities

Strategic alternatives	Costs	Benefits	Benefit/Cost
Plant Redesign	0.373	0.277	0.74
Plant Automation	0.142	0.496	3.49
Plant Consolidation	0.485	0.227	0.47

Sensitivity analysis on the benefits analysis

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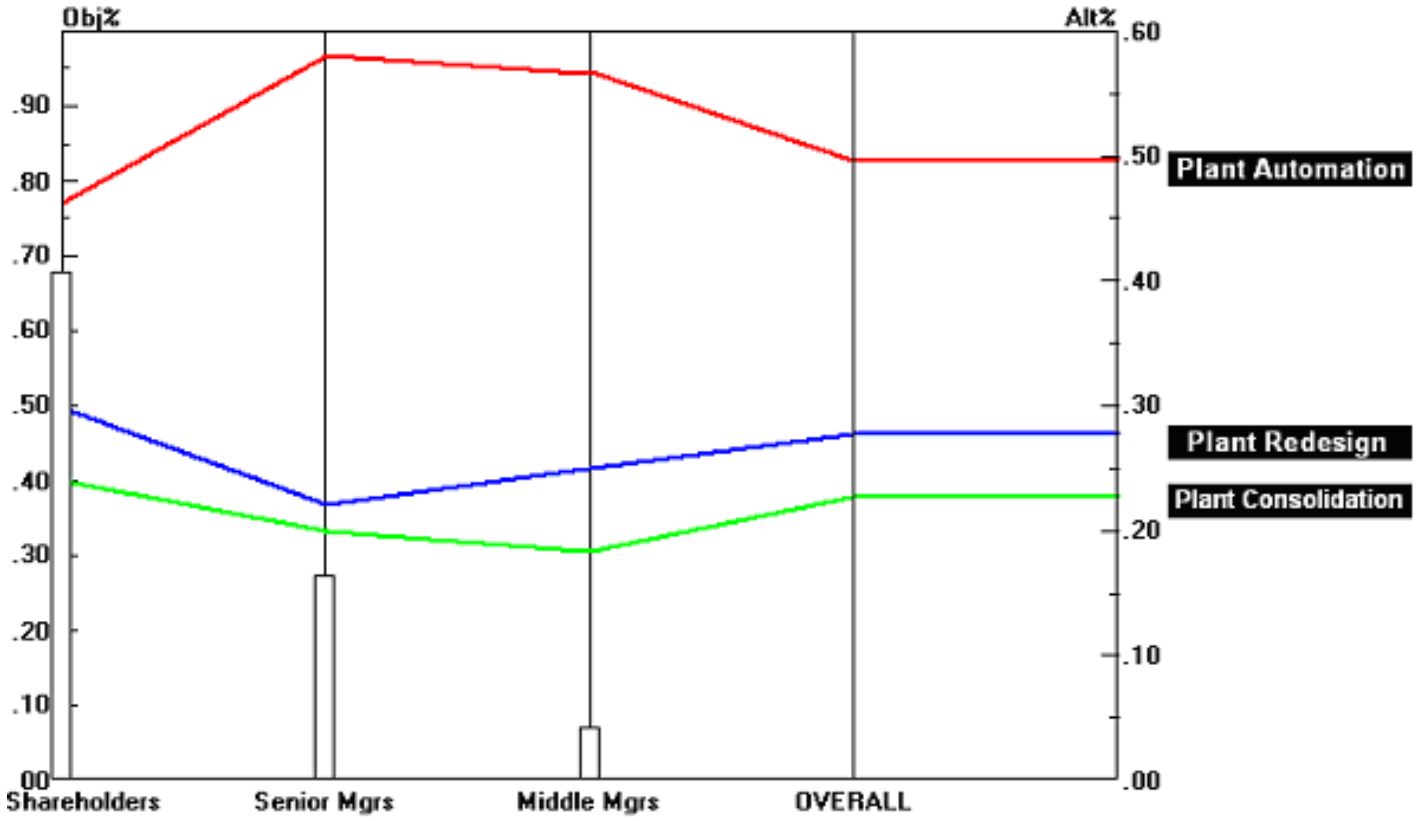

Sensitivity analysis on the costs analysis

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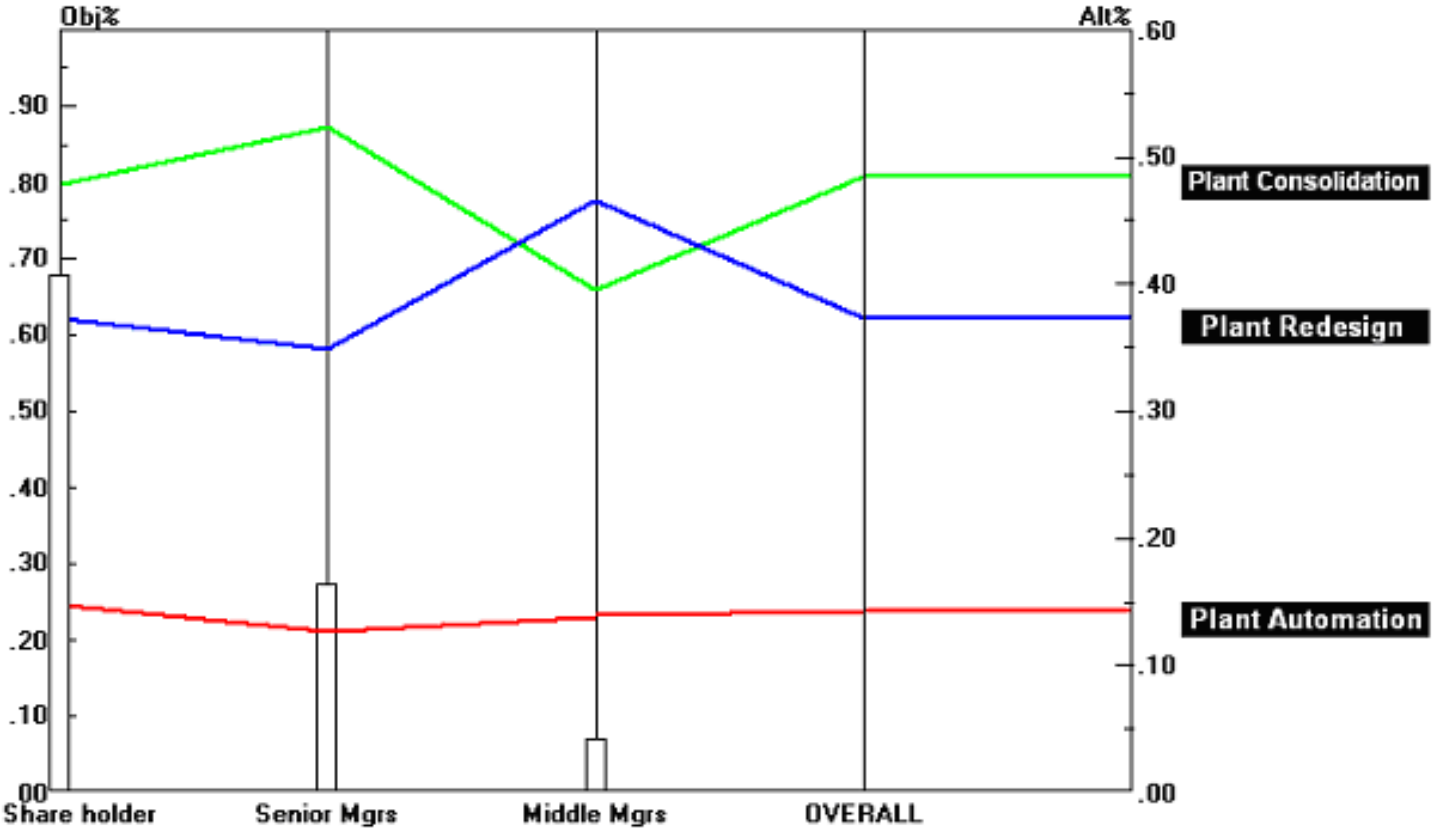
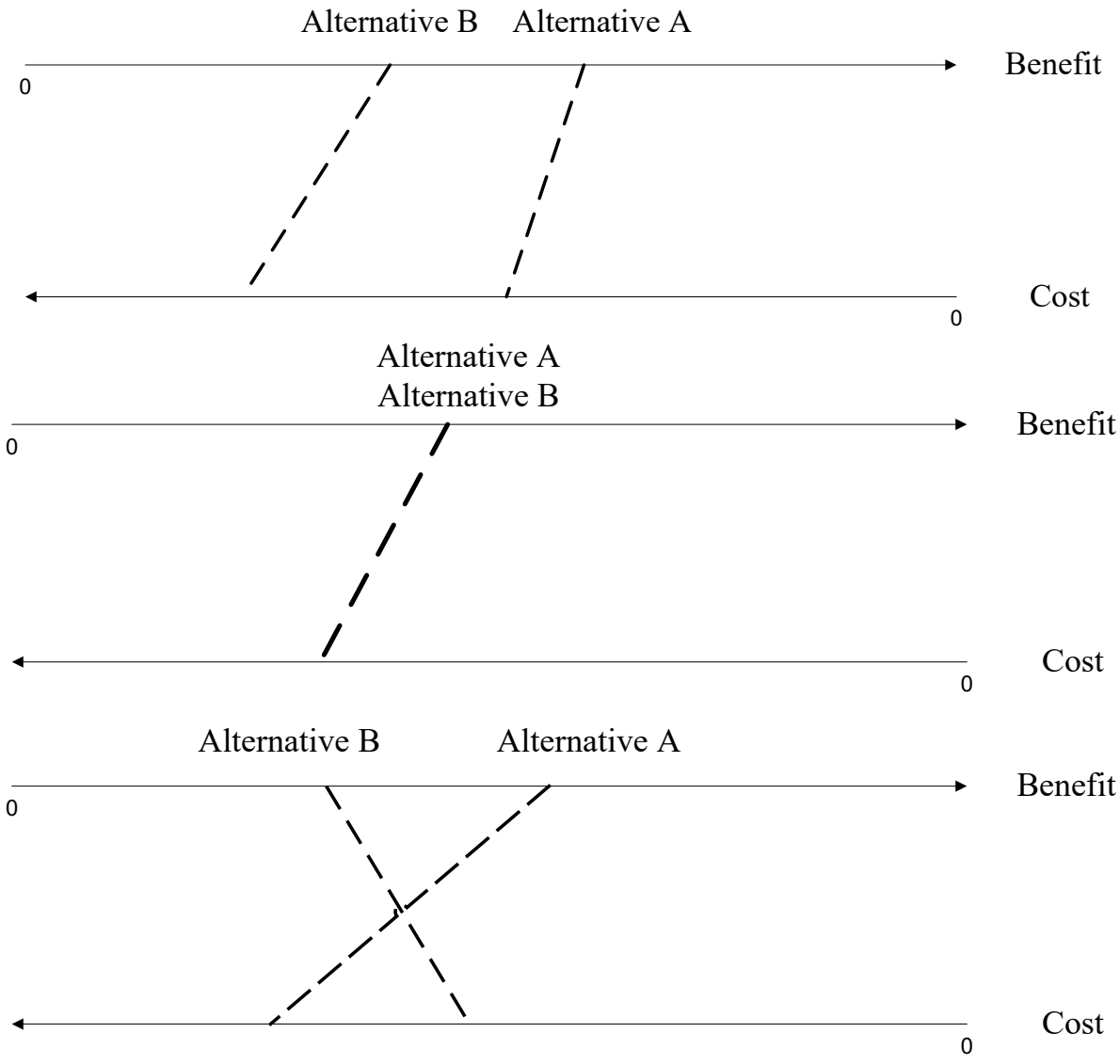
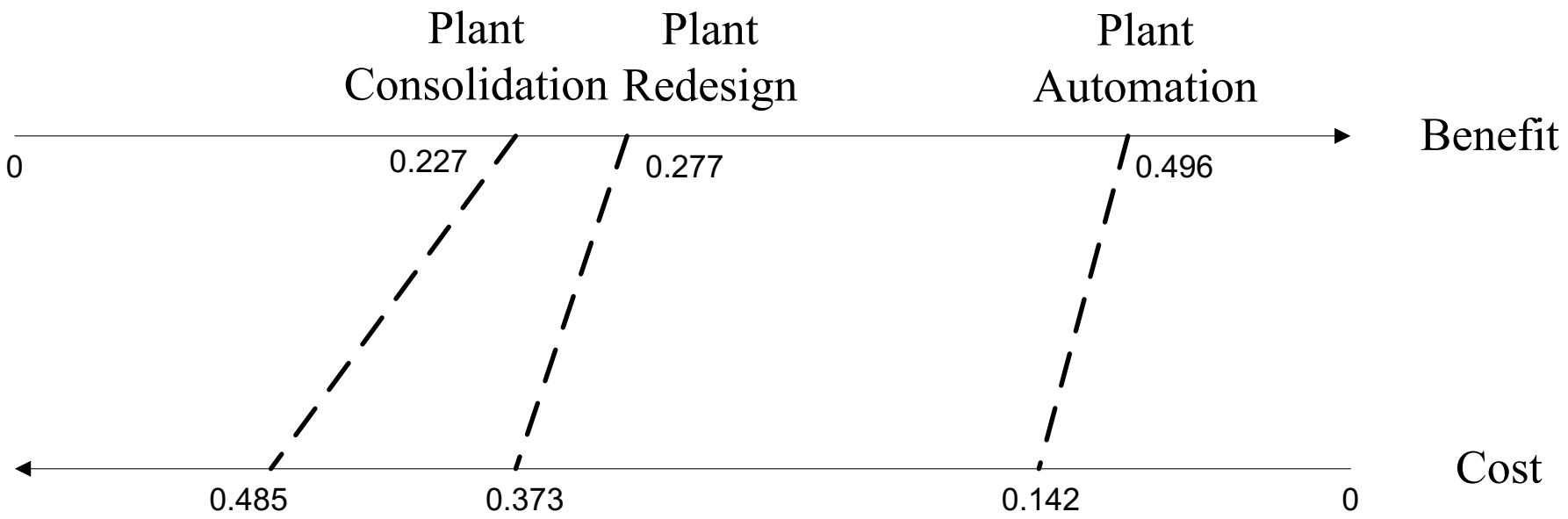


Graphical representation



- Preference
- Indifference
- Incomparability

Graphical representation of our case study



Conclusions

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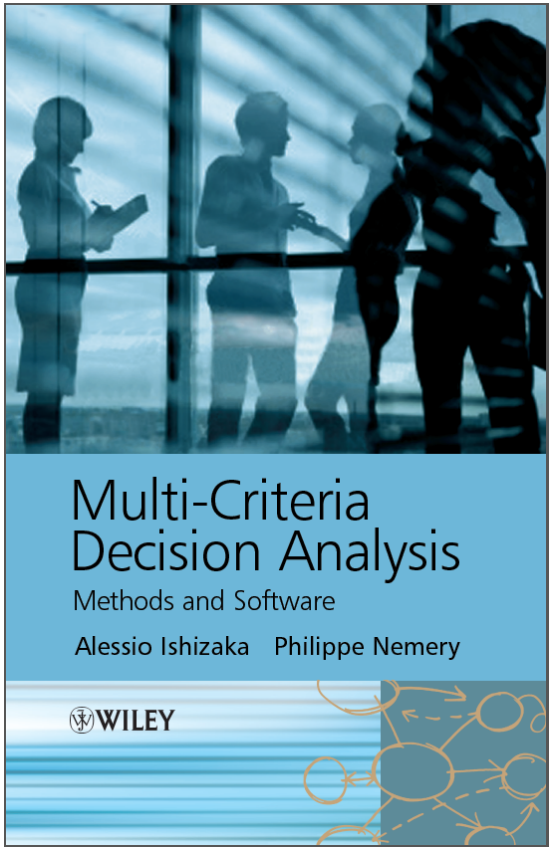
12. **Conclusions**

1. Significant reduction of time and effort in the decision process due to a structured methodology;
2. Easiness for the decision makers to arrive at a consensus, because the hierarchy model brings a common reference, which can be debated;
3. Enhancement of the decision quality, due to the consistency check and sensitivity analysis embedded in the AHP method;
4. Documentation and justification of the decision made.

Thanks for your attention

Questions?



Prof Alessio Ishizaka
NEOMA Business School
1 rue du Maréchal Juin
76130 Mont-Saint-Aignan

Alessio.Ishizaka@neoma-bs.fr