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Availability of enterprise IT systems – an expert-based Bayesian model

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Agenda

- [x] Who?
- [ ] What?
- [ ] Why?
- [ ] How?

AVAILABILITY OF ENTERPRISE IT SYSTEMS – WHAT?

Availability of enterprise IT systems – an expert-based Bayesian model

- A Bayesian decision support model, designed to help enterprise IT systems decision makers evaluate the consequences of their decisions by analyzing various scenarios
- The model is based on expert elicitation from 50 academic experts on IT systems availability, obtained through an electronic survey
- The Bayesian model uses a leaky Noisy-OR method to weigh together the expert opinions on 16 factors affecting systems availability

AVAILABILITY OF ENTERPRISE IT SYSTEMS – WHY?

Costs of downtime

Industry	Business operation	Average cost per hour of downtime	Average cost per hour of downtime (2009 $)
Financial	Brokerage operations	$6.5 million	$8.6 million
Financial	Credit card/sales authorization	$2.6 million	$3.4 million
Media	Pay-per-viewtelevision	$1.1 million	$1.45 million
Retail	Home shopping (TV)	$113.0 thousand	$149 thousand
Retail	Home catalog sales	$90.0 thousand	$118.5 thousand
Transportation	Airline reservations	$89.5 thousand	$118 thousand

IBM Global Services, 1998
U.S. Bureau of Labor Statistics

Importance of high availability

- Nordic and Baltic stock market crash
  - Closed down for 5 hours on June 4 2008
  - The outage prevented transactions worth approximatively €2 billion
- System quality survey
  - 178 enterprise IT system executives from Germany and Sweden
  - Future prioritization based on ISO-9126
  - 48.9% gave availability the highest mark

An expert-based Bayesian availability model

- Many factors determine the availability of enterprise IT systems
- A lot has been written and proposed, but the ”high availability” literature is rarely based on actual studies
- The area spans many disciplines, from Markovian reliability models to IT governance

AVAILABILITY OF ENTERPRISE IT SYSTEMS – HOW?

The process of model creation

- Identify factors in the literature
- Identify experts based on academic publications
- Create a suitable expert elicitation survey
- Invite the experts, stir, and wait
- Extract the numbers, and voilà!

The Availability Index

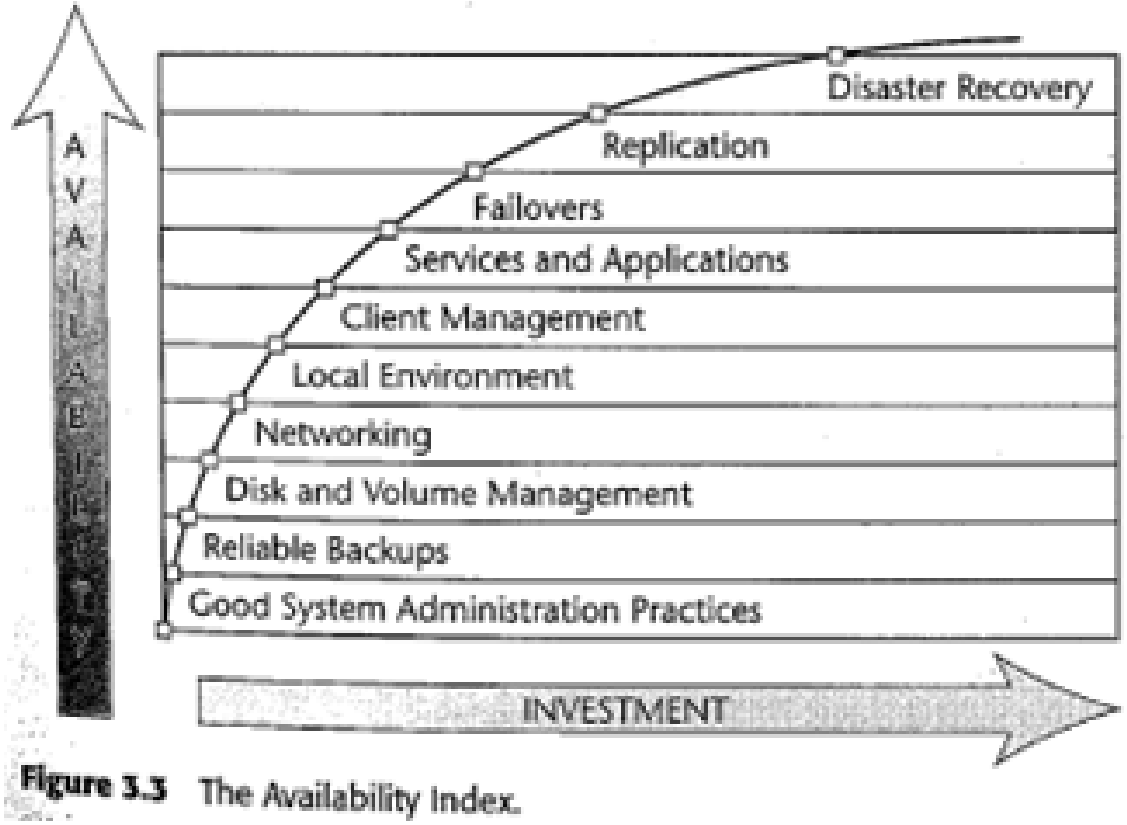


Figure 3.3 The Availability Index.

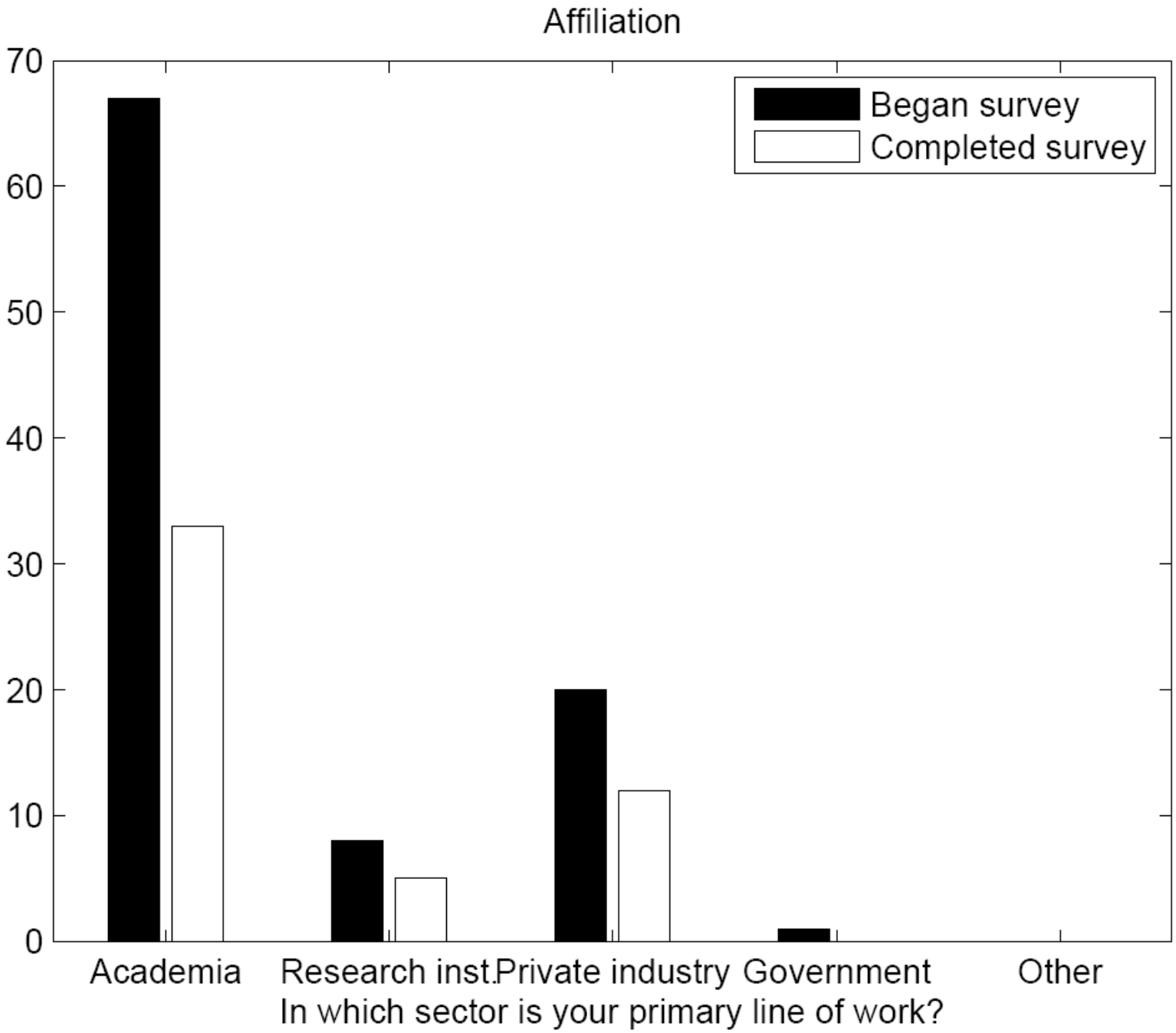
Marcus & Stern, 2003

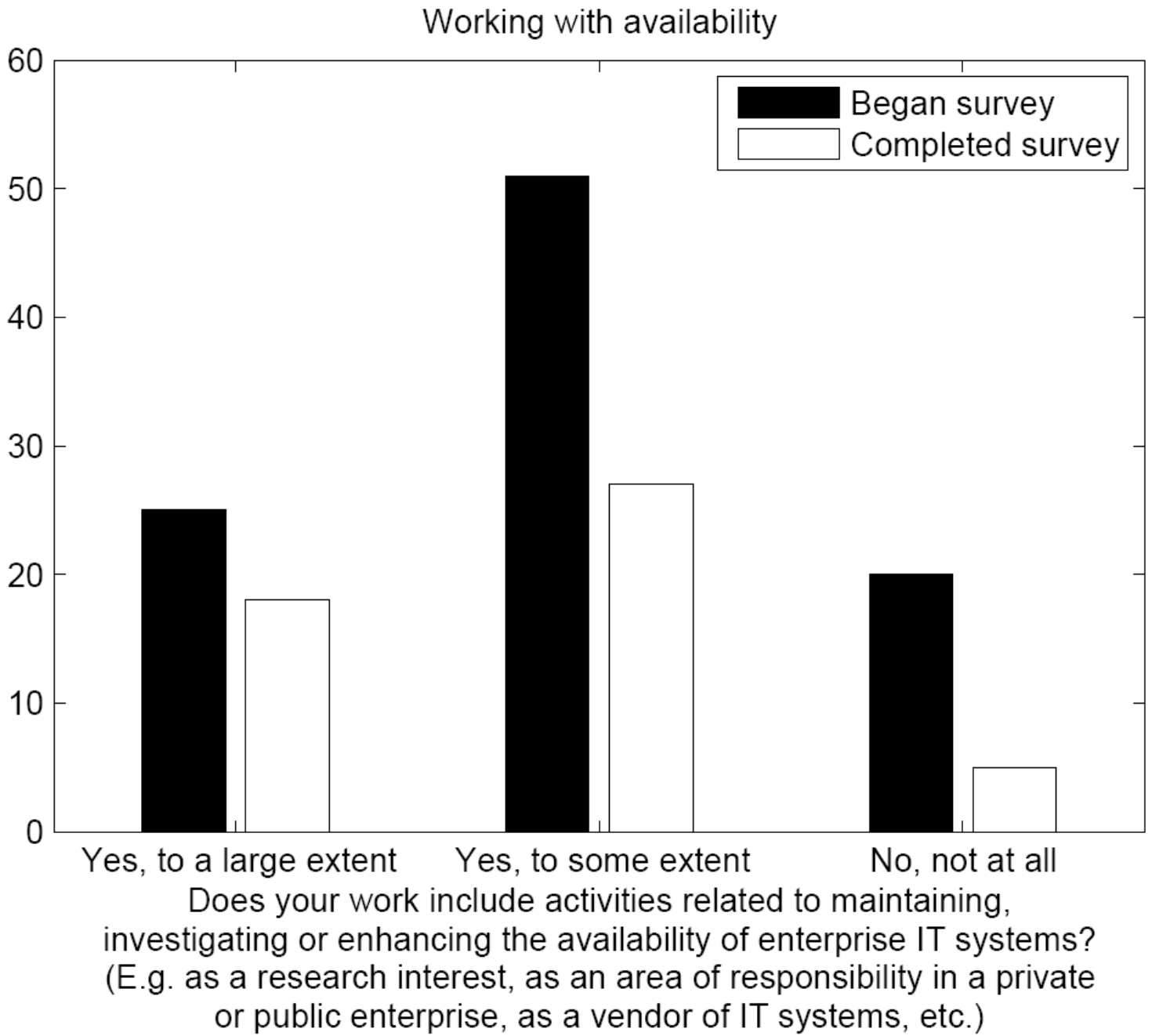
Expert elicitation

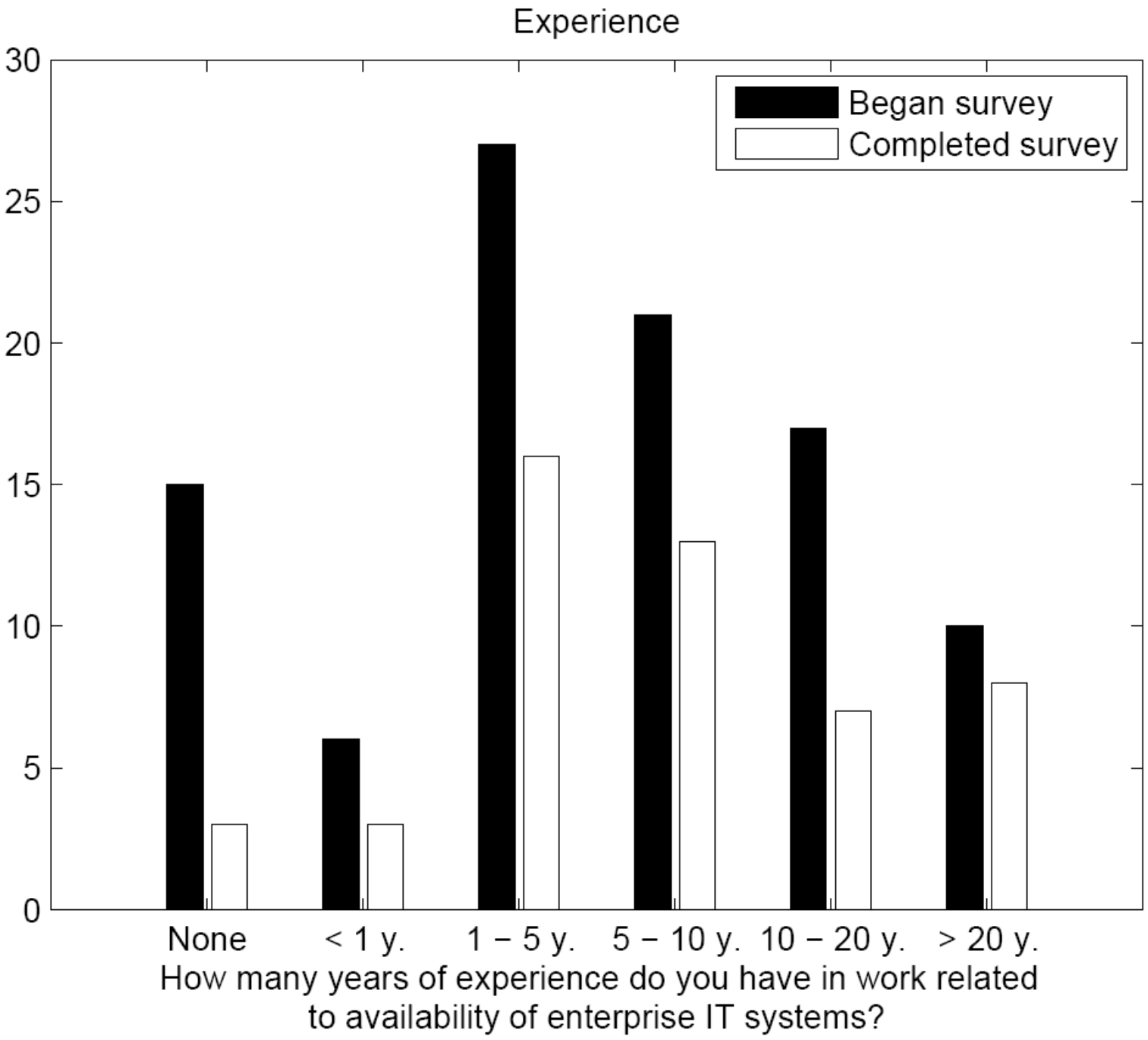
- Select and motivate the experts
- Train the expert
- Structure the questions
- Elicit and document the experts judgments
- Verify the results

The experts

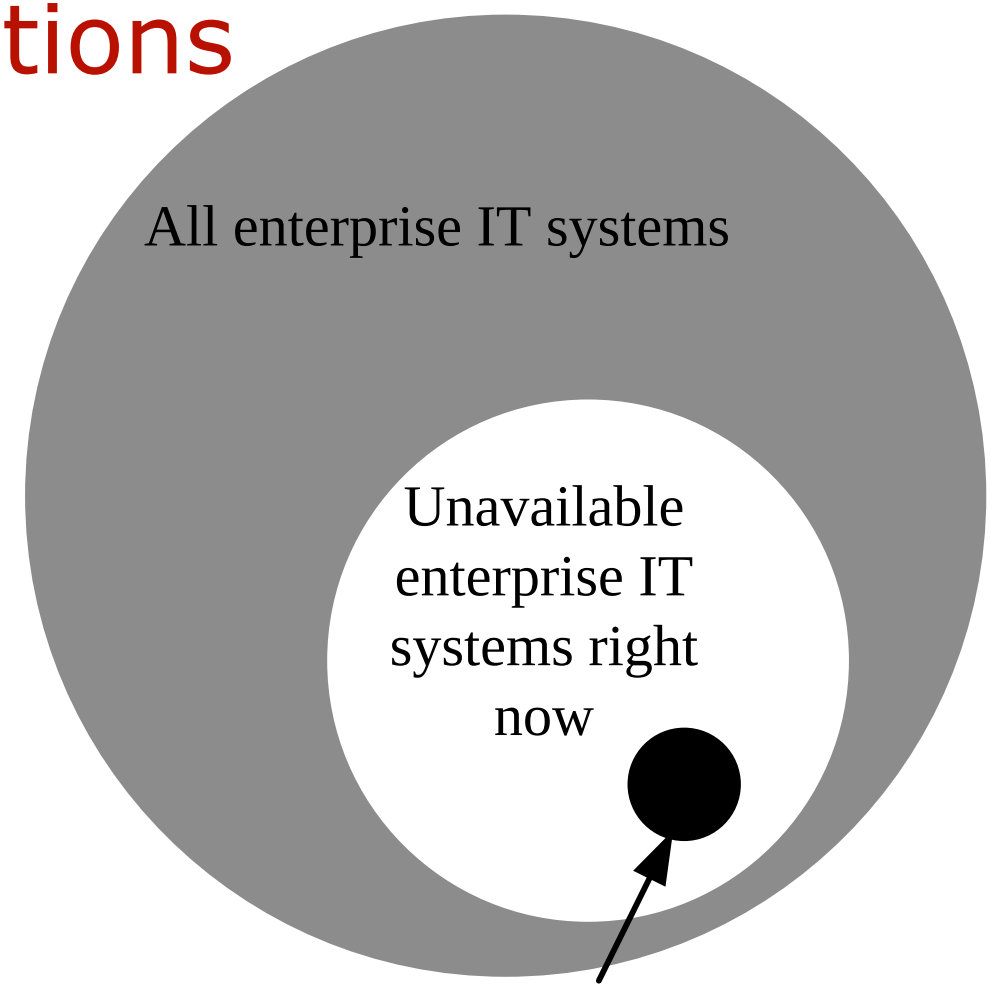
- Search performed in publishing, societies and indexing databases
- Search criteria involved combinations of topic-words
- Publications from 1999
  - 154 authors from journal articles
  - 298 authors from conference articles
  - 11 authors from edited volumes


Affiliation
70
60
50
40
30
20
10
0
Began survey
Completed survey
Academia
Research inst.
Private industry
Government
Other
In which sector is your primary line of work?


Working with availability
60
50
40
30
20
10
0
Began survey
Completed survey
Yes, to a large extent
Yes, to some extent
No, not at all
Does your work include activities related to maintaining, investigating or enhancing the availability of enterprise IT systems? (E.g. as a research interest, as an area of responsibility in a private or public enterprise, as a vendor of IT systems, etc.)


Experience
Began survey
Completed survey
30
25
20
15
10
5
0
None
< 1 y.
1 – 5 y.
5 – 10 y.
10 – 20 y.
> 20 y.
How many years of experience do you have in work related to availability of enterprise IT systems?

Questions



Enterprise IT systems that are unavailable, but would be available if a best practice factor *X* had been present

Questions

- Includes 16 causal factors X

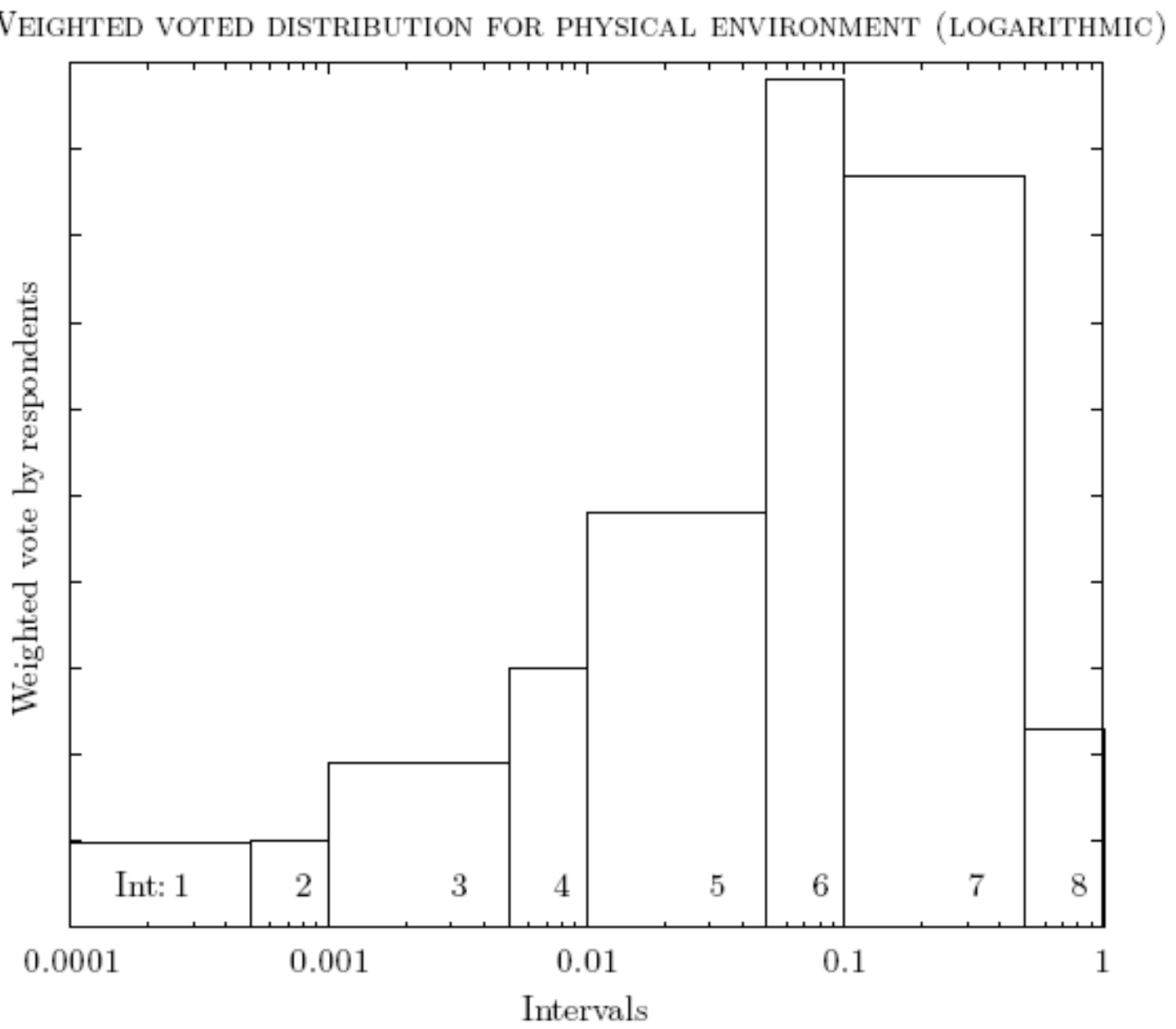
”How large a share of currently unavailable enterprise IT systems would you guess would be available if a best practice factor X had been present?”

The results

		How large a share of currently unavailable enterprise IT systems would you guess would be available if a best practice *factor X* had been present?								
	Causal factor X	$< 0,05\%$	$0,05\%-0,1\%$	$0,1\%-0,5\%$	$0,5\%-1\%$	$1\%-5\%$	$5\%-10\%$	$10\%-50\%$	$> 50\%$	N
1	Physical environment	1	2	3	5	8	18	14	3	54
2	Requirements and procurement	1	1	1	2	10	11	16	5	47
3	Operations	1	0	0	1	6	16	19	5	48
4	Change control	0	1	1	2	7	13	17	8	49
5	Technical solution of backup	2	3	1	6	9	15	5	3	44
6	Process solution of backup	0	2	4	6	12	10	9	0	43
7	Data redundancy	0	2	4	6	8	11	9	4	44
8	Storage architecture redundancy	0	3	3	8	15	6	4	1	40
9	astructure redundancy	1	3	3	8	12	7	5	3	42
10	Avoidance of internal application failures	0	4	3	2	7	12	15	2	45
11	Avoidance of external services that fail	2	1	0	5	4	15	12	4	43
12	Network redundancy	0	4	1	4	11	13	9	2	44
13	Avoidance of network failures	0	5	1	5	9	9	11	2	42
14	Physical location	2	0	7	7	11	8	3	2	40
15	Resilient client/server solutions	1	1	2	5	9	9	6	3	36
16	Monitoring of the relevant components	0	2	1	4	13	6	14	3	43

Weighted vote *w*

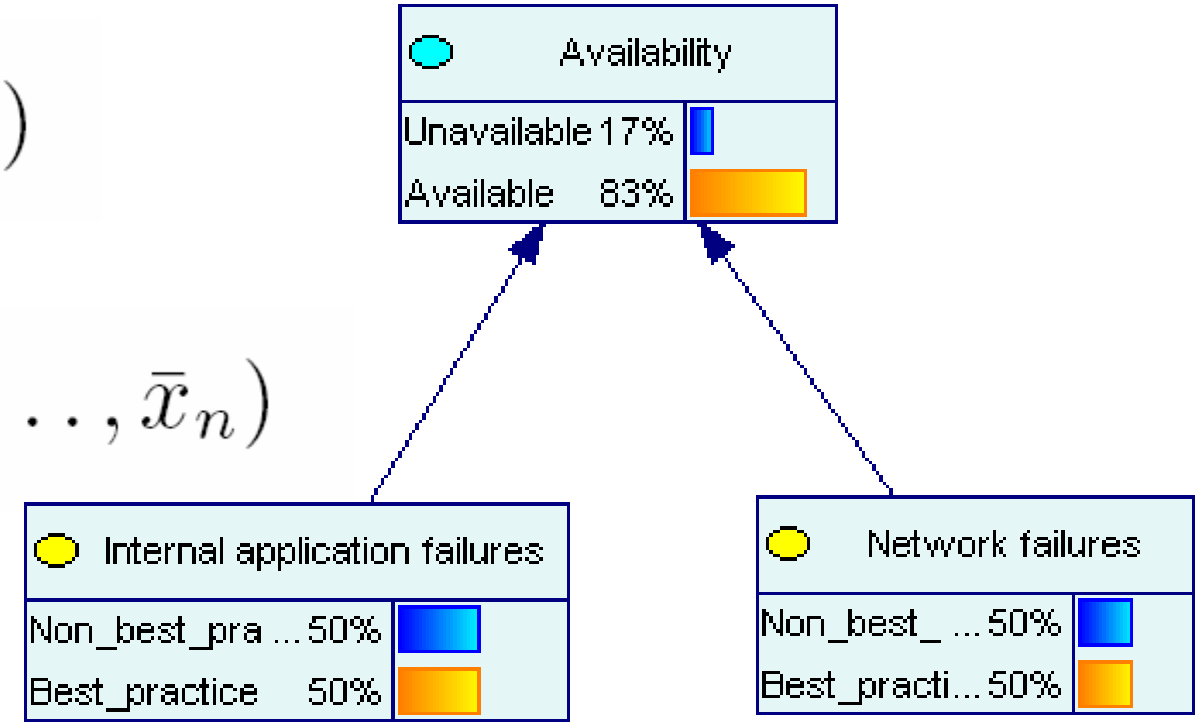
Physical environment	50% (I think so.)	90% (I am quite sure.)	99% (I am almost completely certain.)	Weighted vote w
$< 0,05\%$	0	0	1	0.99
$0,05\% - 0,1\%$	2	0	0	1
$0,1\% - 0,5\%$	2	1	0	1.9
$0,5\% - 1\%$	4	0	1	2.99
$1\% - 5\%$	6	2	0	4.8
$5\% - 10\%$	16	2	0	9.8
$10\% - 50\%$	10	3	1	8.69
$> 50\%$	1	2	0	2.3


Weighted voted distribution for physical environment (logarithmic)
Weighted vote by respondents
Int: 1
2
3
4
5
6
7
8
0.0001
0.001
0.01
0.1
1
Intervals

The leaky Noisy-OR model

$$p_0 = P(y|\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_n)$$

$$p_i = P(y|\bar{x}_1, \bar{x}_2, \ldots, x_i, \ldots, \bar{x}_n)$$

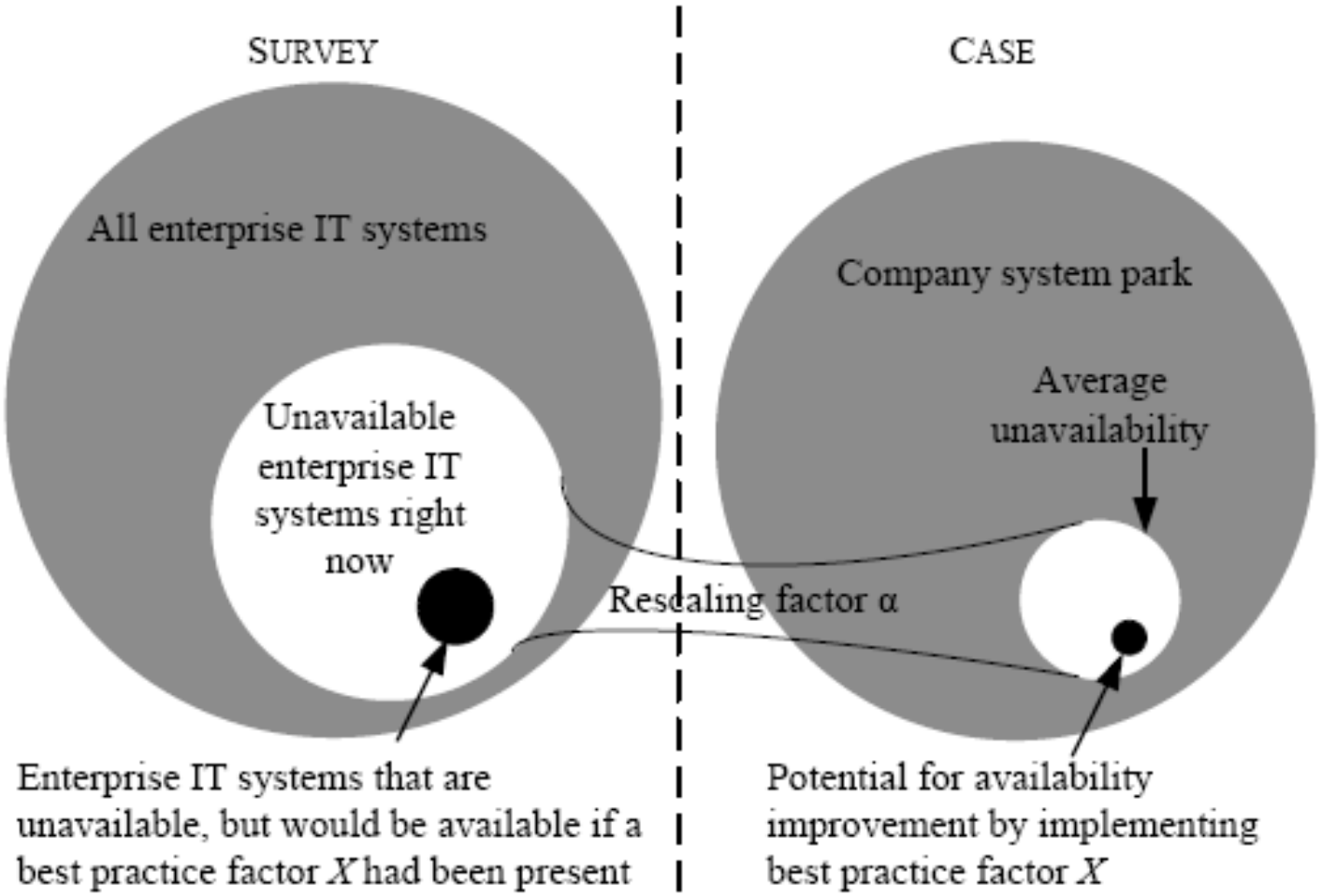


$$P(y|\mathbf{X}_p) = 1 - (1 - p_0) \prod_{i:X_i \in \mathbf{X}_p} \frac{(1 - p_i)}{(1 - p_0)}$$

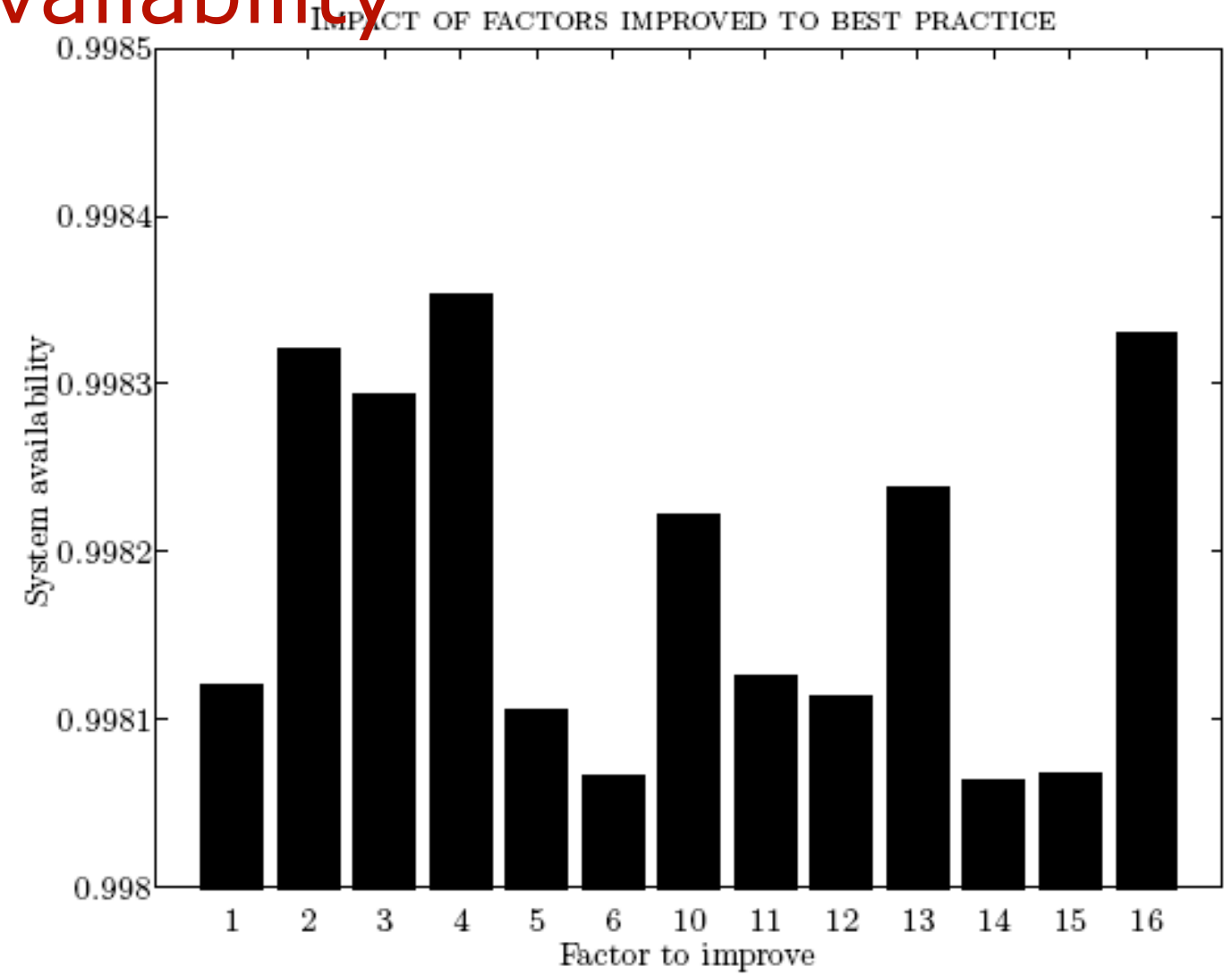
The leaky Noisy-OR model

	Causal factor X_i Lack of best practice ...	p_i
1	... physical environment	8.2%
2	... requirements and procurement	25.2%
3	... operations	23.0%
4	... change control	28.1%
5	... technical solution of backup	7.0%
6	... process solution of backup	3.6%
7	... data redundancy	7.8%
8	... storage architecture redundancy	2.8%
9	... infrastructure redundancy	2.9%
10	... avoidance of internal application failures	16.9%
11	... avoidance of external services that fail	8.7%
12	... network redundancy	7.6%
13	... avoidance of network failures	18.3%
14	... physical location	3.3%
15	... resilient client/server solutions	3.6%
16	... monitoring of the relevant components	26.1%

Rescaling for case-based assessment



Improvement from 99.8% availability



Thank you!

Questions

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