UNIVERSITEIT GENT

FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

CLASSIFICATION OF RISK ANALYSIS AND PROJECT CONTROL PERFORMANCE ON EMPIRICAL PROJECT DATA

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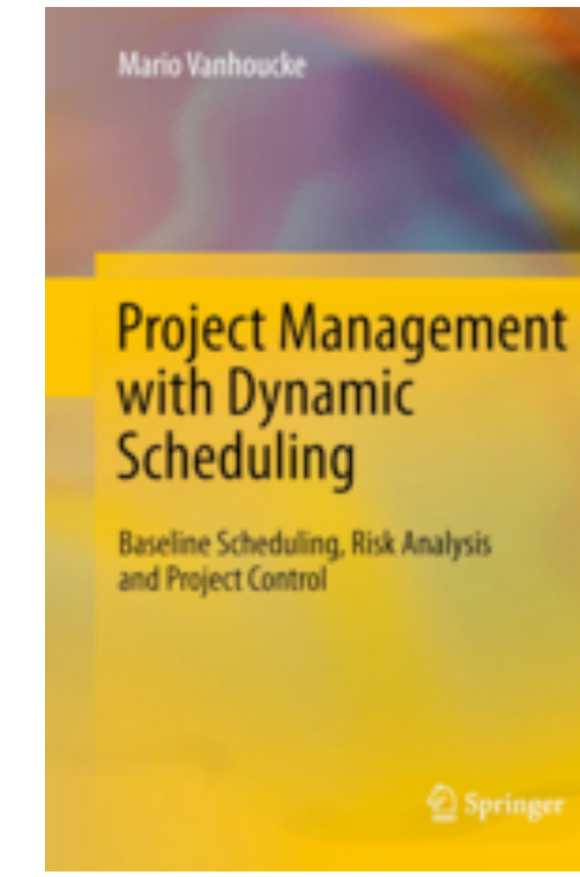
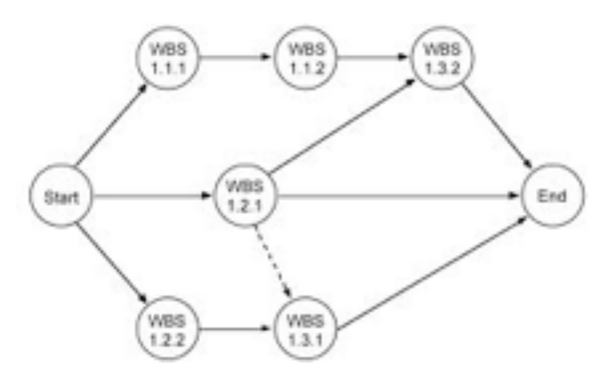
Supervised by prof. dr. Mario Vanhoucke

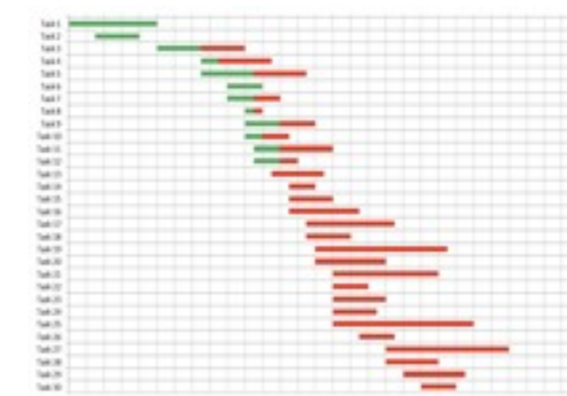
SITUATING THE RESEARCH

Integrated Project Management and Control

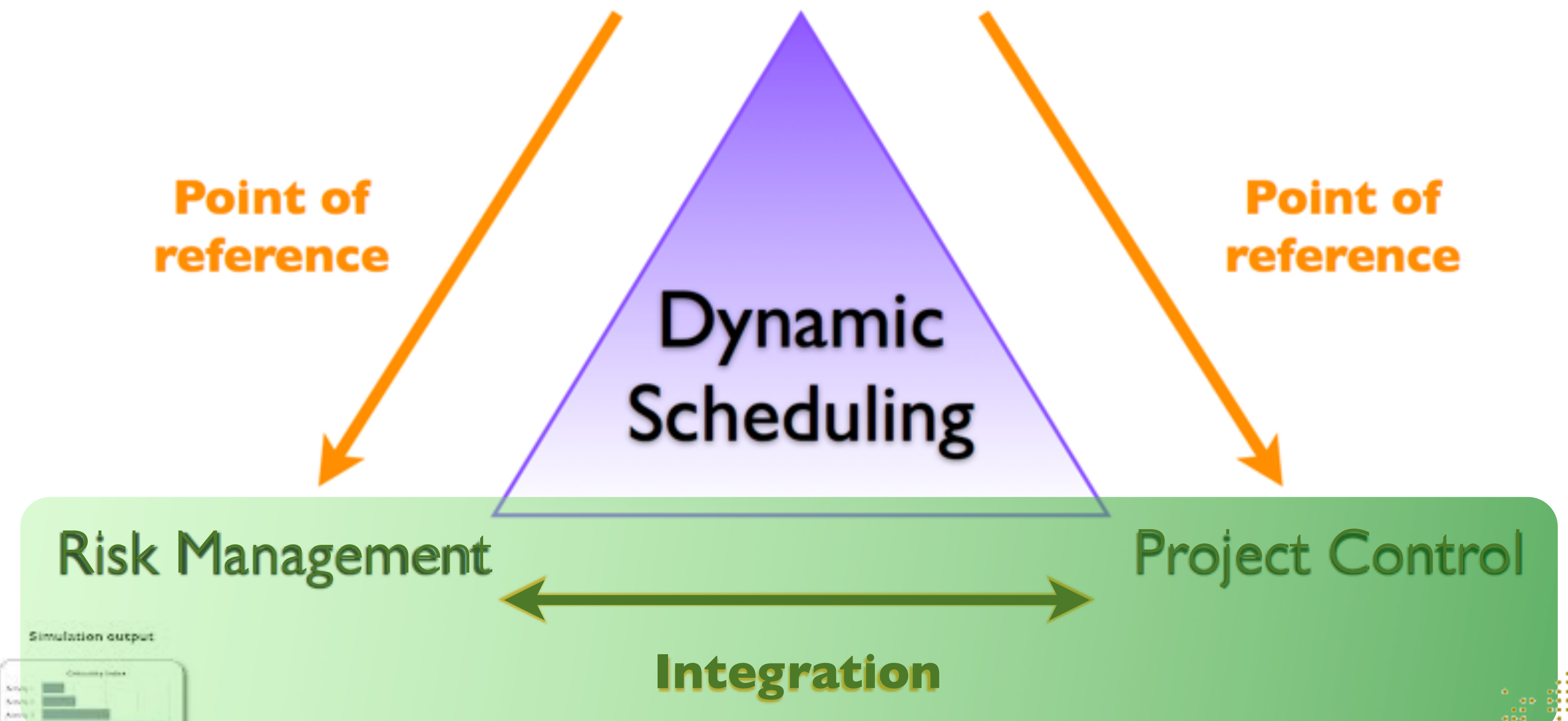
(Vanhoucke, 2012)



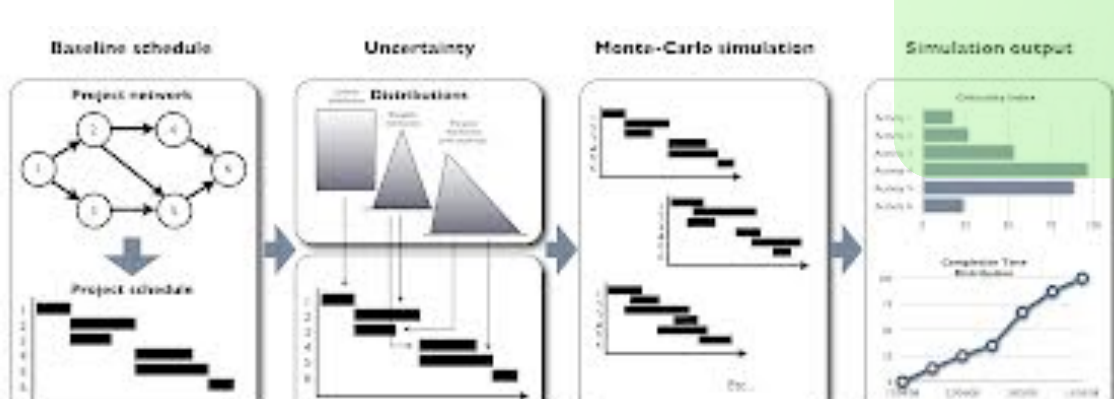




Baseline Scheduling



SRA



DATABASE CONSTRUCTION

Goal Create the **largest** and **most diverse** **real-life** project database in project management literature

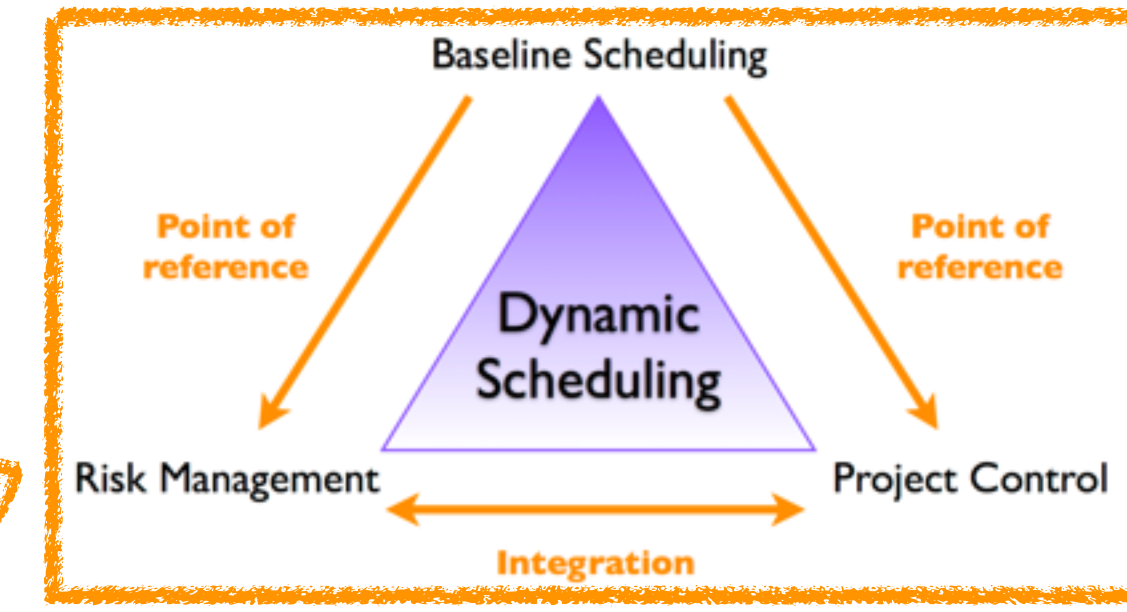
➡ *real* project data needed (⟷ generated/simulated projects)

➡ selecting the best case studies received by our department (group works, master dissertations, ...)

➡ structuring the project data in **project cards**

= tool for categorizing, evaluating and acquiring project data

PROJECT CARD



	Case Name: **Claeys-Verhelst Premises**	Sector	Construction (Commercial Building)	
	OR-AS Operations Research - Applications and Solutions www.or-as.be info@or-as.be	Baseline Schedule	Schedule with resources	
			Schedule with costs	
		Risk Analysis	Random simulation	
			One of nine std. scenarios	
Submitted by	Laura Demevere		User defined distributions	
Date	December 23, 2011	Project Control	Automatic tracking	
File Name	C2011-13 Claeys-Verhelst Premises.p2x		Tracking based on user input	

Baseline Schedule
Risk Analysis
Project Control

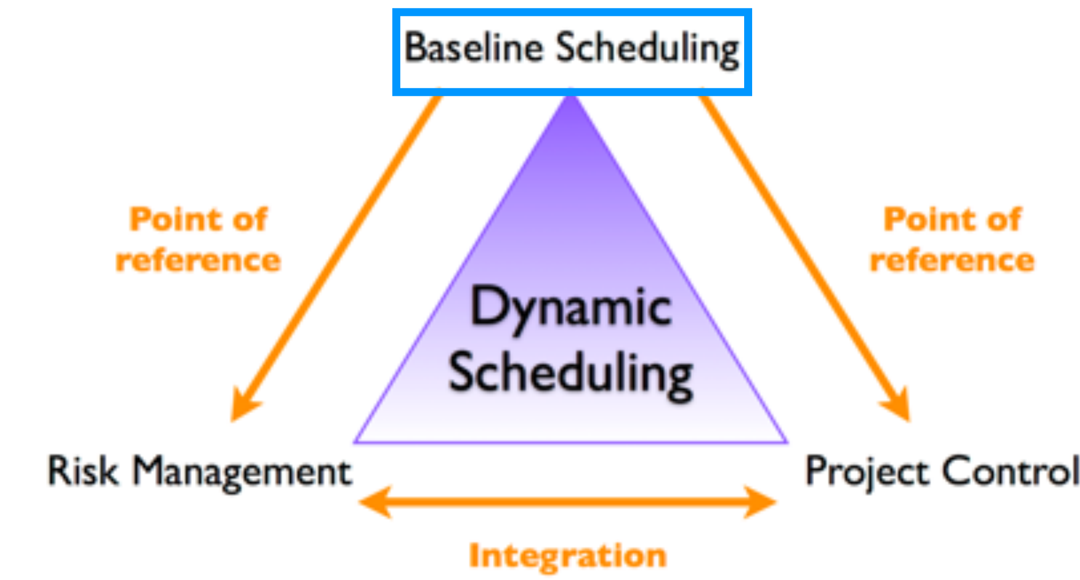
1. Project description

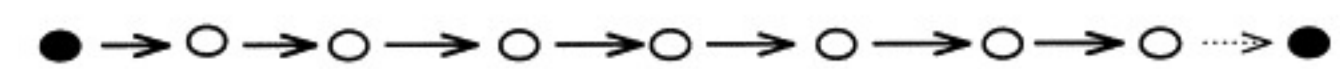
Project authenticity

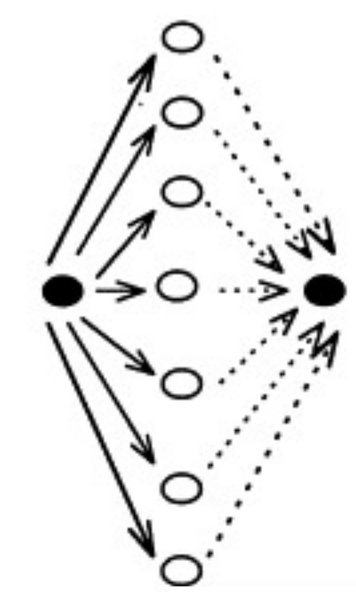
The expansion of the company premises of sanitary specialist Claeys-Verhelst, located in Oudenburg (Belgium), through the construction of a new three-floor building harboring a warehouse, office space, a small showroom and recreational facilities for the employees.

The project consists of activity, resource and cost data that were obtained directly from the actual project owner.

PROJECT CARD



serial  SP = 100%

parallel  SP = 0%

2. Project properties

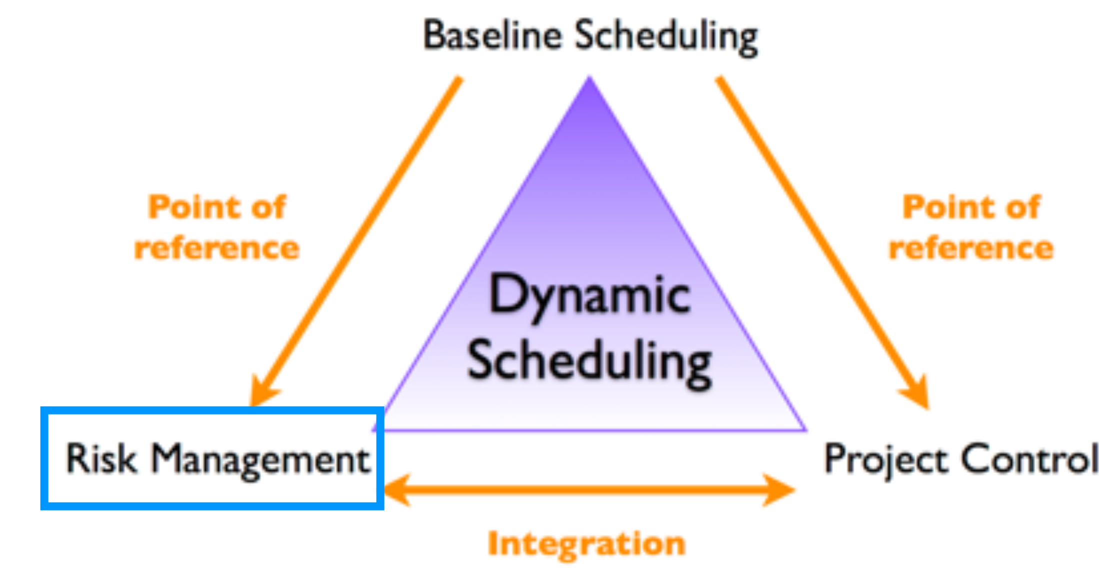
2.1. Baseline Schedule

General	
# Activities	49
Planned Duration (PD)	442 days*
Budget At Completion (BAC)	3,027,133 €
Renewable Resources	12
Consumable Resources	-

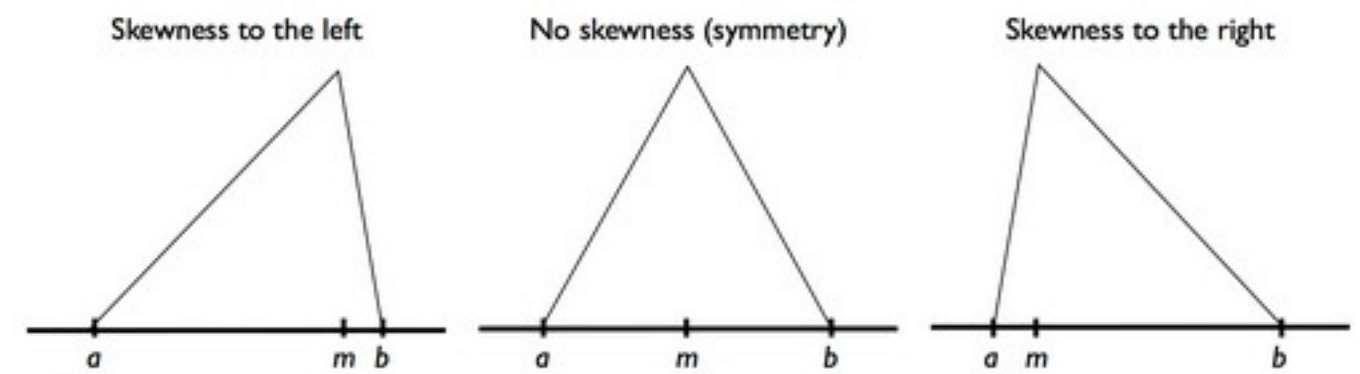
* standard eight-hour working days

Network topology	
Serial/Parallel (SP)	41%
Activity Distribution (AD)	50%
Length of Arcs (LA)	5%
Topological Float (TF)	43%

PROJECT CARD



2.2. Risk Analysis



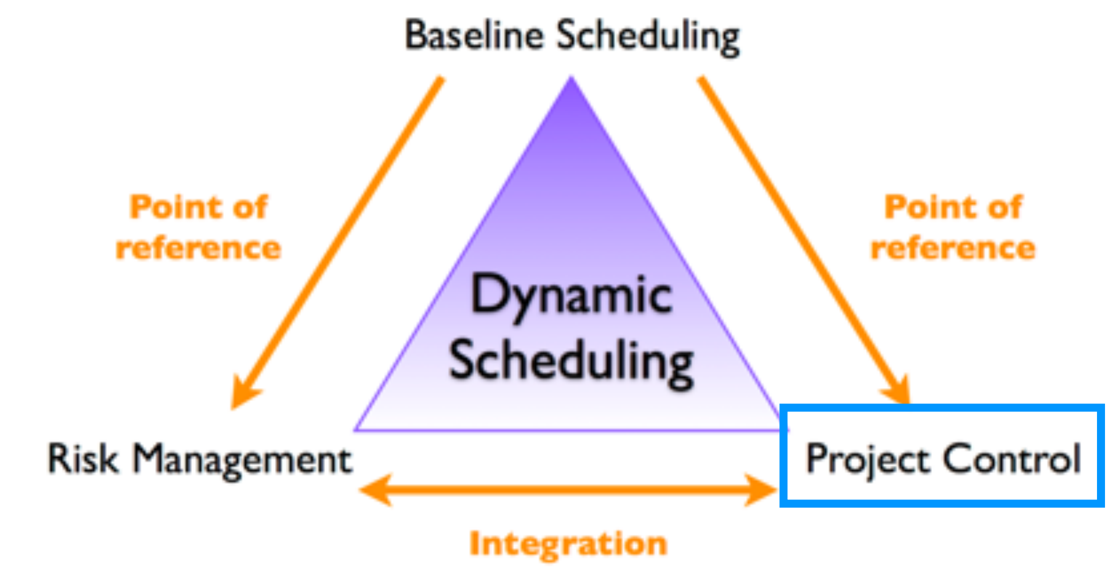
Use of many different non-standard triangular distribution profiles inputted by the user (mostly skewed), complemented by some predefined symmetrical, skewed and risk-free distributions.

	Cost sensitivity		
	avg [%]	std dev [%]	skew [-]
CRI-r	7.7	13.2	2.5
CRI-rho	35.2	18.8	-0.6
CRI-tau	61.6	43.3	-0.3

	Resource sensitivity		
	avg [%]	std dev [%]	skew [-]
CRI-r	17.9	22.4	1.3
CRI-rho	34.0	20.8	-0.3
CRI-tau	44.6	41.2	0.5

	Time sensitivity		
	avg [%]	std dev [%]	skew [-]
CI	17.0	28.0	1.8
SI	42.9	29.2	0.4
SSI	3.5	8.8	3.2
CRI-r	6.6	10.4	2.6
CRI-rho	20.3	19.5	0.7
CRI-tau	33.0	41.4	1.0

PROJECT CARD



2.3. Project Control

2.3.1. Simulated forecasting accuracy

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A - F_t}{A}\right|$$

lower MAPE
= higher
accuracy

The accuracy of time and cost forecasting methods has been evaluated based on Monte Carlo simulation runs using the risk profiles described in section "2.2. Risk Analysis". Based on these risk profiles, the Mean Absolute Percentage Error (MAPE) and Mean Percentage Error (MPE) has been calculated to evaluate the expected accuracy of the time and cost predictions, EAC(t) and EAC, respectively.

Planned Value Method
(Anbari, 2003)

Earned Duration Method
(Jacob & Kane, 2004)

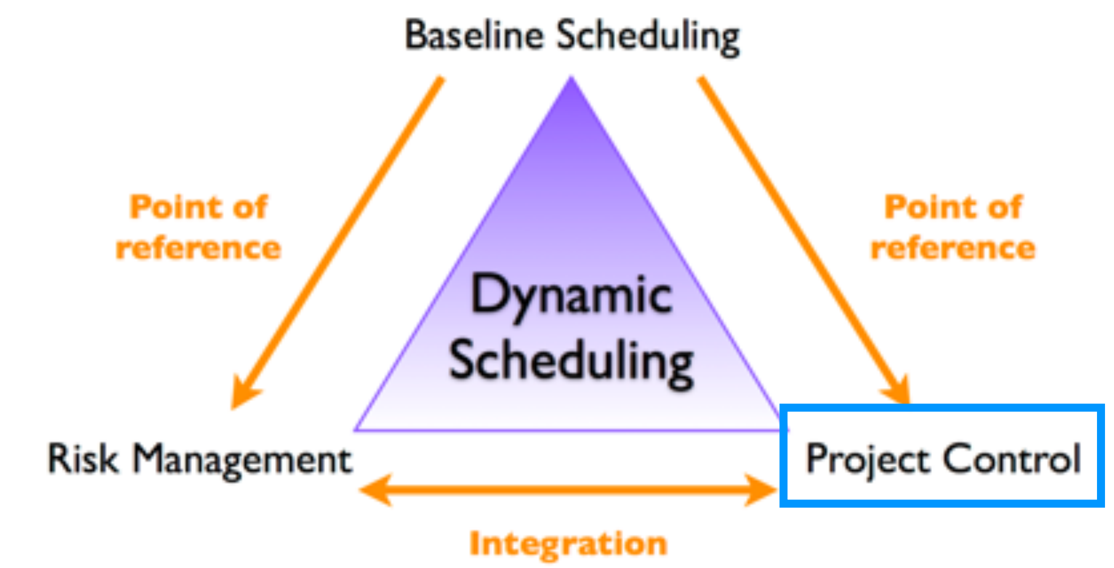
Earned Schedule Method
(Lipke, 2003)

Simulated EAC(t) accuracy		
method - PF	MAPE [%]	MPE [%]
PV - 1	4.9	3.0
PV - SPI	38.3	-29.2
PV - SCI	38.4	-29.3
ED - 1	9.7	6.0
ED - SPI	38.0	-29.5
ED - SCI	38.1	-29.6
ES - 1	3.5	1.9
ES - SPI(t)	18.7	-13.7
ES - SCI(t)	18.7	-13.7

Simulated EAC accuracy		
method (PF)	MAPE [%]	MPE [%]
1	0.7	0.6
CPI	0.7	0.6
SPI	36.1	-33.2
SPI(t)	18.6	-17.3
SCI	36.2	-33.2
SCI(t)	18.7	-17.3
0.8 CPI + 0.2 SPI	2.3	0.3
0.8 CPI + 0.2 SPI(t)	2.2	-1.3

According to the MAPE values[1] the best performance for time forecasting can be expected from the unweighted Earned Schedule method. For cost forecasting the unweighted and CPI-weighted methods should yield the best results.

PROJECT CARD



Tracking authenticity

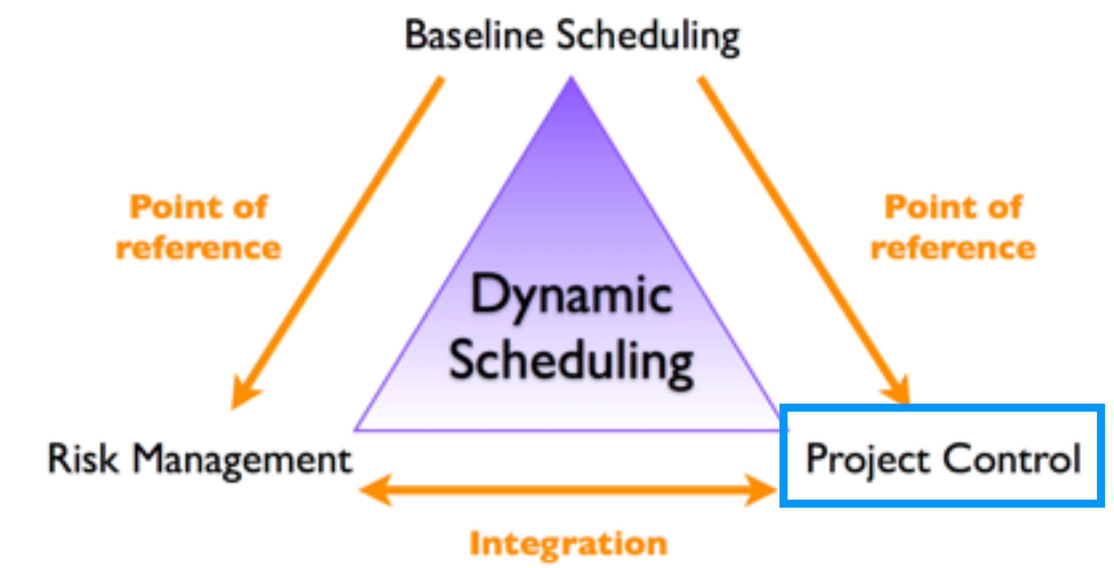
2.3.2. Tracking description

Manual tracking was performed over 8 tracking periods with irregular lengths varying from approximately one month to six months. The Real Duration and Real Cost mentioned in section "2.3.3. Earned Value Management" are based on manual user input.

The tracking information obtained from the project owner and introduced in ProTrack includes actual activity start dates and durations, but no actual activity costs.

www.protrack.be

PROJECT CARD

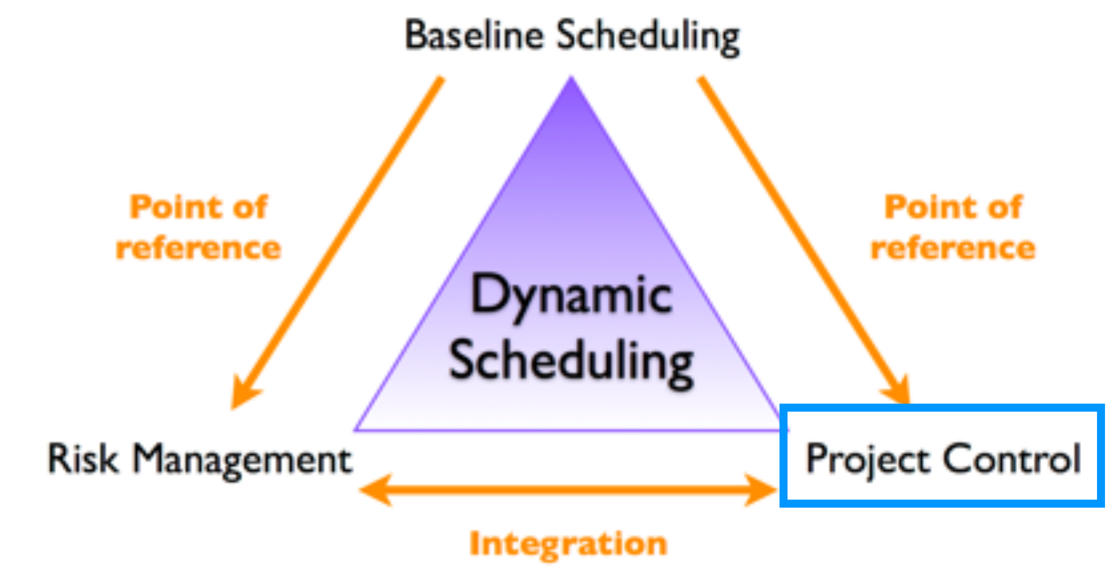


2.3.3. Earned Value Management

2.3.3.1. Performance metrics

	CV [€]	SV [€]	SV(t) [d]	CPI [-]	SPI [-]	SPI(t) [-]	p-factor [-]
avg	-51,705	-214,051	-22.20	0.96	0.82	0.92	1.00
std dev	30,253	240,842	14.86	0.03	0.23	0.07	0.00
final	-75,263	0	-12.00	0.98	1.00	0.97	1.00

PROJECT CARD



2.3.3.2. Time forecasting

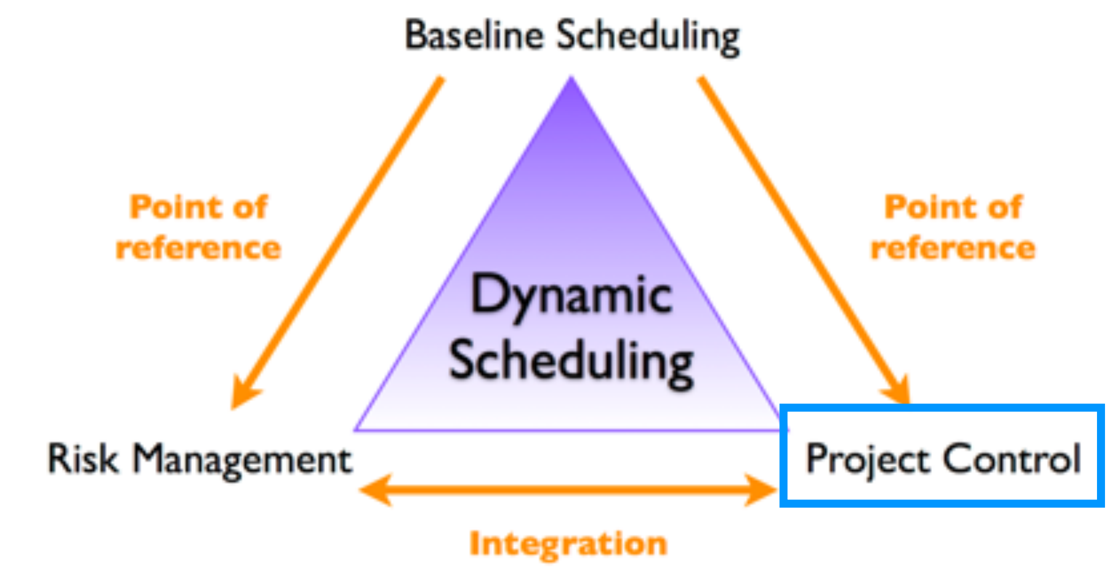
PD	442 days

Real Duration	454 days

Late	2.71%

EAC(t)			Real Accuracy	
method - PF	avg [d]	std dev [d]	MAPE [%]	MPE [%]
PV - 1	473.52	35.18	6.7	4.3
PV - SPI	624.66	295.86	39.9	37.6
PV - SCI	659.19	342.84	45.9	45.2
ED - 1	490.61	51.57	9.2	8.1
ED - SPI	627.47	294.16	39.2	38.2
ED - SCI	4649.98	336.28	44.2	43.2
ES - 1	464.52	14.90	3.0	2.3
ES - SPI(t)	484.11	38.61	7.3	6.6
ES - SCI(t)	493.09	50.47	9.3	8.6

PROJECT CARD



2.3.3.3. Cost forecasting

BAC	3,027,133 €	Real Cost	3,102,395 €	Over Budget	2.49%

EAC			Real Accuracy	
method (PF)	avg [€]	std dev [€]	MAPE [%]	MPE [%]
1	3,078,838	30,253	0.9	-0.8
CPI	3,152,058	100,643	2.3	1.6
SPI	4,113,269	1,842,501	33.2	32.6
SPI(t)	3,272,787	238,336	6.1	5.5
SCI	4,284,566	2,159,545	38.7	38.1
SCI(t)	3,361,159	356,377	9.0	8.3
0.8 CPI + 0.2 SPI	3,249,074	243,574	5.3	4.7
0.8 CPI + 0.2 SPI(t)	3,174,061	122,906	2.9	2.3

Project cards ➜ better overview

➜ easier categorization

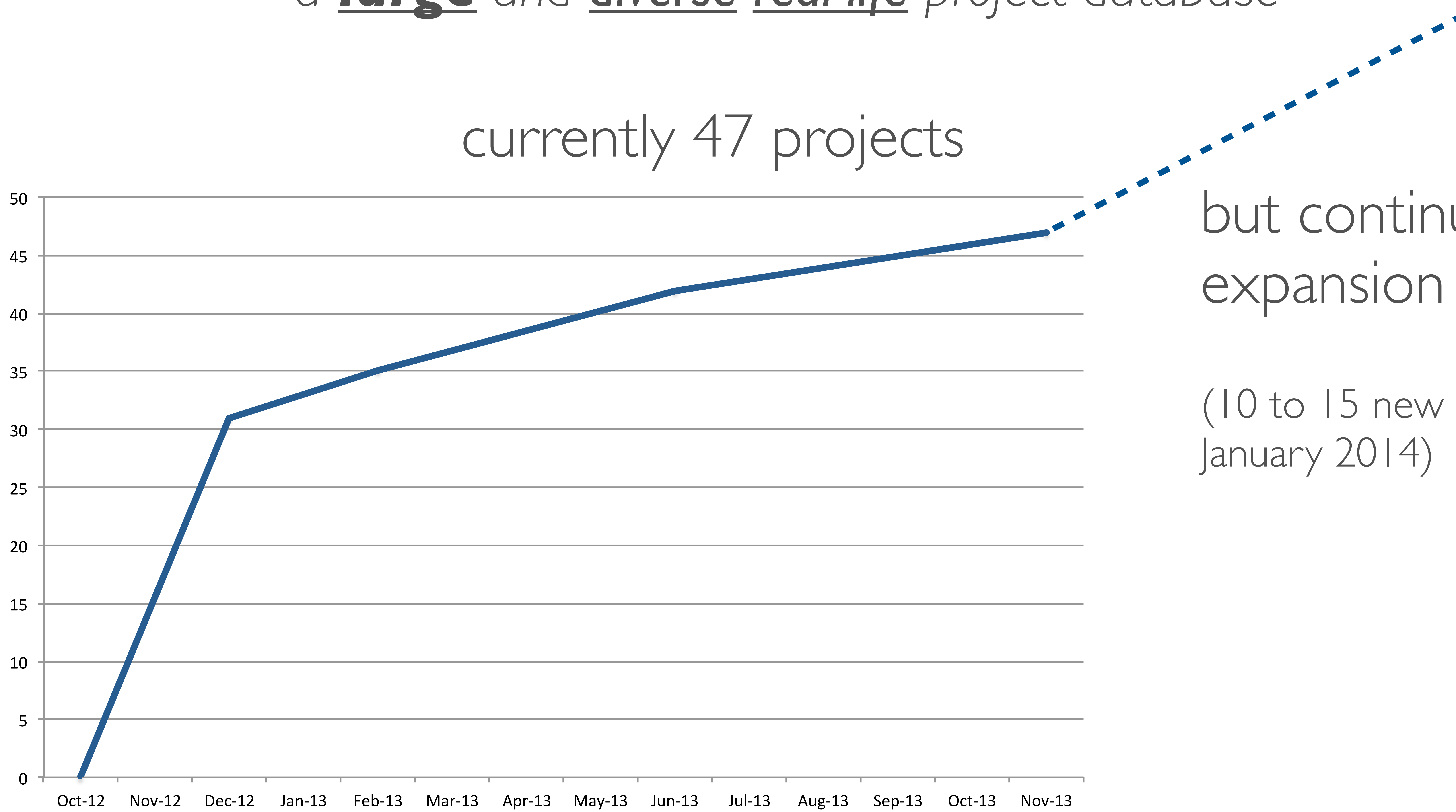
➜ **enable qualitative expansion of database**

PROJECT DATABASE

*a **large** and **diverse** **real-life** project database*

Size

currently 47 projects



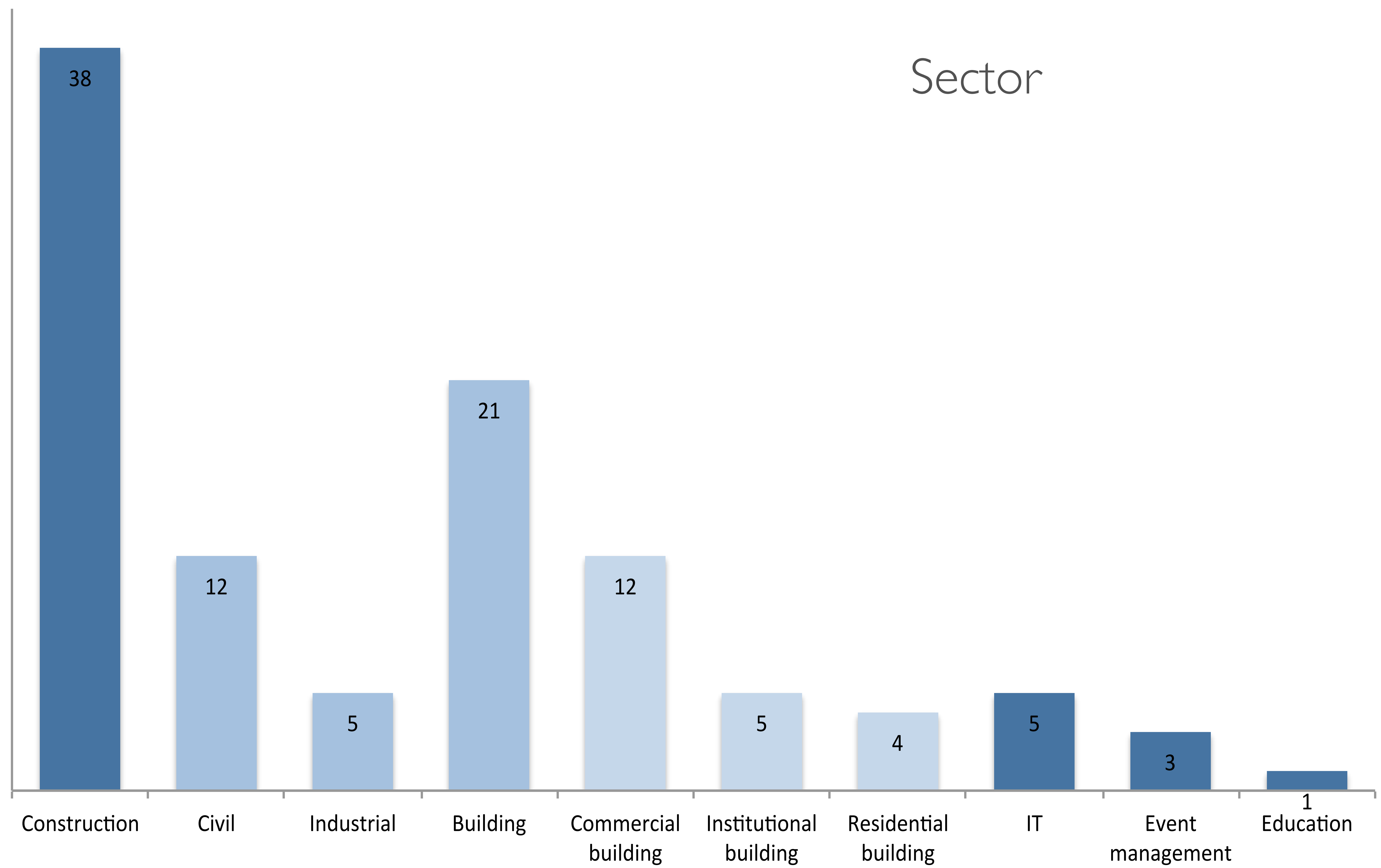
but continuous expansion

(10 to 15 new projects by January 2014)

PROJECT DATABASE

*a **large** and **diverse** **real-life** project database*

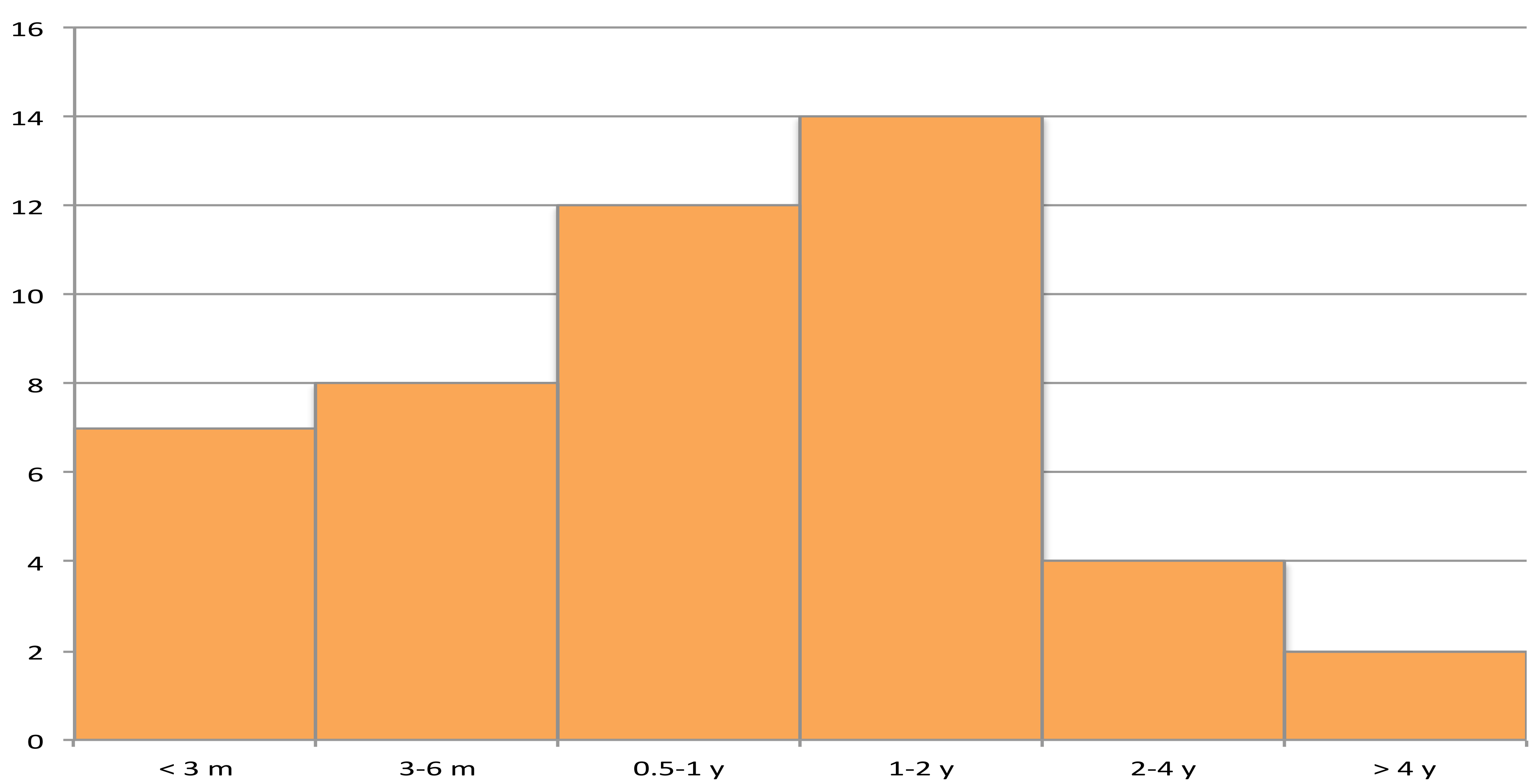
Diversity

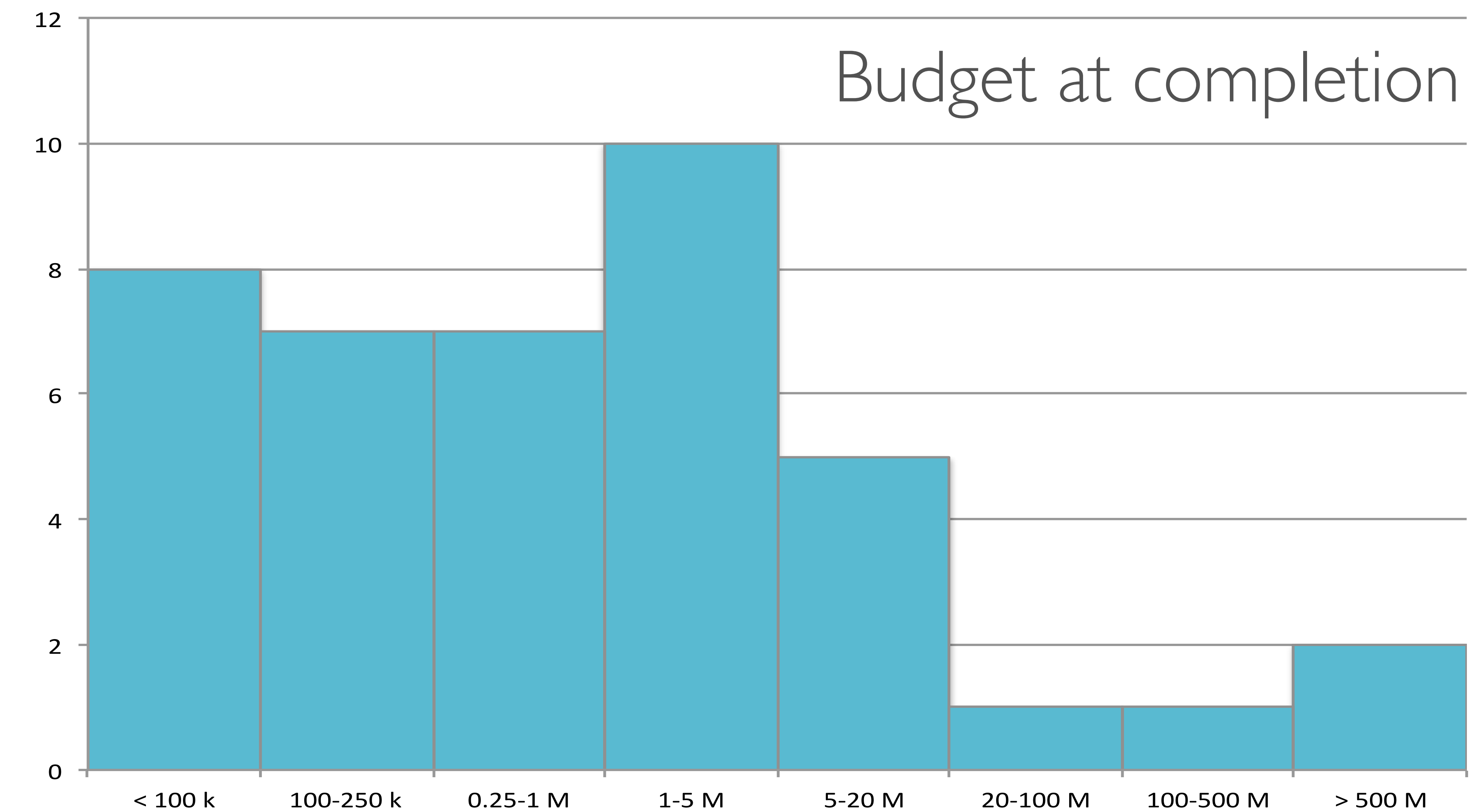


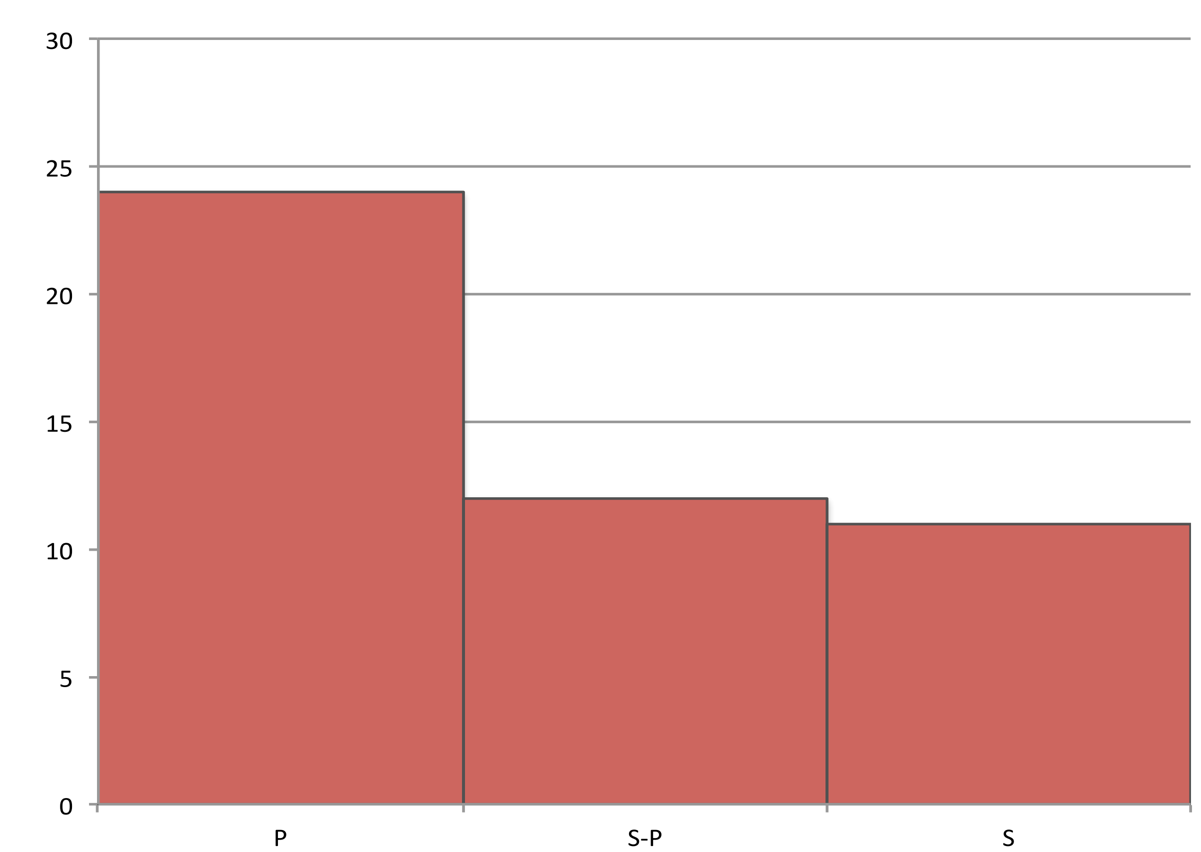
PROJECT DATABASE

*a **large** and **diverse** **real-life** project database*

Diversity







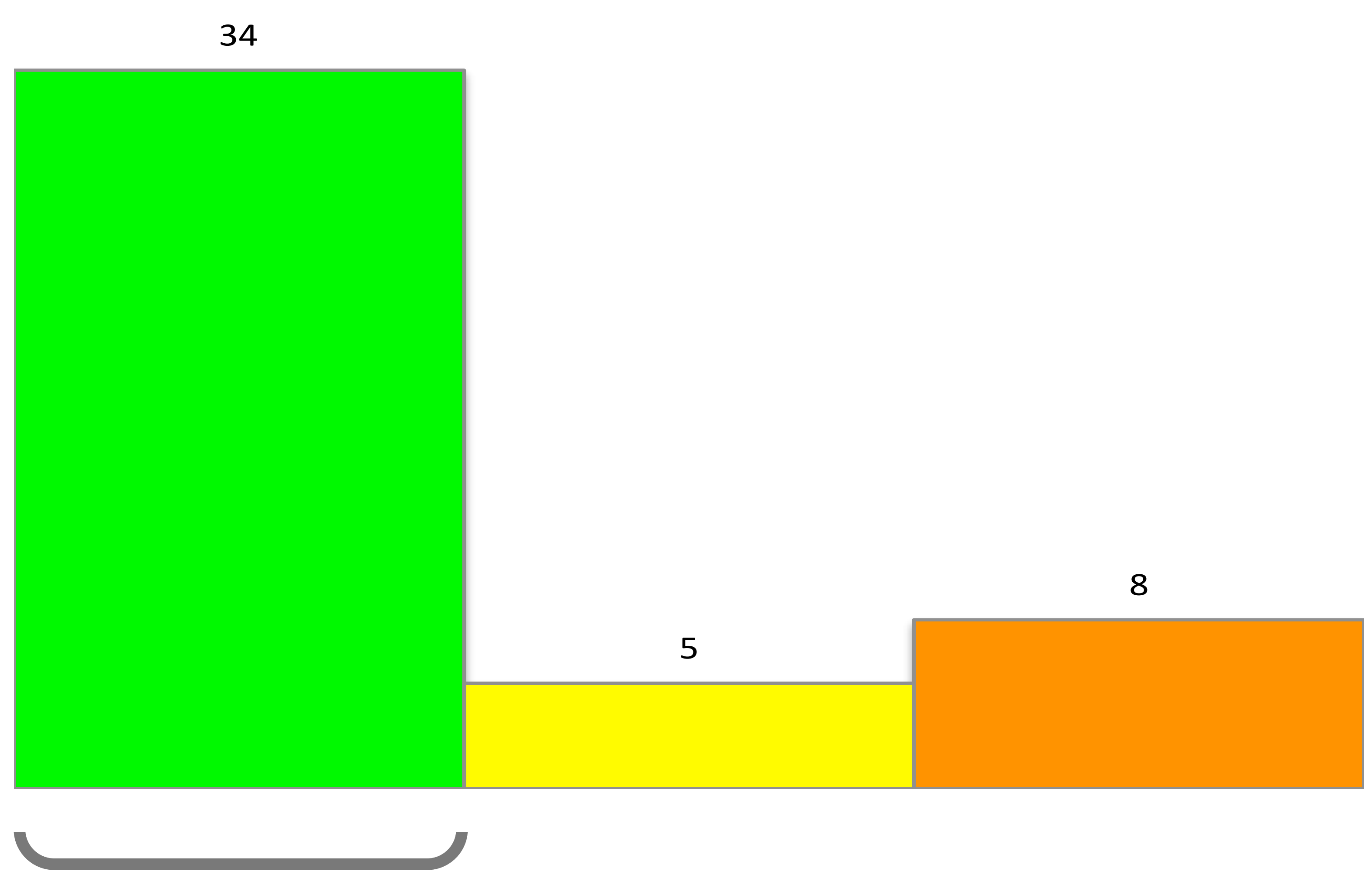
Network structure (serial-parallel)

PROJECT DATABASE

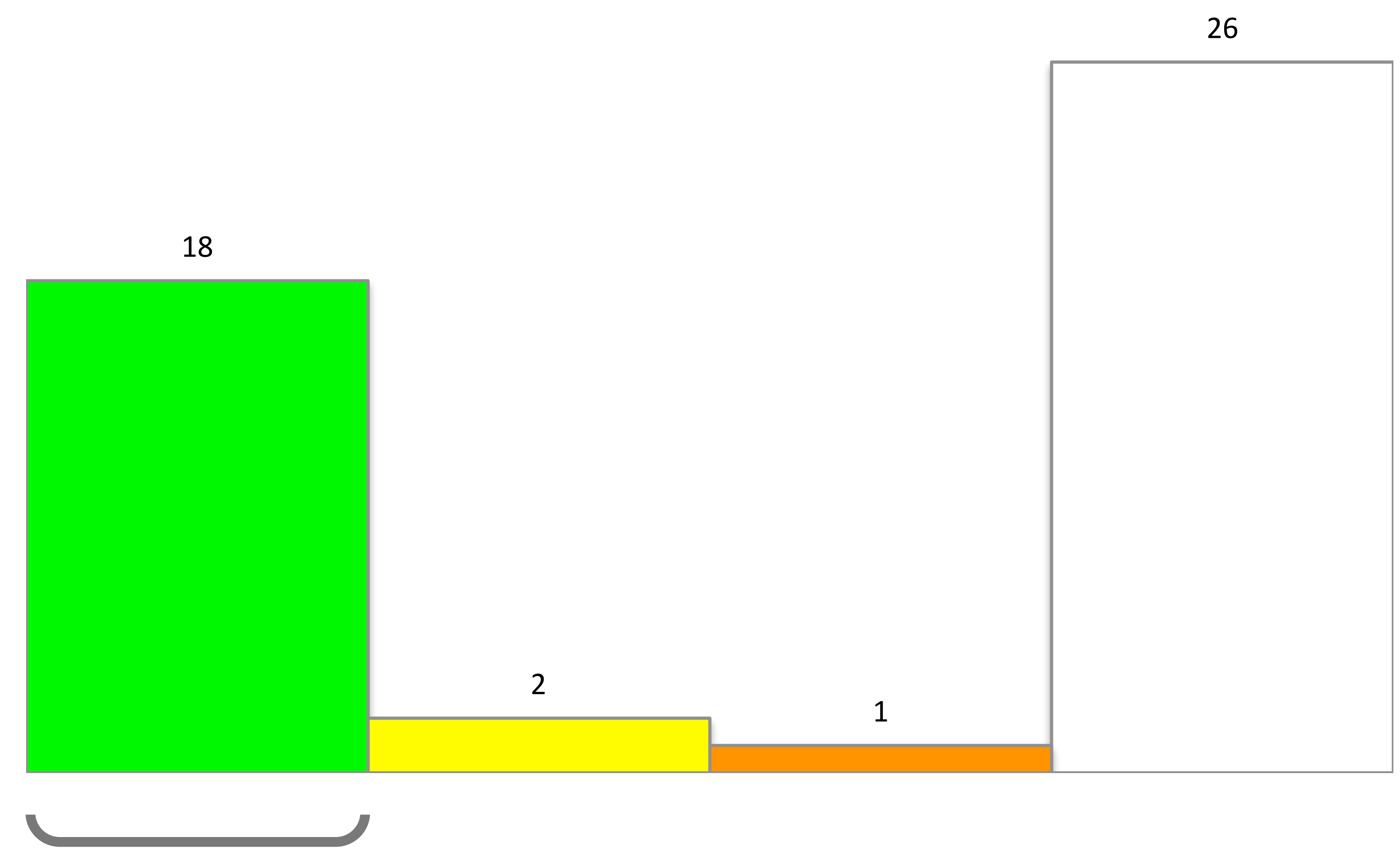
*a **large** and **diverse** **real-life** project database*

Authenticity

Project authenticity



Tracking authenticity



➡ extend database with fully authentic projects with tracking

(all new projects will fulfill these requirements)

DISSERTATION PRESENTATIONS

Pieter Van Schoors	Comparison of the performance of SRA and EVM for parallel projects
Livine Maerschalck	Benefits of the Work Package Methodology compared to traditional EVM
Annelies Troch	Evaluation of EVM time and cost forecasting methods based on multiple simulated scenarios

COMPARISON OF EVM AND SRA: A CASE STUDY

Pieter Van Schoors

CONTENT

- Case study projects
- Research questions
- Results
- Conclusions

CASE STUDY PROJECTS

- Collaboration with Beddeleem
- Projects with remarkable SP values

Project	SP
Construction site 1	0,20
Construction site 3	0,25
Construction site 5	0,66
Construction site 6	0,36

RESEARCH QUESTIONS

- "On the dynamic use of project performance and schedule risk information during project tracking" (Vanhoucke, 2011)
- Apply on real-life projects
- *Research question 1:* Is the SRA technique a better alternative compared to the EVM technique in case the project is characterized by a parallel network topology?

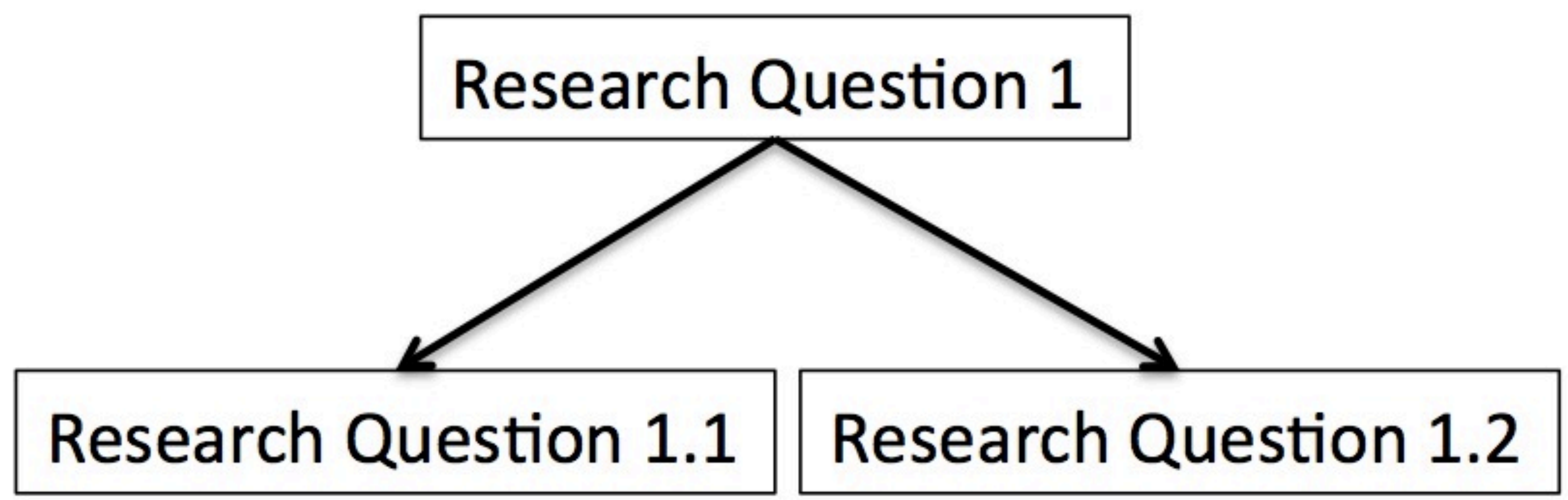
RESULTS

- Results for research question 1

		Which technique is most efficient?			
Projects	**Focus**	**EVM**	**SRA**	**Both**	**None**
Construction site 1	Time	X			
	Cost				X
Construction site 3	Time	X			
	Cost				X
Construction site 5	Time				X
	Cost		X		
Construction site 6	Time				X
	Cost				X

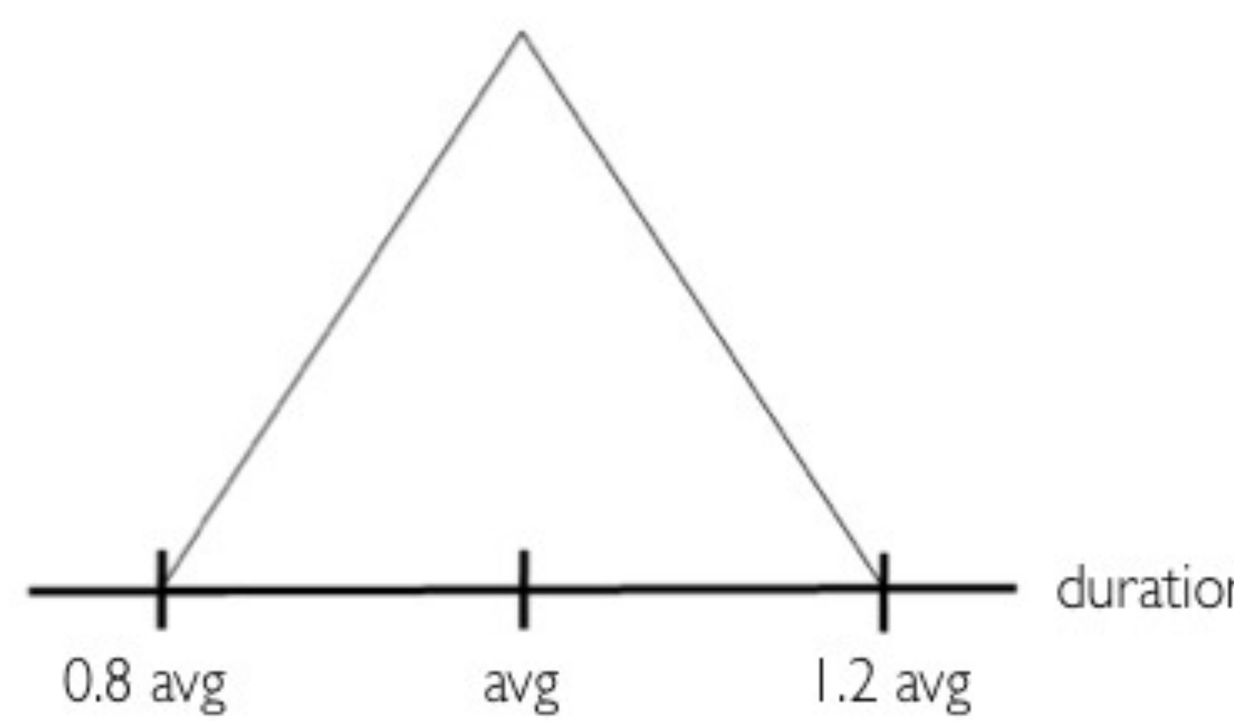
RESULTS

- Search for cause
- Creation of research questions 1.1 and 1.2



RESULTS

- *Research question 1.1:* Adjusted risk distribution profiles for risk analysis



- *Research question 1.2:* Twice as many control points

RESULTS

- Results for research question 1.1

  ➞ No significant improvement

		Which technique is most efficient?			
Projects	**Focus**	**EVM**	**SRA**	**Both**	**None**
Construction site 1	Time	X			
	Cost				X
Construction site 3	Time	X			
	Cost				X
Construction site 5	Time				X
	Cost		X		
Construction site 6	Time		X		
	Cost				X

RESULTS

- Results for research question 1.2

  ➜ Positive trend

		Which technique is most efficient?			
Projects	**Focus**	**EVM**	**SRA**	**Both**	**None**
Construction site 1	Time	X			
	Cost				X
Construction site 3	Time	X			
	Cost		X		
Construction site 5	Time				X
	Cost		X		
Construction site 6	Time		X		
	Cost		X		

CONCLUSIONS

- No conclusive evidence
- More control points
  = better results
- Bad planning
  = bad project management

			Which technique is most efficient?			
	Projects	Focus	EVM	SRA	Both	None
Research question 1	Construction site 1	Time	X			
		Cost				X
	Construction site 3	Time	X			
		Cost				X
	Construction site 5	Time				X
		Cost		X		
	Construction site 6	Time				X
		Cost				X
Research question 1.1	Construction site 1	Time	X			
		Cost				X
	Construction site 3	Time	X			
		Cost				X
	Construction site 5	Time				X
		Cost		X		
	Construction site 6	Time		X		
		Cost				X
Research question 1.2	Construction site 1	Time	X			
		Cost				X
	Construction site 3	Time	X			
		Cost		X		
	Construction site 5	Time				X
		Cost		X		
	Construction site 6	Time		X		
		Cost		X		

CASE STUDY: THE INFLUENCE OF THE WORK PACKAGE METHODOLOGY ON THE FORECAST OF COST AND TIME USING EVM

Livine Maerschalck

CONTENT

EVM-WPM | Case Study | Results | Next Steps

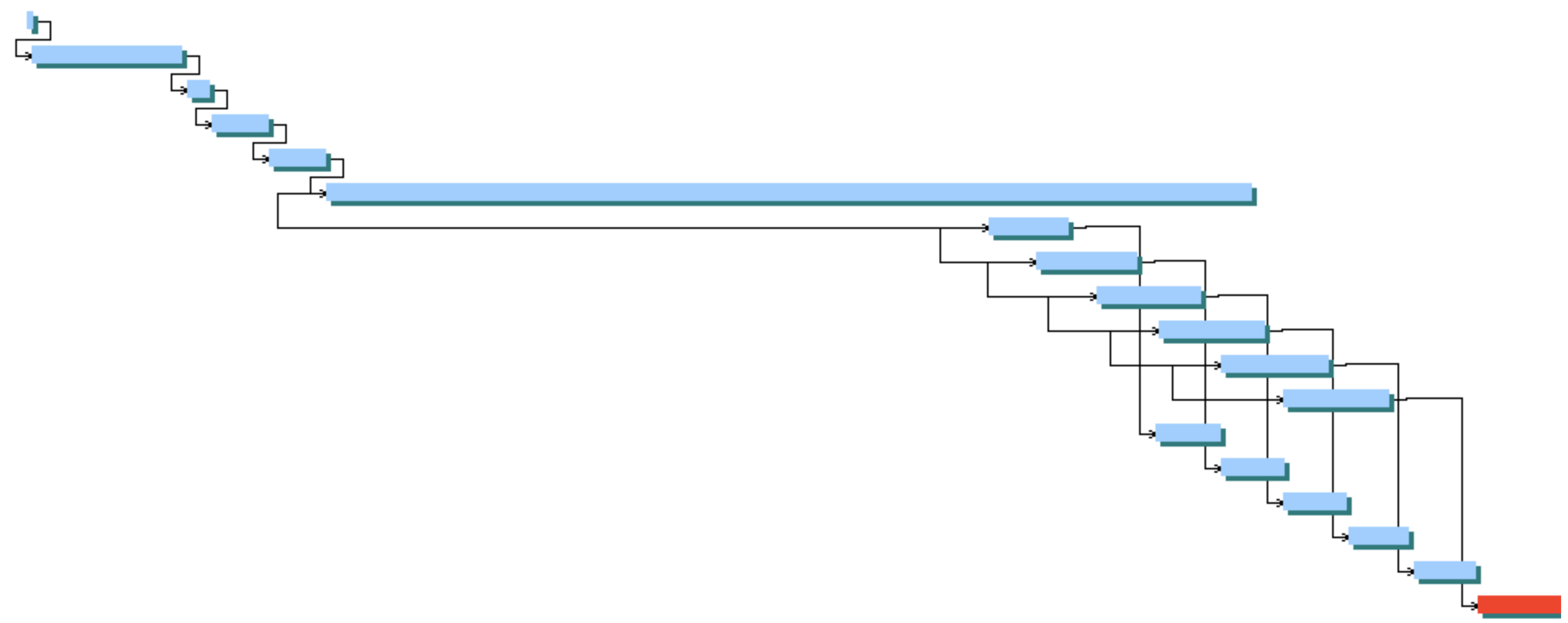

EVM-WPM


Case Study

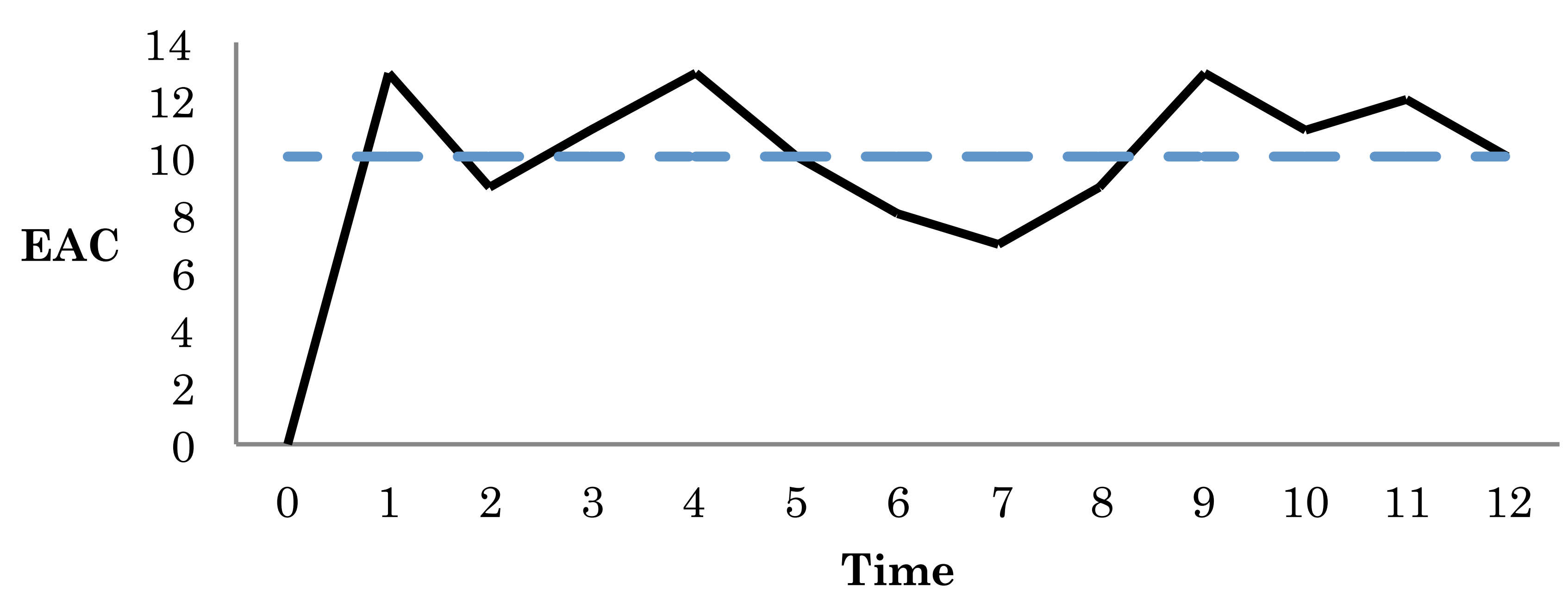

First Results


Next Steps

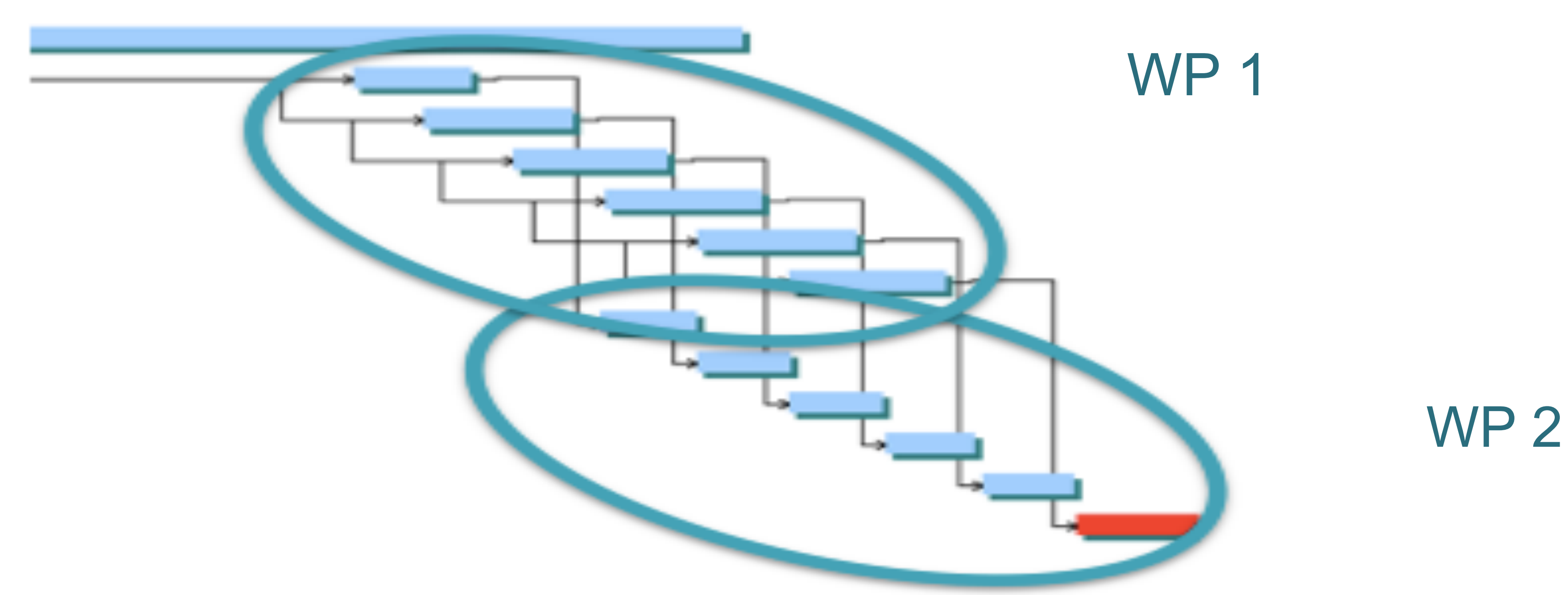
EVM



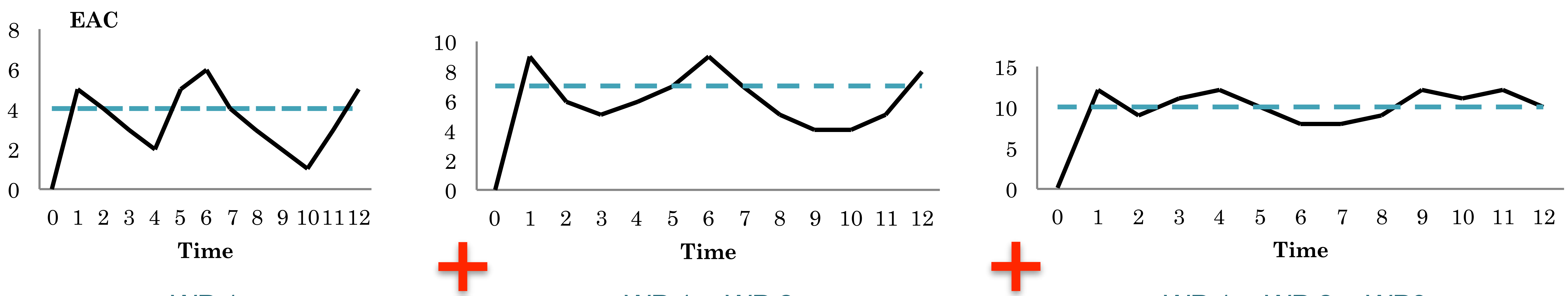
EVM: forecast cost



WPM

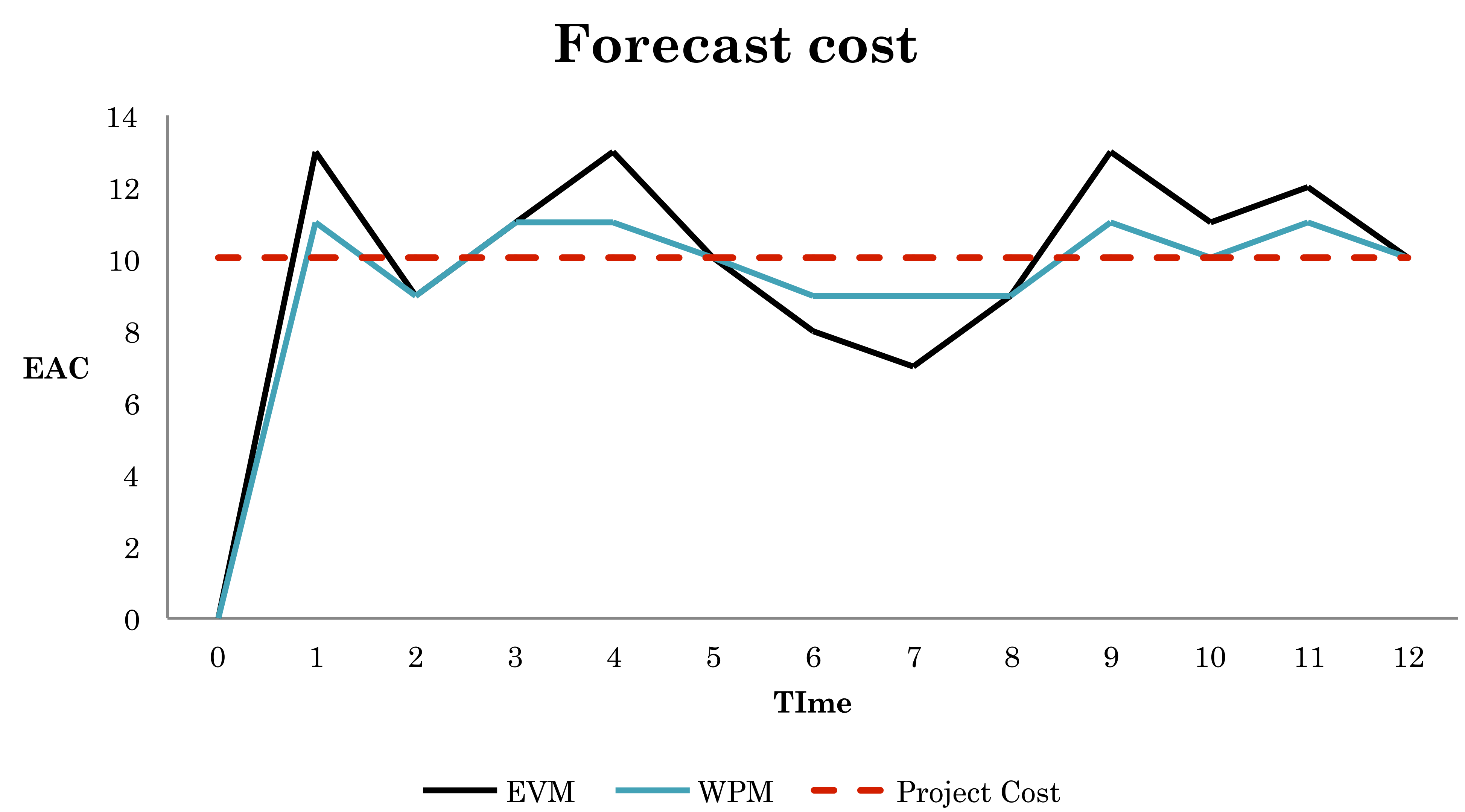


WPM: forecast cost



WP 1 | WP 1 + WP 2 | WP 1 + WP 2 + WP3

EVM-WPM



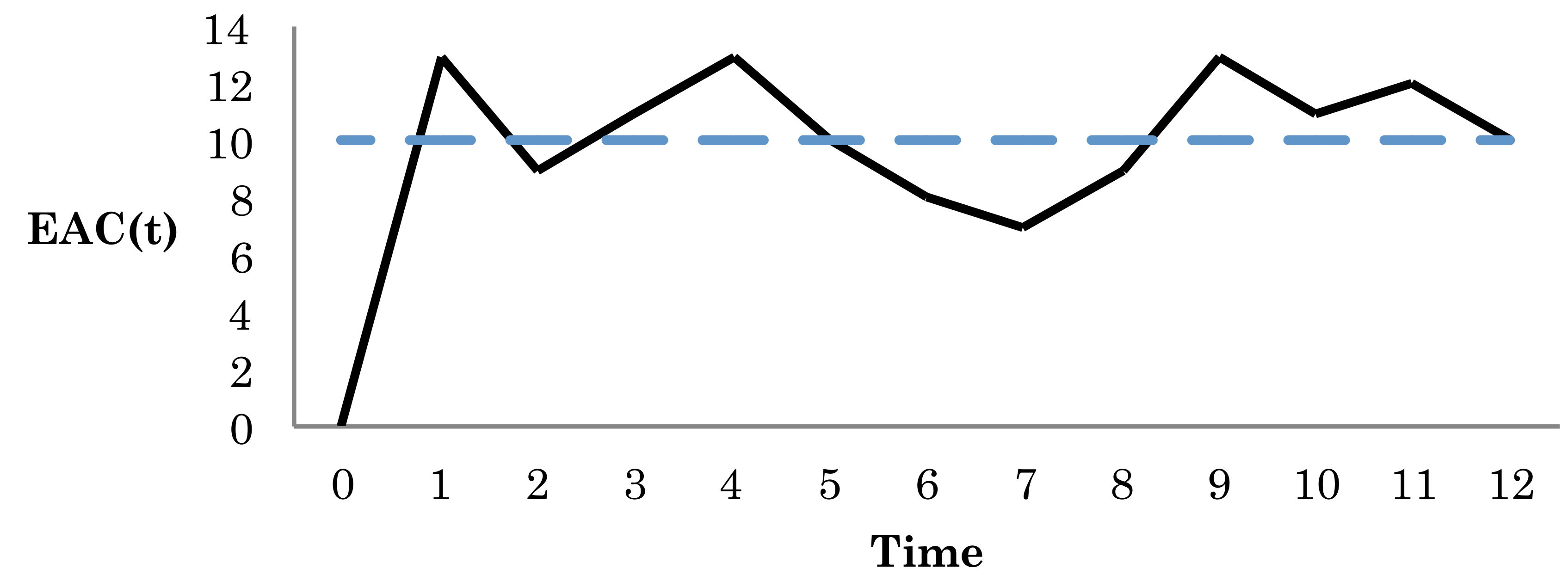
$$\text{MPE}= = \frac{1}{T}\sum_{t=1}^{T}\frac{EAC-RC}{RC} * 100$$

$$\text{MAPE} = \frac{1}{T}\sum_{t=1}^{T}\frac{|EAC-RC|}{RC} * 100$$

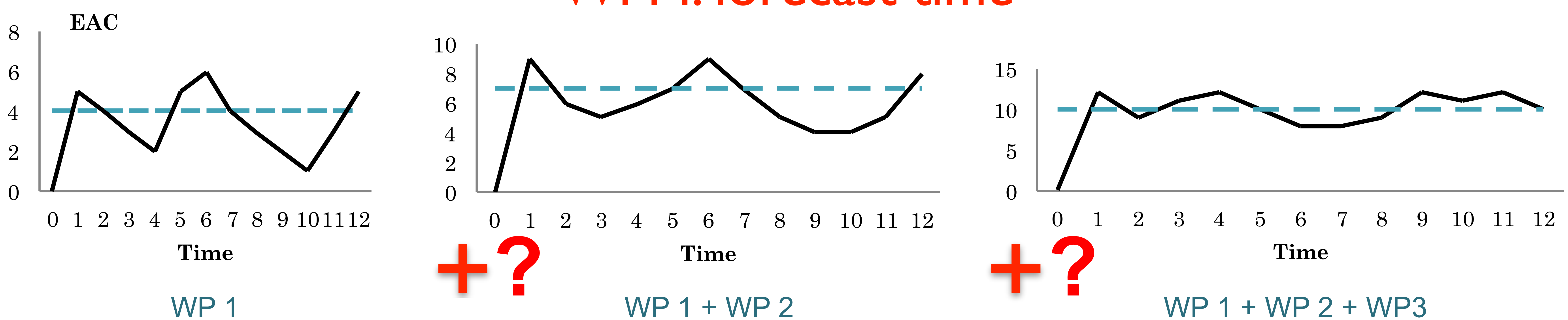
EAC = AC + PCWR

EVM-WPM

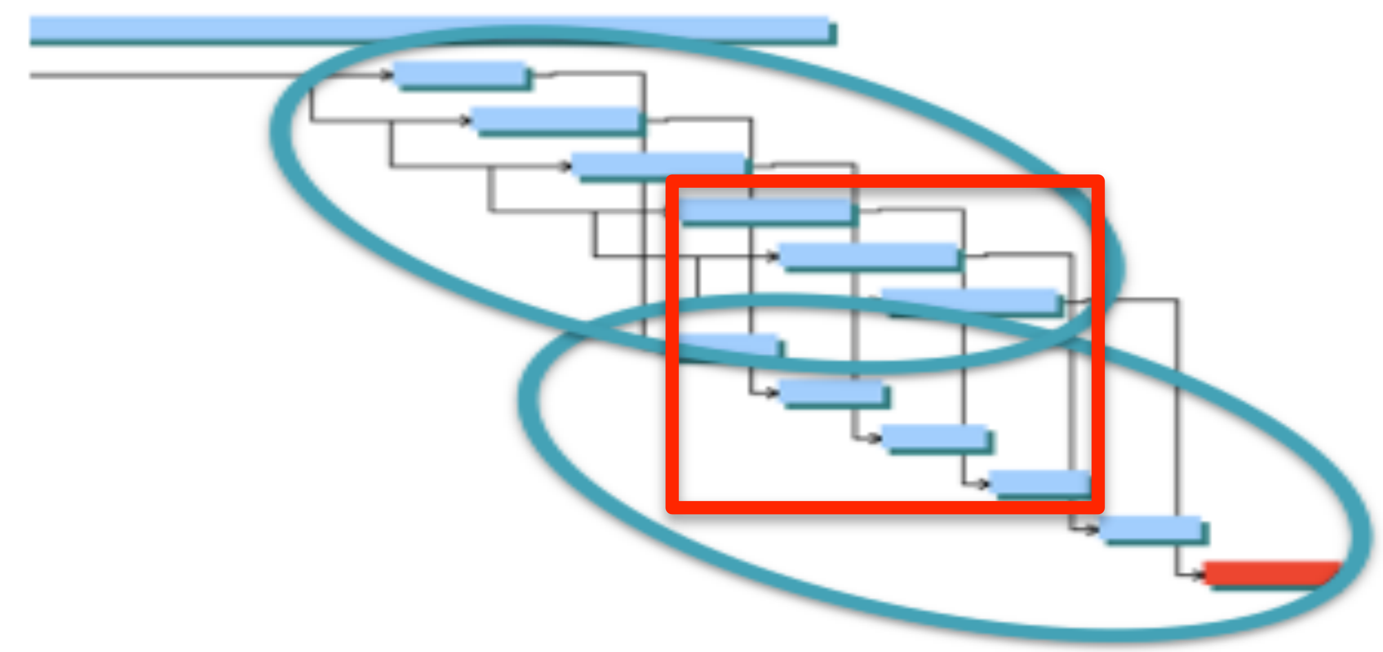
EVM: forecast time



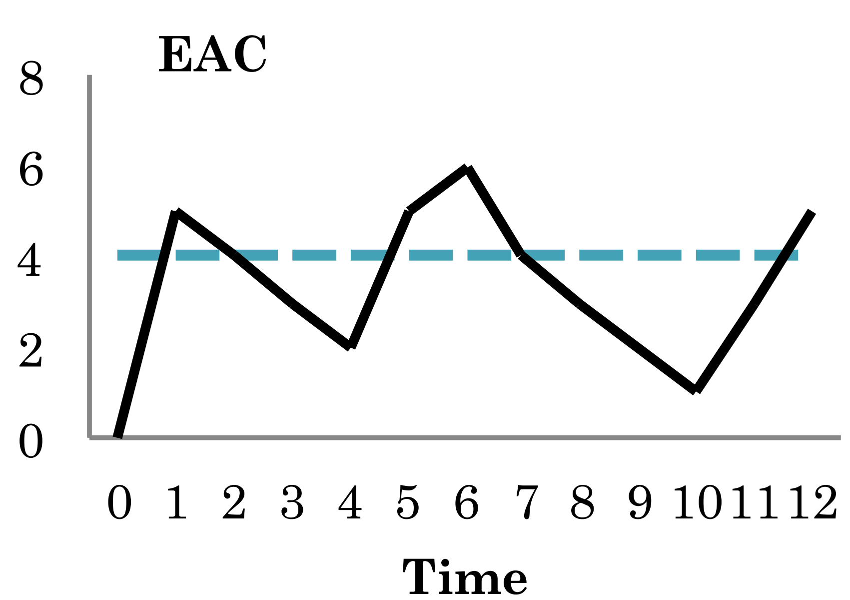
WPM: forecast time



EVM-WPM

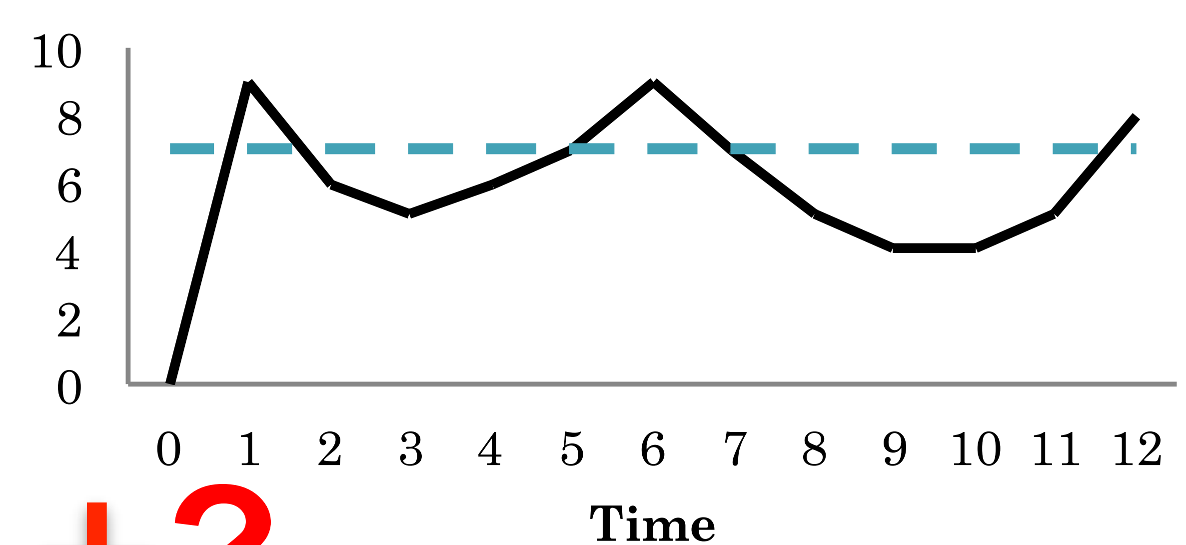


WPM: forecast time



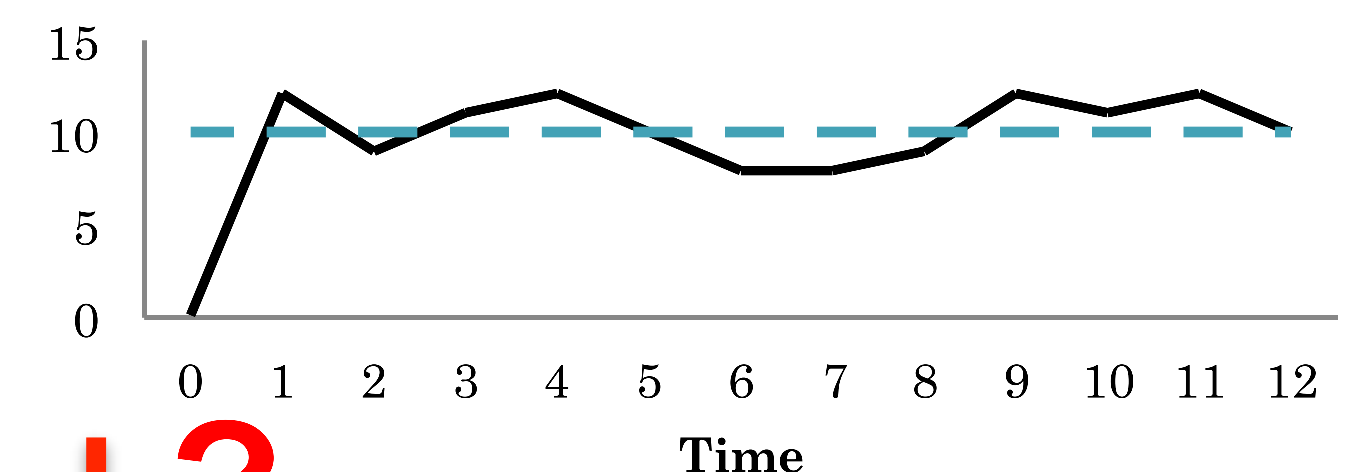
WP 1

+?



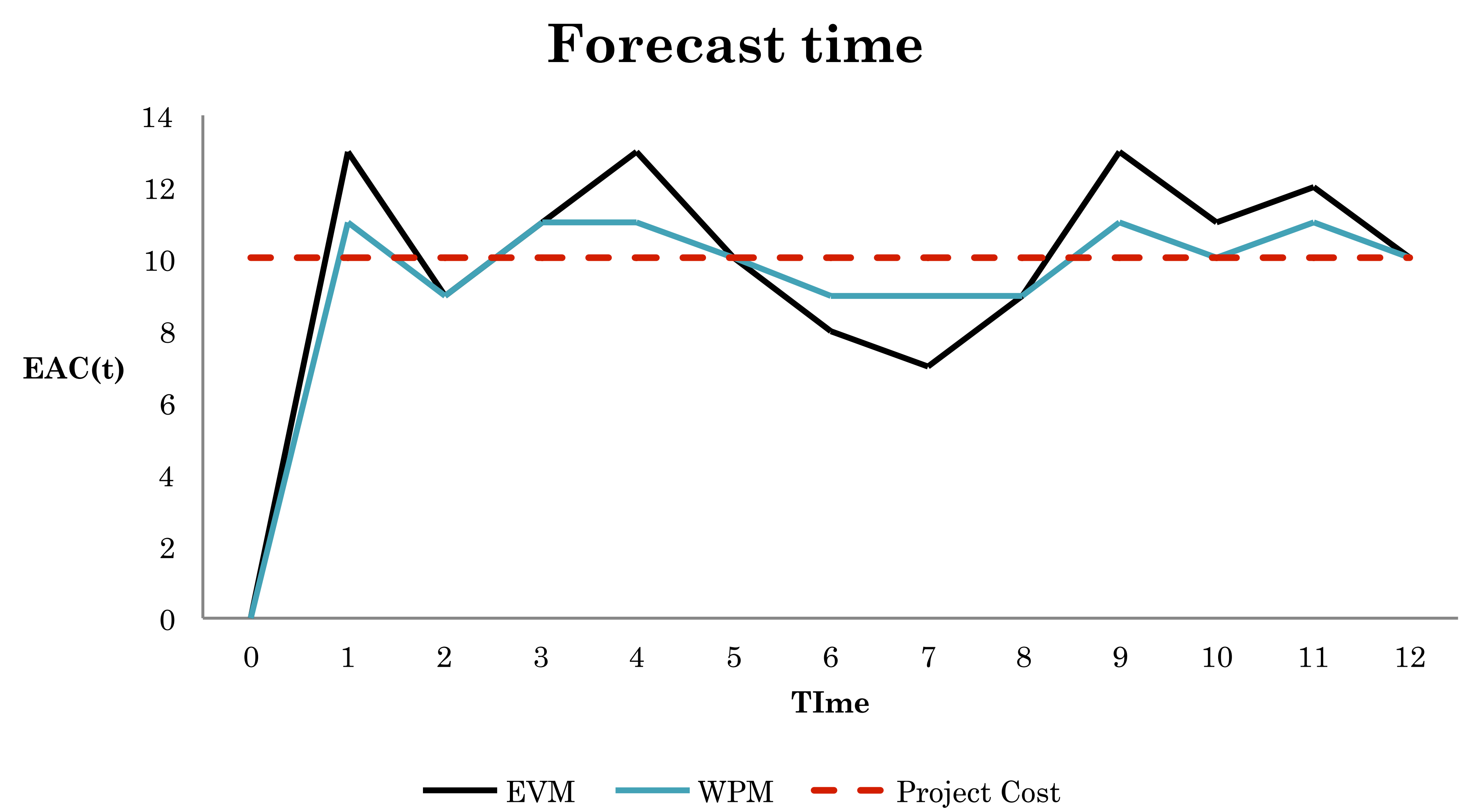
WP 1 + WP 2

+?



WP 1 + WP 2 + WP3

EVM-WPM



$$\text{MPE=} = \frac{1}{T}\sum_{t=1}^{T}\frac{EAC(t)-RD}{RD} * 100$$

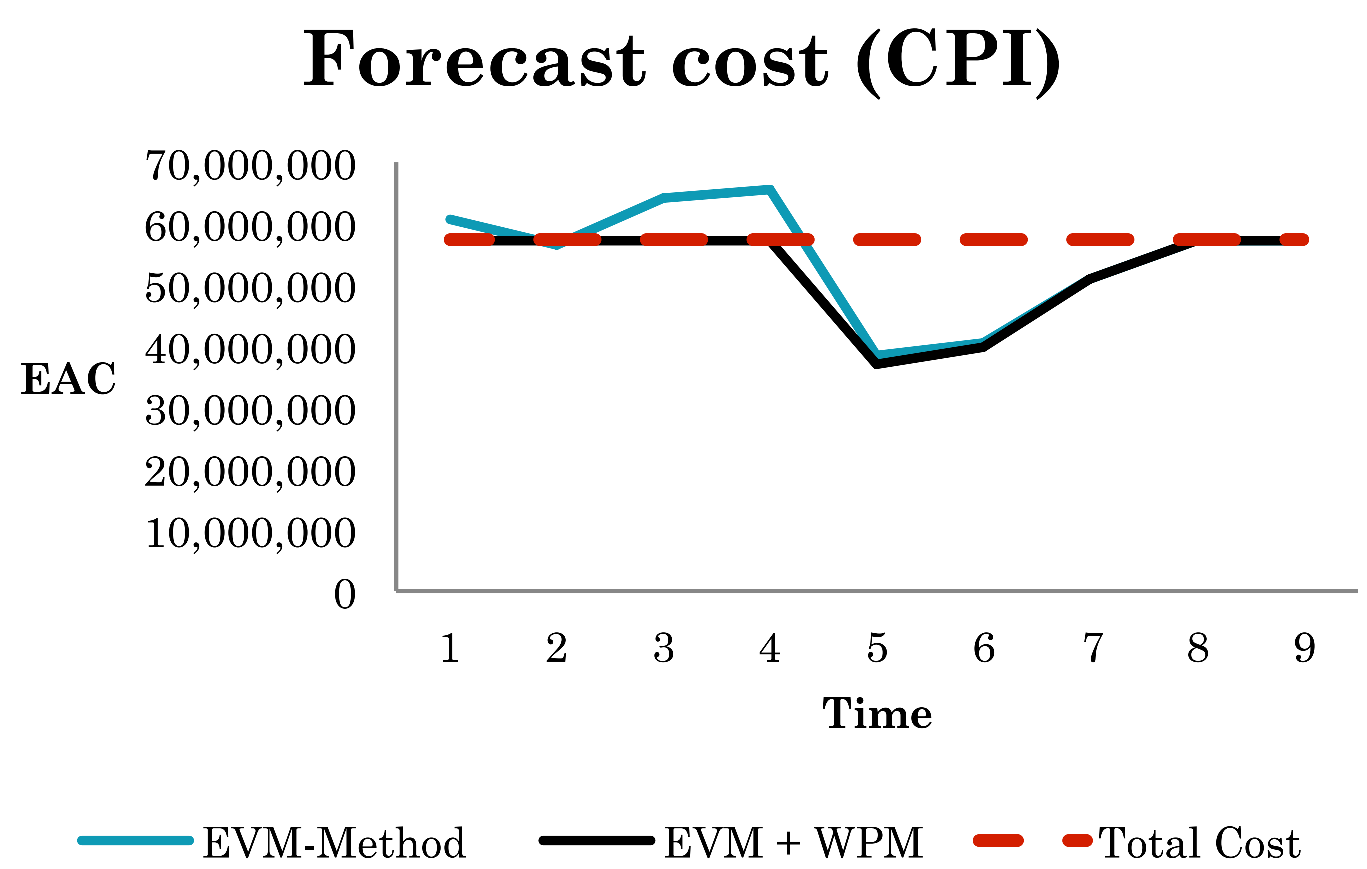
$$\text{MAPE} = \frac{1}{T}\sum_{t=1}^{T}\frac{|EAC(t)-RD|}{RD} * 100$$

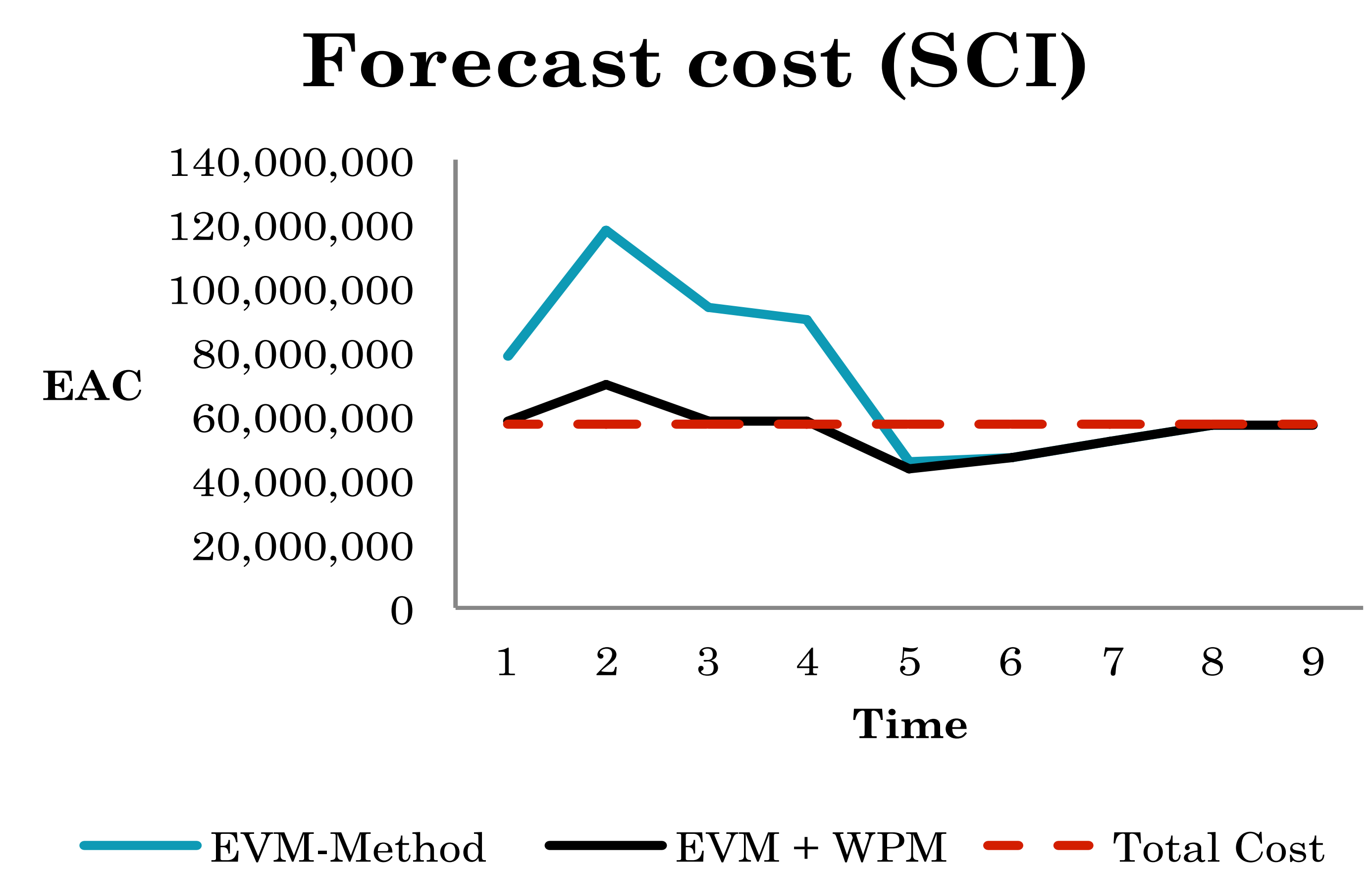
EAC(t) = AD + PDWR

CASE STUDY

# PROJECT	BUDGET	DURATION	STATE	# ACTIVITIES
1	60 MIO €	4 Y	ON SCHEME	18
2	61 MIO €	11 Y	+ TIME	17
3	1,8 MIO €	5 Y	+ COST, + TIME	38
4	1,3 MIO €	6 M	+ TIME	5
5	17 MIO €	5 Y	ON SCHEME	12
6	60 MIO €	3 Y	-COST, + TIME	10
7	3 MIO €	2 Y	- COST	14
8	5,7 MIO €	3Y	+ COST	22
9	1 MIO €	5M	+ TIME	7
10	0,051MIO €	2 M	+ TIME, + COST	5
11	0, 23 MIO €	6 M	ON SCHEME	5
12	5,5 MIO €	2 Y	+ TIME	34
13	0, 9 MIO €	5 M	+ COST, -TIME	5
14	…	…	…	…
15	…	…	…	…

FIRST RESULTS





PF	EVM MAPE	WPM MAPE
1	3.90%	3.90%
SPI	26.05%	5.45%
CPI	12.06%	8.84%
SCI	34.36%	8.68%

(results for project 1)

FIRST RESULTS

Early warning signals

# PROJECT	EVM	WPM
1	/	80%: 5 CPIs
	/	75%: 4 CPIs 2 SPIs
2	/	/
	/	/
3	/	80%: 5 CPIs
	/	75%: 5 CPIs

THE NEXT STEPS

Issues

- Grouping in WPs
- Forecast time: WP + ?
- Incorporate Earned Schedule
  - WPM → back to project level

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PROJECT CONTROL USING EARNED VALUE MANAGEMENT: A CASE STUDY

Annelies Troch

9 SCENARIOS

Non-critical activities \ Critical activities	-	0	+
-	**1** SPI(t) > 1 RD < PD	**4** SPI(t) > 1 RD = PD	**7** SPI(t) > 1 RD > PD
0	**2** SPI(t) > 1 RD < PD	**5** SPI(t) = 1 RD = PD	**8** SPI(t) < 1 RD > PD
+	**3** SPI(t) < 1 RD < PD	**6** SPI(t) < 1 RD = PD	**9** SPI(t) < 1 RD > PD

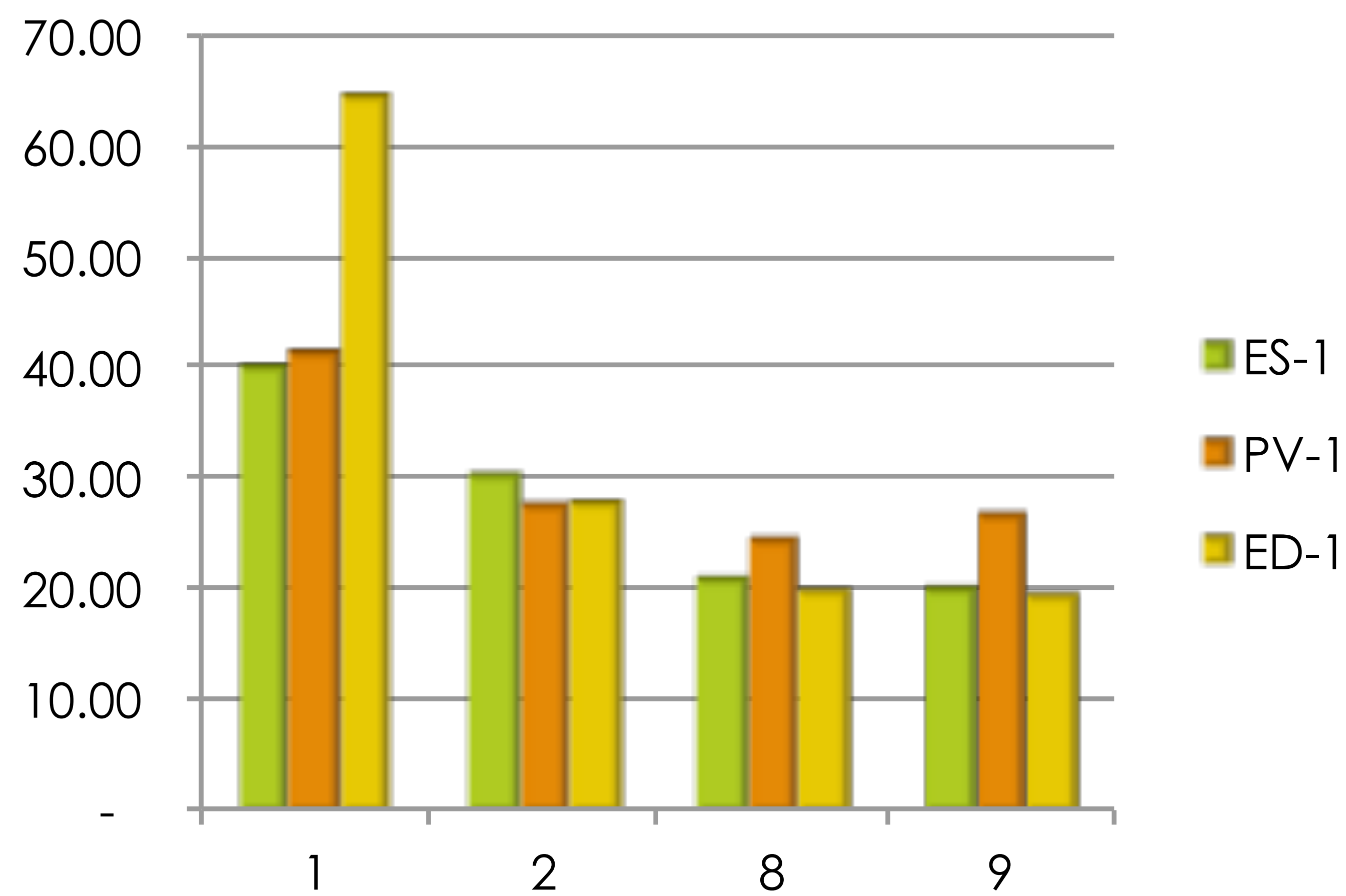
PROJECTS

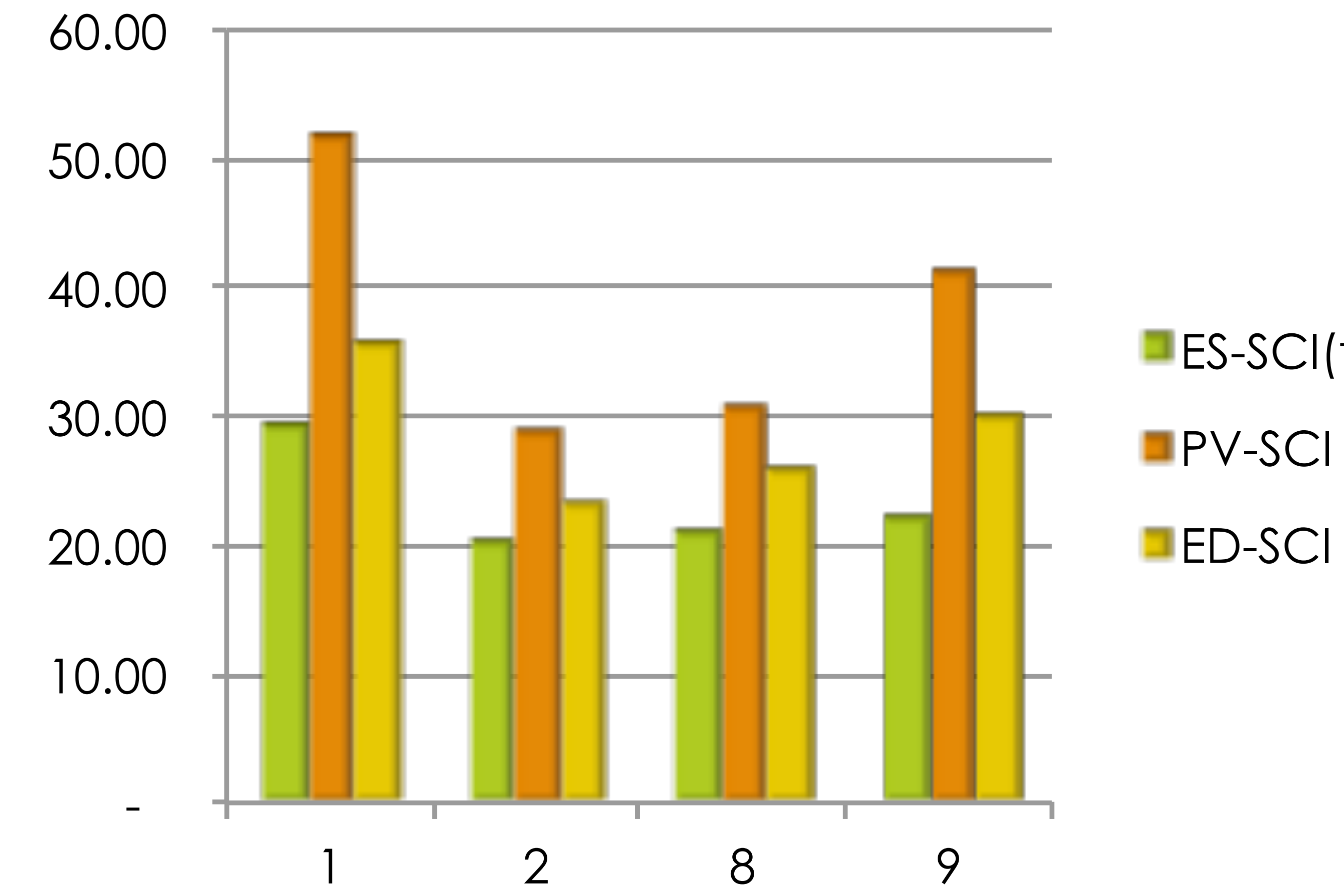
- 4 construction projects of ± 15 activities
- 1 construction project of ± 55 activities
- 2 production projects of ± 20 activities
- 1 software implementation project of ± 85 activities

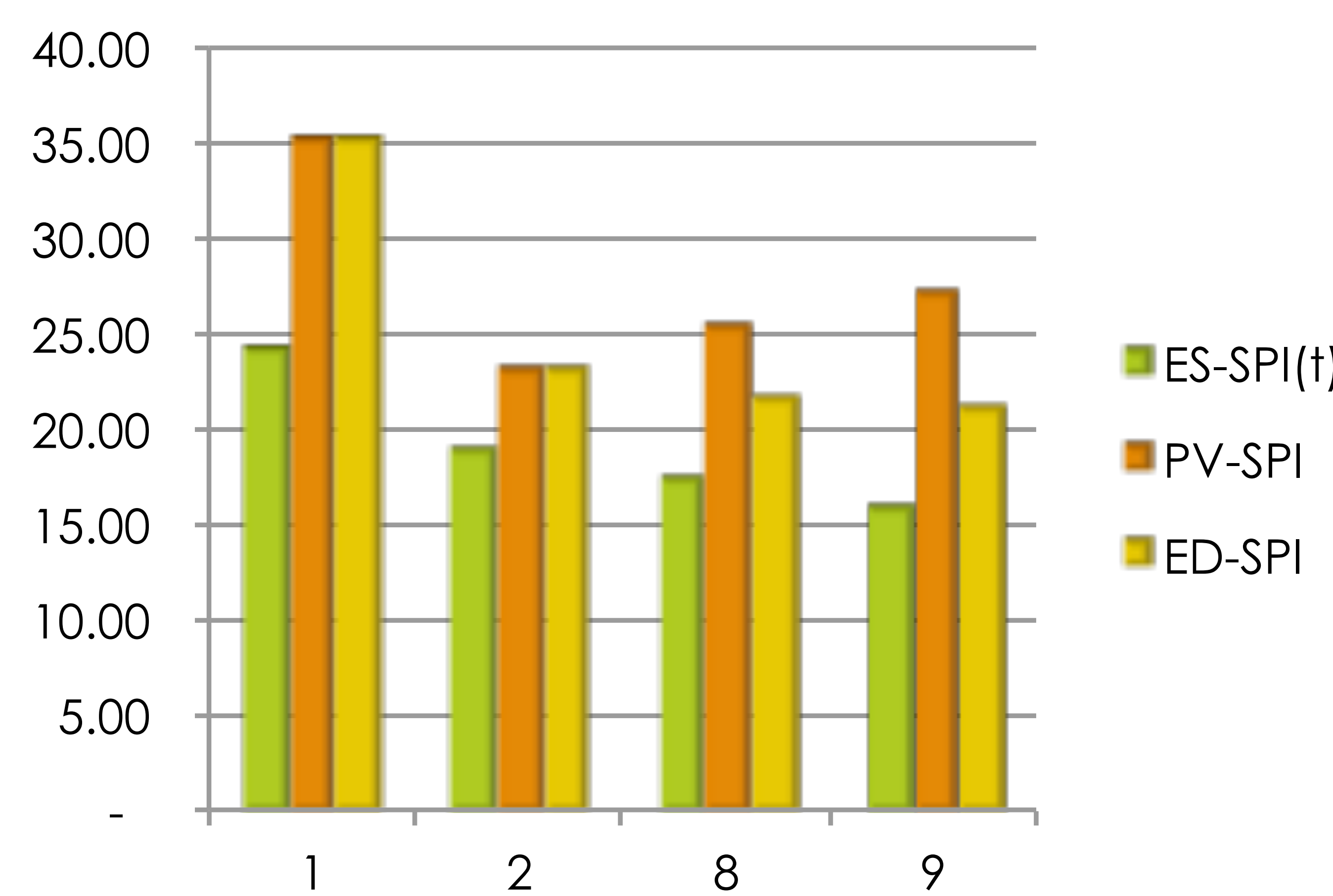
MAPE TIME

	ES-1	ES-SPI(t)	ES-SCI(t)	PV-1	PV-SPI	PV-SCI	ED-1	ED-SPI	ED-SCI
Scenario 1	39,94	24,25	29,25	41,20	35,17	51,80	64,42	35,17	35,62
Scenario 2	30,24	19,06	20,25	27,52	23,17	29,08	27,77	23,17	23,37
Scenario 3	5,94	16,75	48,28	5,59	13,95	66,92	5,18	13,95	45,35
Scenario 4	16,78	19,88	24,05	18,57	24,89	35,75	35,26	24,89	26,35
Scenario 5	15,38	13,70	13,70	11,54	13,33	13,33	9,63	13,33	13,33
Scenario 6	4,97	18,10	49,85	3,98	13,10	67,47	3,45	13,10	44,75
Scenario 7	15,95	19,15	22,58	14,01	19,50	26,89	13,58	19,14	21,76
Scenario 8	20,99	17,37	21,04	24,34	25,53	30,90	20,17	21,84	25,88
Scenario 9	19,86	16,08	22,18	26,59	27,17	41,12	19,63	21,21	30,16
Correct Scenarios	27,76	19,19	23,18	29,91	27,76	38,23	33,00	25,35	28,76
Misleading Scenarios	10,91	18,47	36,19	10,54	17,86	49,26	14,37	17,77	34,55
Overall	18,90	18,26	27,91	19,26	21,76	40,36	22,12	20,64	29,62

MAPE TIME


70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
1
2
8
9
ES-1
PV-1
ED-1

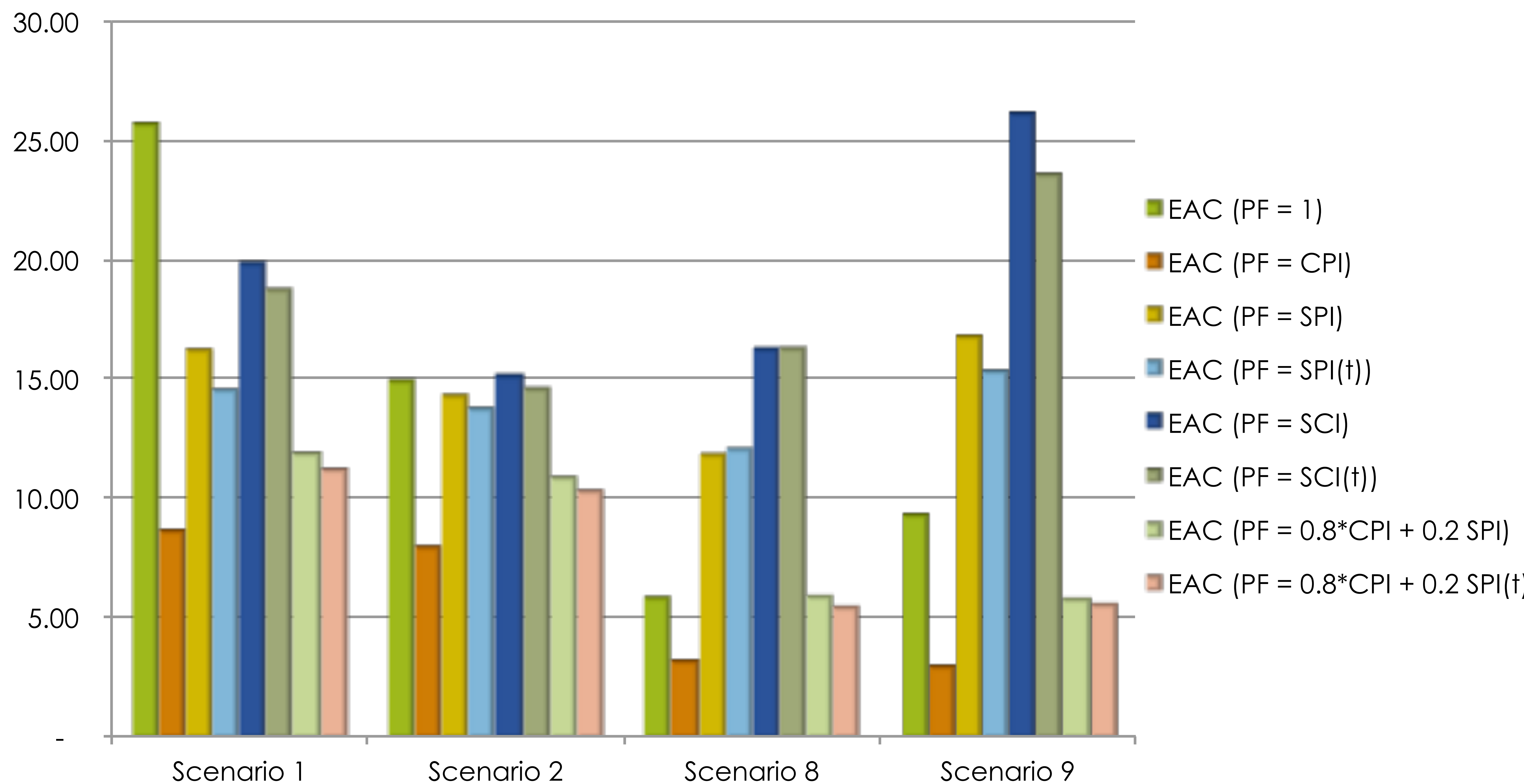

60.00
50.00
40.00
30.00
20.00
10.00
-
1
2
8
9
ES-SCI(t)
PV-SCI
ED-SCI


40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
-
1
2
8
9
ES-SPI(t)
PV-SPI
ED-SPI

MAPE COST

	EAC (PF = 1)	EAC (PF = CPI)	EAC (PF = SPI)	EAC (PF = SPI(t))	EAC (PF = SCI)	EAC (PF = SCI(t))	EAC (PF = 0.8*CPI + 0.2 SPI)	EAC (PF = 0.8*CPI + 0.2 SPI(t))
Scenario 1	25,64	8,60	16,22	14,52	19,87	18,75	11,87	11,11
Scenario 2	14,96	7,88	14,28	13,68	15,17	14,60	10,80	10,26
Scenario 3	7,31	65,25	13,51	15,21	842,20	839,48	21,40	20,94
Scenario 4	7,48	5,62	9,80	9,95	12,70	13,23	7,68	7,30
Scenario 5	-	-	6,81	7,94	6,81	7,94	3,18	2,77
Scenario 6	7,95	67,95	14,87	17,79	862,18	862,53	21,43	21,19
Scenario 7	1,97	6,27	9,15	9,57	12,26	13,07	7,96	7,44
Scenario 8	5,88	3,21	11,86	11,99	16,24	16,32	5,91	5,47
Scenario 9	9,41	2,95	16,68	15,30	26,05	23,56	5,77	5,52
Correct Scenarios	13,97	5,66	14,76	13,87	19,33	18,31	8,59	8,09
Misleading Scenarios	6,17	36,27	11,83	13,13	432,34	432,08	14,62	14,22
Overall	8,95	18,64	12,57	12,88	201,50	201,05	10,67	10,22

MAPE COST


30.00
25.00
20.00
15.00
10.00
5.00
-
Scenario 1
Scenario 2
Scenario 8
Scenario 9
EAC (PF = 1)
EAC (PF = CPI)
EAC (PF = SPI)
EAC (PF = SPI(t))
EAC (PF = SCI)
EAC (PF = SCI(t))
EAC (PF = 0.8*CPI + 0.2 SPI)
EAC (PF = 0.8*CPI + 0.2 SPI(t))

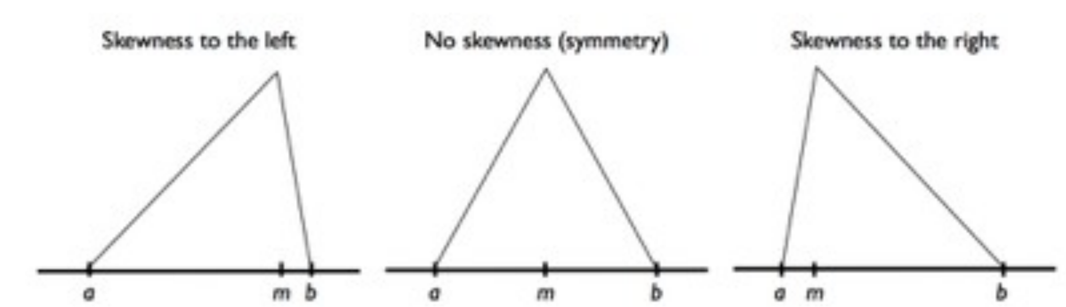
WHAT'S NEXT?

- Scenario analysis of additional projects
- Comparison of SV-SV(t) and SPI-SPI(t)
- Comparison of EAC(t) and RD for all tracking periods and all methods
- Comparison of EAC and RAC for all tracking periods and all methods

GLOBAL RESEARCH

Evaluating the accuracy of earned value management forecasting methods for time and cost

Not only simulated forecasting, but also real forecasting



simulated forecasting = methods evaluated based on simulated project progress

real forecasting = methods evaluated based on real project progress

RESEARCH QUESTIONS

Q1 *Which EVM method performs best for **time** forecasting;*
overall,
and w.r.t. the influence of different project characteristics?

Q2 *Which EVM method performs best for **cost** forecasting;*
overall,
and w.r.t. the influence of different project characteristics?

project seriality	project regularity
SP	RI
(serial/parallel)	(regular/irregular)

RESULTS

Time forecasting - Overall

	PVM			EDM			ESM		
	1	SPI	SCI	1	SPI	SCI	1	SPI(t)	SCI(t)
simulated (a)									
MAPE [%]	22.5	32.1	32.7	M	31.9	32.2	13.4	20.3	20.7
rank [-]	3.4	5.4	6.7	5.5	4.9	5.3	2.0	3.9	4.5
real (b)									
MAPE [%]	13.1	32.9	36.7	13.4	31.1	32.1	8.9	16.4	18.2
rank [-]	3.8	7.2	7.4	3.2	6.1	6.0	1.7	4.3	4.7

- **ESM-1** clearly is the most accurate time forecasting method
- Is there a project characteristic adversely influencing the accuracy of some methods? Yes, **project regularity**!

RESULTS

Time forecasting - Influence of project regularity

	PVM			EDM			ESM		
MAPE [%]	1	SPI	SCI	1	SPI	SCI	1	SPI(t)	SCI(t)
simulated									
regular (a)	12.5	19.2	20.1	16.5	19.0	19.5	9.8	16.5	17.0
mildly irreg.	16.2	25.5	26.4	30.8	25.3	25.7	12.2	17.8	18.5
strongly irreg.	46.4	61.3	61.4	M	61.3	61.2	20.9	29.7	29.7
irregular (b)	32.0	44.3	44.7	M	44.1	44.3	16.8	24.0	24.4
(b) - (a)	19.5	25.0	24.7	M	25.1	24.8	7.0	7.5	7.4
real									
regular (c)	11.7	20.0	25.7	9.2	17.5	21.7	8.4	15.7	19.8
mildly irreg.	11.5	54.8	53.8	16.7	53.0	50.5	7.6	14.6	13.8
strongly irreg.	17.5	29.7	36.1	17.2	29.3	28.8	11.3	19.9	20.7
irregular (d)	14.2	43.4	45.7	16.9	42.2	40.6	9.3	17.0	16.9
(d) - (c)	2.5	23.4	20.0	7.7	24.7	19.0	0.9	1.3	-2.9

accuracy ↘

accuracy ↘

RESULTS

Time forecasting - Influence of project regularity

MAPE [%]	PVM 1	PVM SPI	PVM SCI	EDM 1	EDM SPI	EDM SCI	ESM 1	ESM SPI(t)	ESM SCI(t)
simulated									
regular (a)	12.5	19.2	20.1	16.5	19.0	19.5	9.8	16.5	17.0
mildly irreg.	16.2	25.5	26.4	30.8	25.3	25.7	12.2	17.8	18.5
strongly irreg.	46.4	61.3	61.4	M	61.3	61.2	20.9	29.7	29.7
irregular (b)	32.0	44.3	44.7	M	44.1	44.3	16.8	24.0	24.4
(b) - (a)	19.5	25.0	24.7	M	25.1	24.8	7.0	7.5	7.4
real									
regular (c)	11.7	20.0	25.7	9.2	17.5	21.7	8.4	15.7	19.8
mildly irreg.	11.5	54.8	53.8	16.7	53.0	50.5	7.6	14.6	13.8
strongly irreg.	17.5	29.7	36.1	17.2	29.3	28.8	11.3	19.9	20.7
irregular (d)	14.2	43.4	45.7	16.9	42.2	40.6	9.3	17.0	16.9
(d) - (c)	2.5	23.4	20.0	7.7	24.7	19.0	0.9	1.3	-2.9

- Project irregularity indeed has a significant adverse effect on accuracy
- ESM can better cope with irregularities

RESULTS

Time forecasting - Influence of project seriality

MAPE [%]	PVM			EDM			ESM		
	1	SPI	SCI	1	SPI	SCI	1	SPI(t)	SCI(t)
simulated									
serial	10.0	14.0	16.5	10.8	13.7	15.3	8.6	11.2	12.5
ser.-para.	12.8	16.2	16.5	13.4	15.9	16.1	11.1	16.5	16.7
parallel	14.2	28.2	28.5	25.8	28.2	28.3	9.0	20.9	20.9
real									
serial	19.6	15.2	13.0	12.5	9.8	9.2	11.4	14.5	16.4
ser.-para.	8.1	16.0	23.7	4.7	12.0	15.8	3.7	12.9	17.1
parallel	10.0	23.6	31.6	9.7	22.8	29.0	9.1	17.3	22.3

accuracy ↘

accuracy ↘

- Time forecasting accuracy increases with project seriality

(Vanhoucke & Vandevoorde, 2007)

RESULTS

Cost forecasting - Overall

	EAC							
	1	CPI	SPI	SPI(t)	SCI	SCI(t)	0.8CPI+ 0.2SPI	0.8CPI+ 0.2SPI(t)
simulated (a)								
MAPE [%]	1.0	1.0	13.1	11.7	13.6	12.2	6.8	4.8
rank [-]	1.3	1.5	6.0	5.7	6.5	6.3	3.7	3.4
real (b)								
MAPE [%]	8.1	10.7	27.7	14.4	30.1	16.8	10.8	9.1
rank [-]	3.1	3.3	5.9	4.9	6.1	5.5	3.5	2.9

- The most accurate methods for cost forecasting are:

  EAC-1, **EAC-CPI** and **EAC-0.8CPI+0.2SPI(t)**
- No significant difference between them

RESULTS

Cost forecasting - Influence of project regularity

MAPE [%]	EAC 1	CPI	SPI	SPI(t)	SCI	SCI(t)	0.8CPI+ 0.2SPI	0.8CPI+ 0.2SPI(t)	
simulated									
regular (a)	0.8	0.9	9.3	9.4	10.1	10.2	4.1	3.4	
mildly irreg.	1.7	1.2	12.4	10.8	12.6	11.1	4.5	3.1	
strongly irreg.	0.7	0.8	20.8	16.6	20.8	16.7	13.6	8.7	
irregular (b)	1.2	1.0	16.8	13.8	16.9	14.0	9.5	6.0	
(b) - (a)	0.3	0.1	7.5	4.4	6.8	3.8	5.4	2.6	3.9
real									
regular (c)	5.4	5.8	14.2	12.7	17.9	15.8	5.9	6.0	
mildly irreg.	5.0	9.8	65.5	9.9	58.0	6.5	10.9	4.2	
strongly irreg.	15.6	20.3	21.5	21.2	29.9	26.7	19.5	18.8	
irregular (d)	10.9	15.6	41.1	16.2	42.4	17.7	15.7	12.3	
(d) - (c)	5.5	9.9	26.9	3.5	24.5	1.9	9.7	6.3	11.0

- Project irregularity also has a significant adverse effect on cost forecasting accuracy (of the same magnitude as for time forecasting)

RESULTS

Cost forecasting - Influence of project seriality

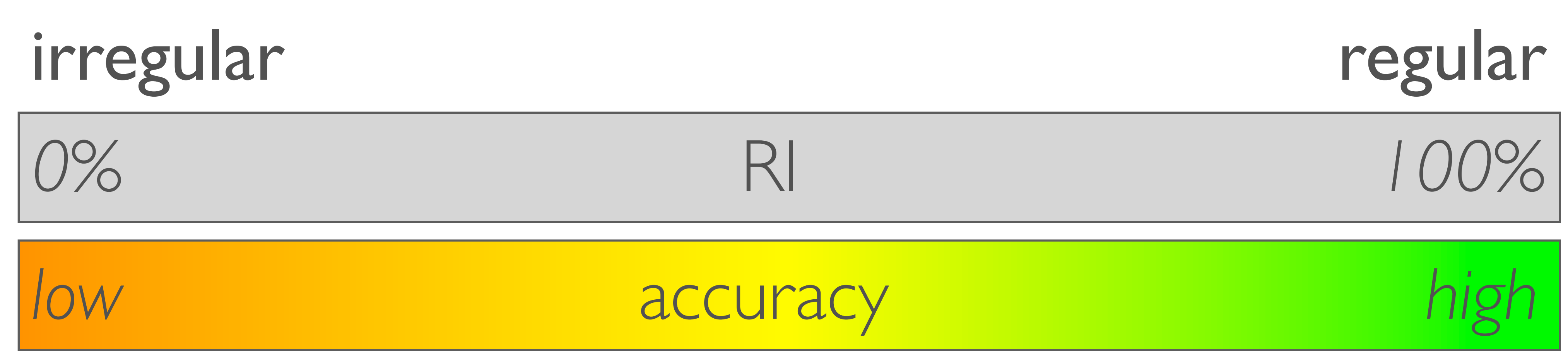
MAPE [%]	EAC							
	1	CPI	SPI	SPI(t)	SCI	SCI(t)	0.8CPI+ 0.2SPI	0.8CPI+ 0.2SPI(t)
simulated								
serial	1.7	1.6	7.5	7.3	10.3	10.1	3.1	3.4
ser.-para.	0.8	1.0	6.9	8.4	7.2	8.7	2.7	2.6
parallel	0.2	0.3	14.3	12.6	14.4	12.6	7.1	4.7
real								
serial	3.0	2.7	14.2	14.3	16.1	17.0	2.9	3.7
ser.-para.	8.6	7.8	10.8	12.4	11.4	13.0	6.0	5.8
parallel	5.1	6.2	15.6	12.2	21.2	16.5	7.1	7.0

- No influence of project seriality (↔ time forecasting)

CONCLUSIONS

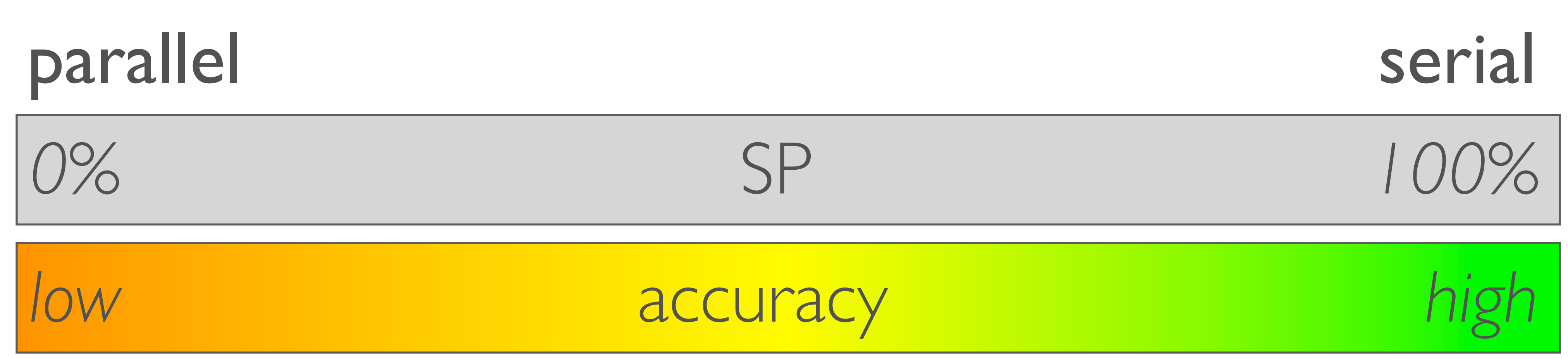
Time forecasting

- Overall: **ESM-1** is the best method
- Influence of project regularity



ESM can handle irregularities

- Influence of project seriality



CONCLUSIONS

Cost forecasting

- Overall: best methods are **EAC-1**, **EAC-CPI** and **EAC-0.8CPI+0.2SPI(t)**
- Influence of project regularity

irregular **regular**

0% RI *100%*

low accuracy *high*

- Influence of project seriality

parallel **serial**

0% SP *100%*

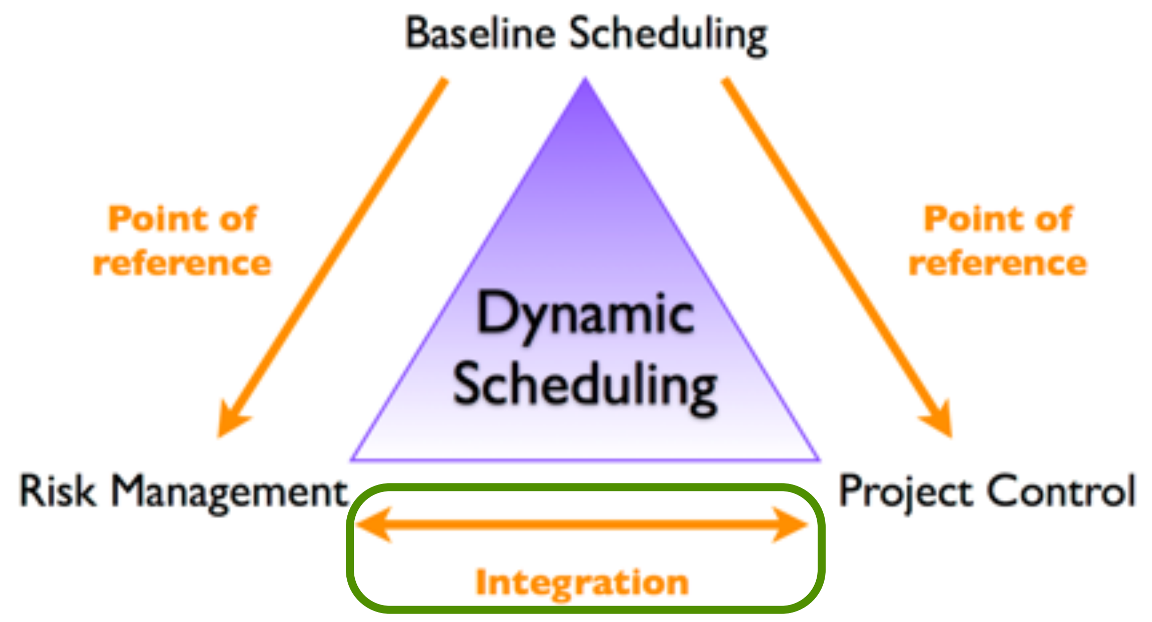
accuracy

FUTURE RESEARCH

- Continuous qualitative expansion of the **empirical** project database
  - → project cards
- Database = basis for multiple future research topics

FUTURE RESEARCH

- Continuous qualitative expansion of the empirical project database
  → project cards
- Database = basis for multiple future research topics
  - Further development of project regularity concept
  - Improving time and cost forecasting techniques (based on EVM)
  - Integration of SRA with EVM



QUESTIONS?

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