OR-AS Operations Research Applications and Solutions	Case Name: **Compressor Station Zelzate**	Sector	Construction (Industrial)	
	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	Tim Vandenbussche		User defined distributions	
Date	May 16, 2014	Project Control	Automatic tracking	
File Name	C2014-04 Compressor Station Zelzate.p2x		Tracking based on user input	■

1. Project description

Project authenticity

At the request of Belgian natural gas operator Fluxys a new compressor station is built in Zelzate (Belgium) in order to increase the natural gas storage capacity of the network.

No information about the true network structure (activities and precedence relations) was available for this project, although monthly cost data were obtained directly from the actual project owner.

2. Project properties

2.1. Baseline Schedule

General	
# Activities	24
Planned Duration (PD)	522 days*
Budget At Completion (BAC)	62,385,600 €
Renewable Resources	-
Consumable Resources	-

Network topology	
Serial/Parallel (SP)	95%
Activity Distribution (AD)	100%
Length of Arcs (LA)	0%
Topological Float (TF)	100%

* standard eight-hour working days

2.2. Risk Analysis

Random simulation by ProTrack was performed using the default symmetric triangular risk distribution profiles.

	Cost sensitivity		
	avg [%]	std dev [%]	skew [-]
CRI-r	21.0	11.4	0.6
CRI-rho	20.2	11.1	0.4
CRI-tau	12.0	7.4	0.6

	Resource sensitivity		
	avg [%]	std dev [%]	skew [-]
CRI-r	N/A	N/A	N/A
CRI-rho	N/A	N/A	N/A
CRI-tau	N/A	N/A	N/A

	Time sensitivity		
	avg [%]	std dev [%]	skew [-]
CI	100.0	0.0	0.0
SI	100.0	0.0	0.0
SSI	17.9	1.6	-0.9
CRI-r	23.1	6.9	0.2
CRI-rho	22.4	6.6	0.0
CRI-tau	12.9	4.5	-0.2

2.3. Project Control

2.3.1. Simulated forecasting 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) have been calculated to evaluate the expected accuracy of the time and cost predictions, EAC(t) and EAC, respectively.

Simulated EAC(t) accuracy		
method - PF	MAPE [%]	MPE [%]
PV - 1	1.3	-0.7
PV - SPI	1.9	-0.4
PV - SCI	4.1	0.3
ED - 1	1.3	-0.7
ED - SPI	1.9	-0.5
ED - SCI	3.2	-0.2
ES - 1	1.2	-0.7
ES - SPI(t)	2.1	-0.2
ES - SCI(t)	3.5	0.0

Simulated EAC accuracy		
method (PF)	MAPE [%]	MPE [%]
1	1.1	-0.4
CPI	2.0	0.0
SPI	1.6	-0.1
SPI(t)	1.9	0.0
SCI	3.0	0.1
SCI(t)	3.3	0.3
0.8 CPI + 0.2 SPI	1.9	0.0
0.8 CPI + 0.2 SPI(t)	2.0	0.0

According to the MAPE values[1] the best performance for time forecasting can be expected from one of the three unweighted methods. For cost forecasting the unweighted method should also yield the best results.

2.3.2. Tracking description

Tracking authenticity

Manual tracking was performed over 36 tracking periods with a length of approximately one month. 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 (in this case an activity is actually the work planned to be completed in a particular month) start dates, durations and costs.

[1] The MAPE gives the best indication for the forecast accuracy (the lower the MAPE, the more accurate the method) since all deviations from the targeted real duration (real cost) are cumulated, whereas for the MPE underestimates can be compensated by overestimates and vice versa, possibly leading to an overly positive evaluation of a certain method. However, the MPE can provide useful information about the nature of the deviations, i.e. does the method rather underestimate or overestimate the real duration (real cost)?

2.3.3. Earned Value Management

2.3.3.1. Performance metrics

	CV [€]	SV [€]	SV(t) [d]	CPI [-]	SPI [-]	SPI(t) [-]	p-factor [-]
avg	-1,056,294	-5,646,742	-102.21	0.98	0.83	0.73	1.00
std dev	1,055,960	4,143,552	80.09	0.02	0.15	0.13	0.00
final	-3,141,328	0	-326.00	0.95	1.00	0.62	1.00

2.3.3.2. Time forecasting

PD	522 days

Real Duration	848 days

Late	62.45%

EAC(t)			**Real Accuracy**	
method - PF	avg [d]	std dev [d]	MAPE [%]	MPE [%]
PV - 1	569.25	34.67	32.9	-32.9
PV - SPI	655.00	135.74	24.8	-22.8
PV - SCI	665.64	128.71	23.6	-21.5
ED - 1	621.92	87.36	26.7	-26.7
ED - SPI	709.79	124.81	18.4	-16.3
ED - SCI	711.21	123.98	18.3	-16.1
ES - 1	624.21	80.09	26.4	-26.4
ES - SPI(t)	743.56	143.43	17.8	-12.3
ES - SCI(t)	745.14	142.31	17.6	-12.1

2.3.3.3. Cost forecasting

BAC	62,385,600 €

Real Cost	65,526,930 €

Over Budget	5.04%

EAC			**Real Accuracy**	
method (PF)	avg [€]	std dev [€]	MAPE [%]	MPE [%]
1	63,441,893	1,055,960	3.2	-3.2
CPI	63,569,407	1,122,394	3.0	-3.0
SPI	73,690,196	12,343,798	14.0	12.5
SPI(t)	77,234,359	16,747,889	18.7	17.9
SCI	73,833,675	12,262,958	14.0	12.7
SCI(t)	77,390,919	16,651,468	18.9	18.1
0.8 CPI + 0.2 SPI	64,963,961	1,100,258	1.6	-0.9
0.8 CPI + 0.2 SPI(t)	65,321,980	1,436,054	1.8	-0.3