

 Operations Research Applications and Solutions	Case Name: <b>Railroad construction</b>	Sector	Construction (Civil)	
	<b>OR-AS</b> Operations Research - Applications and Solutions <a href="http://www.or-as.be">www.or-as.be</a> <a href="mailto:info@or-as.be">info@or-as.be</a>	Baseline Schedule	Schedule with resources	
			Schedule with costs	
		Risk Analysis	Random simulation	
			One of nine std. scenarios	
			User defined distributions	
Submitted by	Stef Pauwels, Emile Van de Walle			
Date	June, 2023	Project Control	Automatic tracking	
File Name	C2023-12		Tracking based on user input	

## 1. Project description

Project authenticity

The construction of five above-ground railroads, including hardware and software construction.

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

## 2. Project properties

### 2.1. Baseline Schedule

General	
# Activities	73
Planned Duration (PD)	383*
Budget At Completion (BAC)	7612805.15 €
Renewable Resources	-
Consumable Resources	-

\* standard eight-hour working days

Network topology	
Serial/Parallel (SP)	12%
Activity Distribution (AD)	40%
Length of Arcs (LA)	1%
Topological Float (TF)	49%

### 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	5.56	23.07	3.96
CRI-rho	100.00	0.00	-
CRI-tau	100.00	0.00	-

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

	Time sensitivity		
	avg [%]	std dev [%]	skew [-]
CI	6.18	10.88	3.35
SI	31.45	22.21	1.04
SSI	3.23	7.63	3.73
CRI-r	3.91	7.96	6.07
CRI-rho	3.91	7.90	5.60
CRI-tau	3.57	5.68	5.39

## 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			Simulated EAC accuracy		
method - PF	MAPE [%]	MPE [%]	method (PF)	MAPE [%]	MPE [%]
PV - 1	15.42	-8.05	1	0.00	0.00
PV - SPI	23.21	4.66	CPI	0.00	0.00
PV - SCI	23.21	4.66	SPI	5.72	5.72
ED - 1	57.15	-57.15	SPI(t)	6.70	6.70
ED - SPI	23.21	4.66	SCI	5.72	5.72
ED - SCI	23.21	4.66	SCI(t)	6.70	6.70
ES - 1	12.20	-1.08	0.8 CPI + 0.2 SPI	2.81	2.81
ES - SPI(t)	34.20	33.38	0.8 CPI + 0.2 SPI(t)	4.22	4.22
ES - SCI(t)	34.20	33.38			

According to the MAPE values<sup>1</sup> the best performance for time forecasting can be expected from the unweighted Earned Duration method. For cost forecasting the unweighted and CPI-weighted methods should yield the best results.

### 2.3.2. Tracking description

Tracking authenticity

Manual tracking was performed over 17 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 start dates, durations and costs.

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<sup>1</sup> 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	636912.13	-2311014.19	-120.25	1.06	0.38	0.35	0.74
std dev	1065504.88	1138538.61	79.63	0.89	0.37	0.37	0.21
final	329559.00	-2121499.5	-108.00	1.07	0.71	0.71	0.71

#### 2.3.3.2. Time forecasting

PD	383 days	Real Duration	403 days	Late	5.22%
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EAC(t)			Real Accuracy	
method - PF	avg [d]	std dev [d]	MAPE [%]	MPE [%]
PV - 1	500.94	57.30	24.30	-24.30
PV - SPI	1098.60	1196.99	172.61	-172.61
PV - SCI	1014.67	1255.21	170.01	-151.78
ED - 1	465.58	53.24	15.53	-15.53
ED - SPI	1098.60	1196.99	172.61	-172.61
ED - SCI	1051.18	1228.24	163.28	-160.84
ES - 1	473.54	58.46	17.50	-17.50
ES - SPI(t)	2049.41	3049.31	408.54	-408.54
ES - SCI(t)	1992.19	3086.51	394.34	-394.34

#### 2.3.3.3. Cost forecasting

BAC	7612805.15 €	Real Cost	4791783.00 €	Under Budget	37.06%
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EAC			Real Accuracy	
method (PF)	avg [€]	std dev [€]	MAPE [%]	MPE [%]
1	2184107.38	1065504.88	45.58	-45.58
CPI	1670610.95	1987687.89	48.33	-34.86
SPI	14238052.75	22804898.32	297.13	-297.13
SPI(t)	31377416.25	56632385.18	654.82	-654.82
SCI	13496049.38	23356397.66	287.59	-281.65
SCI(t)	30543857.75	57208794.39	640.1	-637.42
0.8 CPI + 0.2 SPI	2143984.63	2258662.42	55.55	-44.74
0.8 CPI + 0.2 SPI(t)	2186958.7	2301433.97	56.28	-45.64