Using exponential smoothing to integrate the impact of corrective actions on project time forecasting

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If you want to refer to this presentation, please refer to:
- Martens, A., & Vanhoucke, M. (2020). Integrating corrective actions in project time forecasting using exponential smoothing. *JOURNAL OF MANAGEMENT IN ENGINEERING*, *36*(5). https://doi.org/10.1061/(asce)me.1943-5479.0000806
- https://www.projectmanagement.ugent.be/research/data/realdata

PROJECT TIME FORECASTING

Indicator for performance: performance of similar completed projects

- Historical data not always available
- Definition of similarity not always clear

Indicator for performance: past performance of the project

- General EVM/ES and EDM forecasting formula:

$$EAC(t) = AT + \frac{PD - ES}{PF} \qquad EDAC = AT + \frac{PD - ED}{PF}$$

PF = Performance Factor, e.g. SPI(t) or DPI

- **Corrective action:** temporary / local performance improvement by the project manager to get the project back on track

↓

past performance no longer an accurate indicator of future performance!

EXPONENTIAL SMOOTHING FOR PROJECT TIME FORECASTING

- Forecasting method based on weighted average of past observations
- Assign greater weights to project performance of recent periods by smoothing the performance factor of the EVM/ES or EDM forecasting formula:[1,2]

$$\mathrm{SPI}(t)'_t = \alpha \mathrm{SPI}(t)_t + (1-\alpha)\mathrm{SPI}(t)'_{t-1} \qquad \mathrm{DPI}'_t = \alpha \mathrm{DPI}_t + (1-\alpha)\mathrm{DPI}'_{t-1}$$

α = smoothing parameter

- Determination of α: dynamic and qualitative
  - **Dynamic:** α can vary during project execution
  - **Qualitative:** α is adjusted by the PM after human intervention

Use 2 values for smoothing parameter α:
- α_1 if no corrective actions have been taken in tracking period *t-1*
- α_2 if corrective actions have been in tracking period *t-1*

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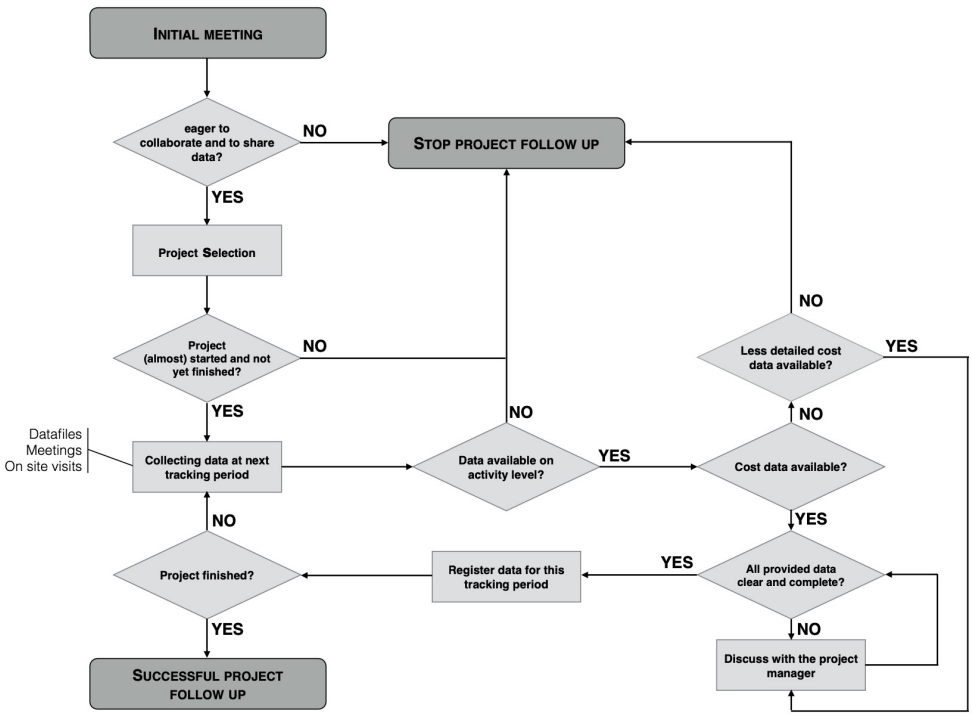
[1] Khamooshi, H. and Abdi, A. (2016). "Project duration forecasting using earned duration management with exponential smoothing techniques." *Journal of Management in Engineering*, 33(1), 04016032.
[2] Batselier, J. and Vanhoucke, M. (2017). "Improving project forecast accuracy by integrating earned value management with exponential smoothing and reference class forecasting." *International Journal of Project Management*, 35(1), 28–43.

DATA COLLECTION



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PROJECT CHARACTERISTICS

ID	Project description	Baseline start	Baseline end	Industry	BAC (€)	# acts	#TPs
P1	Apartment complex	30/07/15	14/08/17	Residential building	1.192.979	86	10
P2	Social Housing	20/01/17	28/05/18	Residential building	734.602	18	10
P3	Emergency Department	15/07/16	13/02/18	Civil construction	967.878	17	22
P4	Nuclear Healthcare	06/01/16	09/06/17	Civil construction	4.318.950	33	24
P5	Fuel Tank Filter	09/05/16	20/05/18	Production	1.456.000	15	10
P6	Production line change	31/10/16	01/09/18	Production	1.512.000	23	11
P7	Gluing machine	11/09/17	06/04/18	Production	107.500	8	10
P8	Labeling machine	04/09/17	09/02/18	Production	114.700	7	9

PROJECT OUTCOMES

ID	PD (workdays)	AD (workdays)	Deviation from PD (%)	BAC (€)	Total Cost	Deviation from BAC (%)
P1	533	672	26.08	1.192.979	1.315.820	10.30
P2	352	355	0.85	734.602	748.556	1.90
P3	413	521	26.15	967.878	1.270.876	31.31
P4	373	519	39.14	4.318.950	4.232.553	-2.00
P5	510	515	0.98	1.456.000	1.476.290	1.39
P6	480	501	4.38	1.512.000	1.534.060	1.46
P7	150	189	26.00	107.500	116.800	8.65
P8	115	182	58.26	114.700	128.200	11.77

CLASSIFICATION OF CORRECTIVE ACTIONS

Category	occurrences	occurrence in projects	type of action
Status update call employees	6	P1, P3, P4, P5, P7	variability reduction/activity crashing
Status update call subcontractor	3	P2, P6, P8	variability reduction/activity crashing
Use new resource/supplier	3	P1, P5, P8	activity crashing
Use compensation claim in contracts	2	P3, P4	activity crashing
Involve higher management	3	P3, P7	variability reduction/activity crashing
Overtime work	2	P1, P6	activity crashing

FORECASTING ACCURACY FOR COMBINATIONS OF α_1 AND α_2

- Best smoothing parameter for $\alpha_1 = \alpha_2$: 0.2
- Best smoothing parameter for $\alpha_1 \neq \alpha_2$: $\alpha_1 = 0.1, \alpha_2$=0.7

		α_1									
		0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**
α_2	**0.1**	***12.58***	12.75	13.02	13.27	13.52	13.78	14.08	14.40	14.66	14.89
	0.2	12.19	***12.43***	12.73	13.00	13.25	13.52	13.86	14.15	14.41	14.64
	0.3	11.87	12.16	***12.47***	12.75	13.02	13.33	13.65	13.94	14.18	14.41
	0.4	11.60	11.91	12.24	***12.53***	12.82	13.17	13.47	13.74	13.98	14.20
	0.5	11.38	11.71	12.04	12.35	***12.69***	13.02	13.31	13.56	13.79	14.09
	0.6	**11.24**	11.58	11.93	12.29	12.61	***12.91***	13.18	13.41	13.63	13.83
	0.7	**10.99**	11.35	11.74	12.12	12.46	12.85	***13.10***	13.32	13.53	13.73
	0.8	**11.17**	11.57	11.94	12.26	12.53	12.79	13.02	***13.24***	13.43	13.63
	0.9	11.35	11.71	12.05	12.33	12.59	12.82	13.04	13.24	***13.43***	13.62
	1.0	11.55	11.87	12.17	12.42	12.65	12.87	13.07	13.26	13.44	***13.63***

COMPARISON OF FORECASTING ACCURACY

	EDAC PF=1	EDAC PF=DPI	EDAC-XSM $\alpha = 0.2$	EDAC-CA $\alpha_1 = 0.1, \alpha_2 = 0.7$
Overall	11.38	13.03	12.43	10.99
Early	17.66	21.46	22.47	20.43
Middle	11.92	10.56	6.80	4.85
Late	6.47	7.11	6.46	5.82

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