Escalation Price Adjustment:

A case study in a 100 Million FIDIC Contract

alpha three

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Washington, DC - USA

Hello!, it’s a pleasure to meet you…

- ✓ Senior Project Controls Manager at Alpha 3 Consulting, NJ, USA.
- ✓ BS on Electrical Engineer with more than 18 years of experience in the development and/or management of Infrastructure Construction Projects for many industries (Energy, Oil & Gas, Mining & Public Administration).
- ✓ MBA, Masters Degree in Electrical Power & Transmission Systems, Diploma Program in Project Management.
- ✓ Professor in PM Programs, International Speaker on Technical Project Management areas (risk, cost, and schedule) since 2015 in Peru, Colombia, Mexico, UK and USA.
- ✓ Regional Director 10 (LATAM & Caribbean) AACE International.
- ✓ PMI Certifications: PMP®, RMP®, ACP®

Something you don't know about me…

- ✓ In my Master's and Diploma program, I earned 1st place and honor recognition (Cum-Laude).
- ✓ I was a volunteer firefighter for more than 12 years, reaching the rank of Fire Lieutenant and being elected Fire Chief of the Volunteer Fire Department (Venezuela) for the 2008 – 2009.
- ✓ That is not my first time that I’m presenting in English!...

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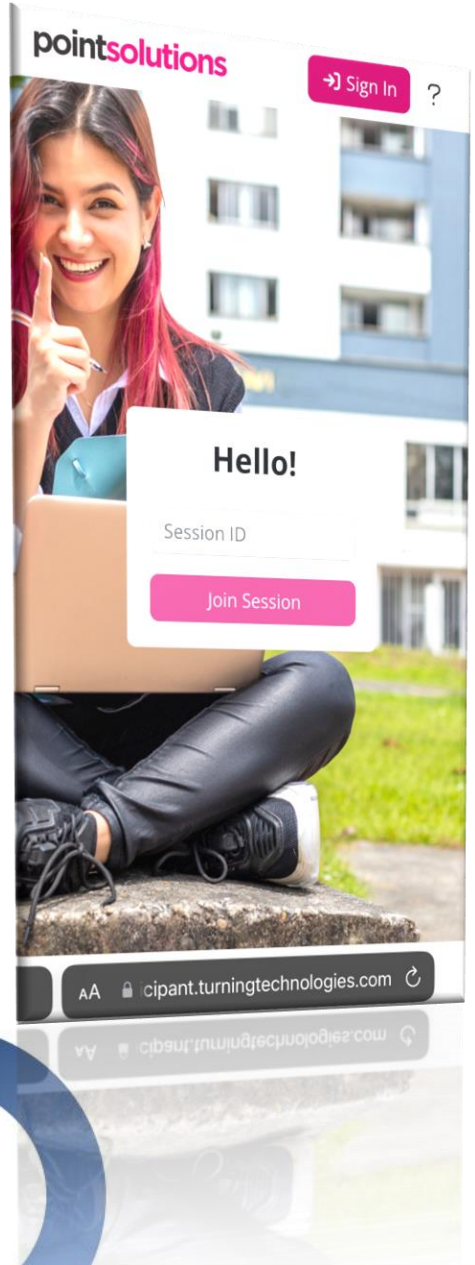
Ok, what are we going to learn, together, today?

The purpose of this presentation is to… gain an understanding of Price Adjustment variables/factor and take the lessons learned from the 100 million USD FIDIC contract.

At the end of this presentation, broadly, you will be able to:

1. **Understand** what is a Price adjustment factor for time and location.
2. **Identify** what options do you have for deciding the AF.
3. **Describe** what are the related indexes, T&T, formulas…
4. **Explain** the use of a Price adjustment factor.
5. **Conclude**, together, the best option for this case study.
6. …



Let's share knowledge and learn, together...

1. Go to ttpoll.com on your (safari, chrome) laptop/cellphone.
2. The session ID is PCEUSA2023.
3. Please just fill your name (last name and email are optional)
4. It's time to share knowledge!

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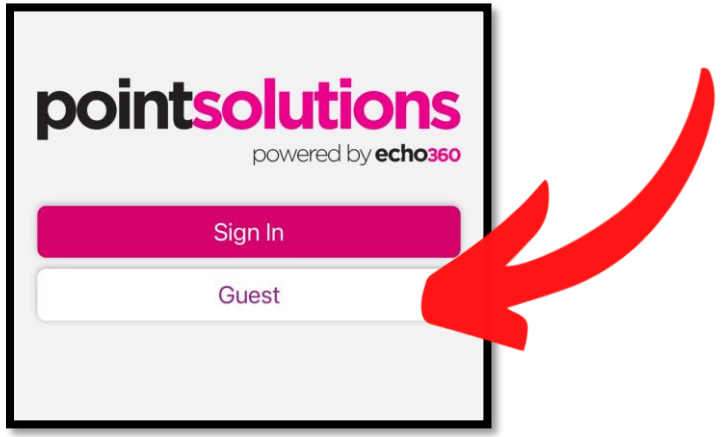

Enter as a GUEST.

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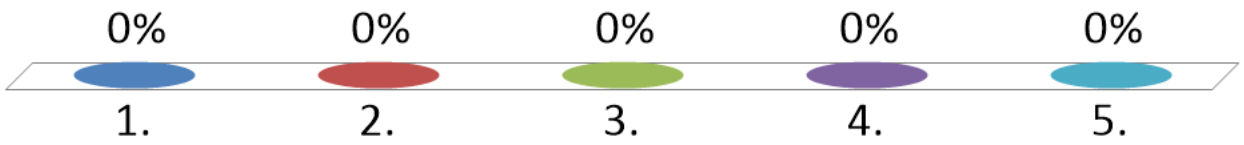
Regarding price adjustment factors, I believe I know a great deal about this topic, which I use frequently in my long-term projects and for which the clauses are typically included in the contract.

1. Strongly Agree
2. Agree
3. Undecided
4. Disagree
5. Strongly Disagree



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Basic Theory of Adjustment Factors

Basic Theory of Adjustment Factors

Value A *AF = Value B

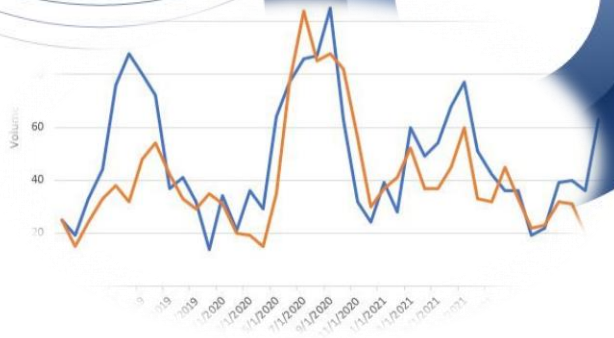
- ✓ The authority in the field *(the government or someone authorized by the government)*, gives us the reference value (and many times we don't even ask why).
- ✓ Although I could use the AF value that I want, always we use the value given by the associated authority.
- ✓ This value will be acepted (whether they want it or not) by the parties.
- ✓ There are RULES, CRITERIA already defined...

The GPS tells me that we are 10 miles away, but I want Kilometers...

This bed is measured in feet, but I understand meters...

I need 1,000 USD, but I have 350 PEN...

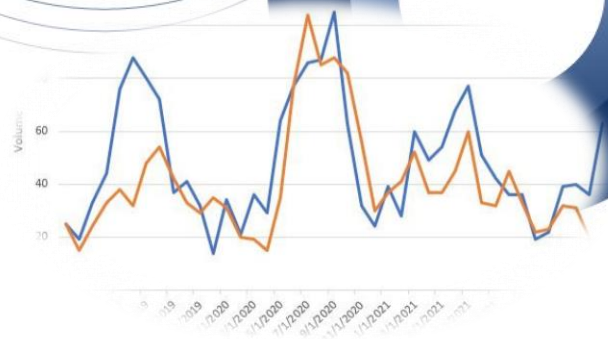
We can use AF for location, for example…



Location Adjustments

- ✓ Derive from many factors, including differences in local labor productivity, wage rates, materials costs, equipment costs & government policies
  - ✓ e.g., labor benefits, insurance, taxes, environmental restrictions, safety requirements
- ✓ Relative costs between locations do not necessarily remain same over **time.**
- ✓ Costs at any location may not change over time in direct proportion to changes in national average costs.
- ✓ For R.S. Means Building Construction Cost Data, location adjustments for various CSI Divisions are relative to an index of 100 for national average cost for such work.

We can use AF for location, for example…



Time Adjustments

- ✓ Derive from inflation & escalation.
  - ✓ General inflation is a result of governmental monetary policy, among others.
  - ✓ In the past 60 years, the United States has only experienced deflation two times; in 2009 with the Great Recession and in 2015, when the CPI barely broke below 0% at −0.1%.[1]
- ✓ Escalation is a result of economic factors & policy, such as labor & materials supply & consumer demand.
  - ✓ Much more variable & difficult to predict than general inflation.
- ✓ Some TAF may be based only on national average costs from year to year.
- ✓ Time adjustment indices may include also location adjustments.
  - ✓ One pair of indices can adjust costs at Location A in Year X to costs at Location B in Year Y.

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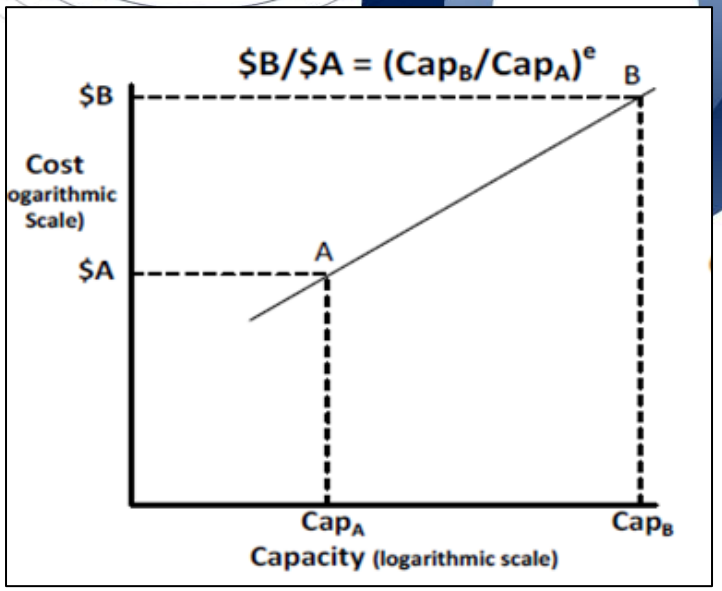
1 = Rosenberg, Yuval (26 February 2015). "America Is In Deflation. So What?". The Fiscal Times.

AF Formulae

Basic equations for Location adjustment / Time adjustment factor and other types of "factors" (Capacity factors?)

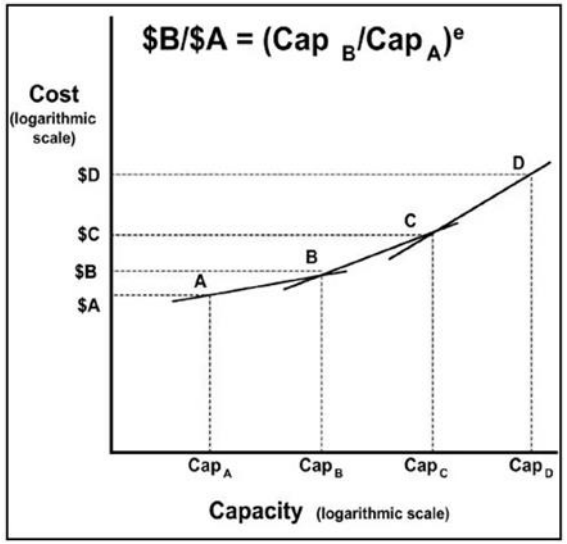


$$C_2 = C_1 \left(\frac{I_2}{I_1} \right)$$

We need Index/Indices

$$C_2 = C_1 \left(\frac{Q_2}{Q_1} \right)^e$$

We don't need Index/Indices



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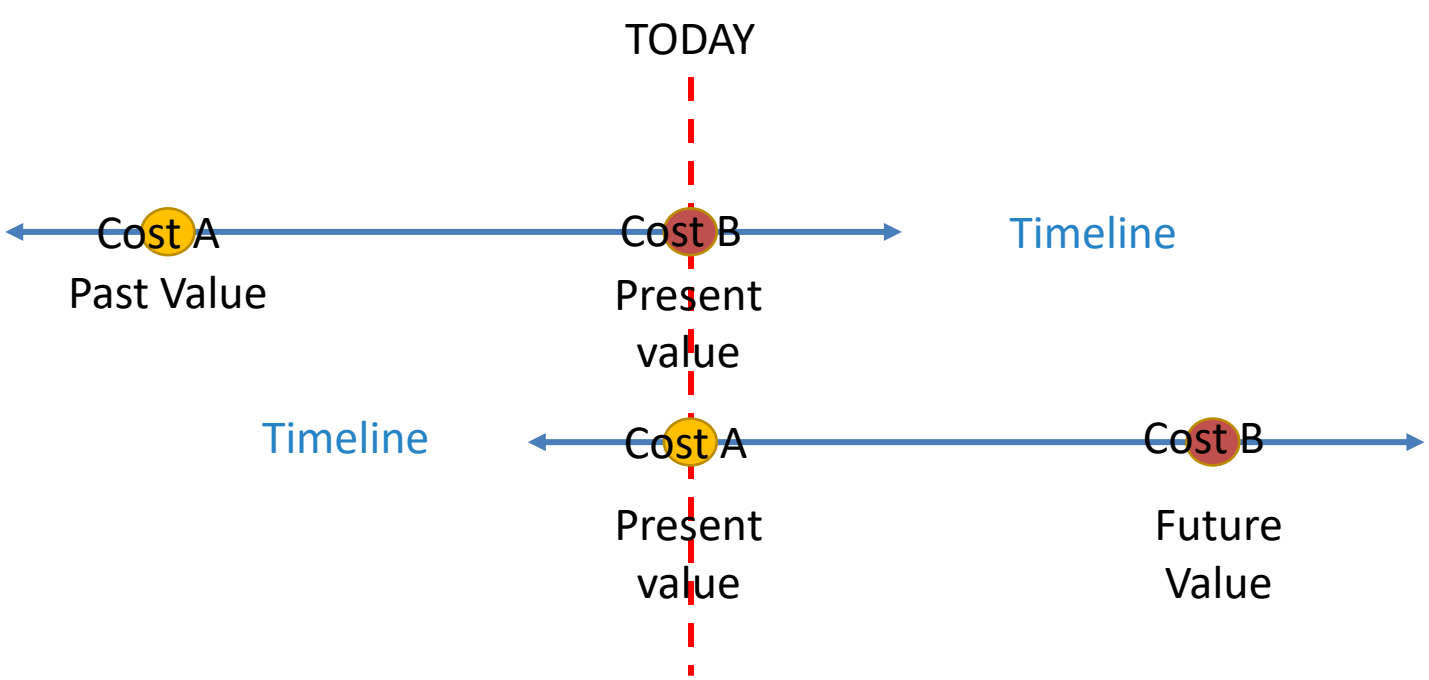
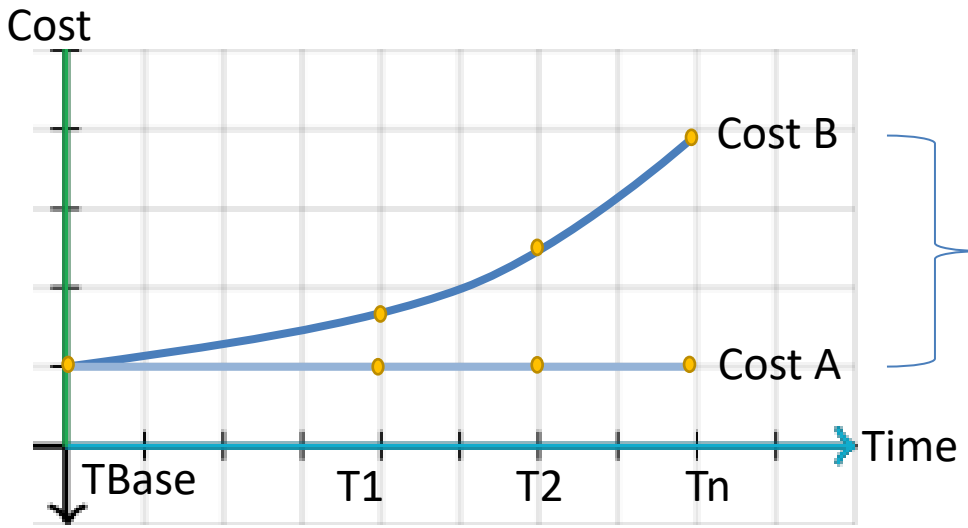
Ok, what is a Time Price/Cost Adjustment Factor (AF)?

Cost A *AF= Cost B

Price A *AF= Price B





Adjustment factor

Factor de Ajuste

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Let's see an example…

- ✓ Process plant built in Location A in 2022 has capacity of 5 MM units per year.
- ✓ A new & similar process plant, to produce 9 MM units per year, being considered for construction in 2025 in Location B.
- ✓ Cost of 2022 plant was $57 MM
- ✓ Exponential relationship for such plants found to be 0.68
- ✓ Estimate cost of proposed plant B using Scale-of-Operations estimating method.
- ✓ Cost index for Location A in 2022 was **1644** and economists estimate the index for Location B in 2025 will be **2091**.

$$C_2 = C_1 \left(\frac{I_2}{I_1} \right)$$

$$C_2 = C_1 \left(\frac{Q_2}{Q_1} \right)^e$$

Let's see an example…

Answer

$C_2 = C_1(Q_2 / Q_1)^e = \$57\ MM\ (9\ MM/5\ MM)^{0.68}$

$C_1 = \$57\ MM$ $= \$57\ MM\ (1.49)$

$Q_2 = 9\ MM$ $C_2 = \$85\ MM$ (w/o index) **2022**

$Q_1 = 5\ MM$

$x = 0.68$

Index Cost – Plant A = $CI_1 = 1644$

Index Cost – Plant B = $CI_2 = 2091$

What is this index?

New (Indexed) Cost – Plant B = $C_2 = (2091/1644) \times \$85\ MM$

$C_2 = 1.27 \times \$85\ MM$

$C_2 = \$108\ MM$ (w/ index) **2025**

$$C_2 = C_1 * \left(\frac{Q_2}{Q_1}\right)^e$$

$$C_2 = C_1 \left(\frac{I_2}{I_1}\right)$$

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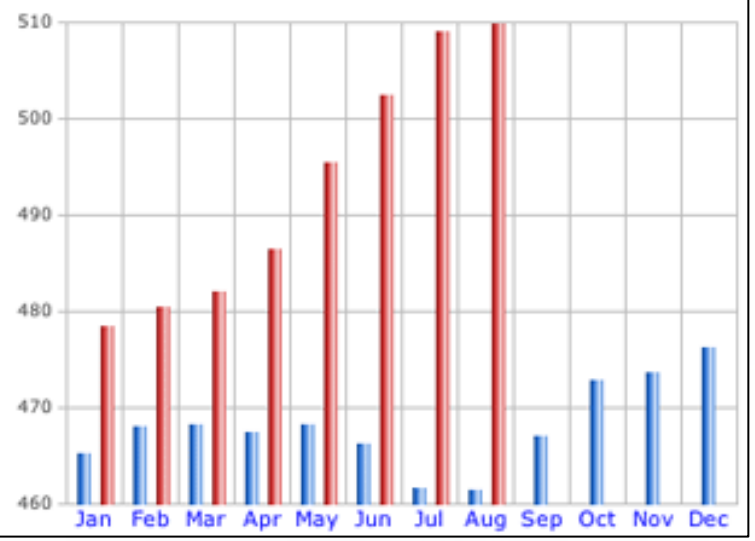
We need Index/Indices

- ✓ Marshall Swift Index (M&S)
- ✓ Chemical Engineering Index
- ✓ Nelson–Farrah Index
- ✓ ENR Index (Engineering News Record)

$$C_2 = C_1 \left(\frac{I_2}{I_1} \right)$$

	Sep '06 Prelim.	Aug '06 Final	Sep '05 Final
CE INDEX	513.1	510.0	467.2
Equipment	606.5	602.3	541.2
Heat Exchanges and Tanks	565.1	560.9	509.2
Process Machinery	559.6	556.2	521.7
Pipe, valves and fittings	734.7	731.7	620.8
Process Instruments	441.4	437.2	379.5
Pumps and Compressions	788.9	788.3	756.3
Electrical equipment	418.9	414.2	374.6
Structural supports	643.7	637.7	579.3
Construction Labor	314.7	312.9	309.1
Buildings	476.9	475.2	444.7
Engineering Supervision	350.7	351.9	346.9



Índices Nelson-Farrar

Refinería de construcción (base 1946)

	1962	1976	1994	1995	1996	1996 Oct.	1997 Set.	1997 Oct.
Bombas, compresoras, etc.	222,5	538,6	1278,2	1316,7	1354,5	1358,9	1390,1	1392,9
Maquinaria eléctrica	189,5	287,2	560,5	563,2	561,7	558,6	553,6	553,1
Maquinaria interna	183,4	348,3	838,2	854,9	875,5	878,7	882,5	883,1
Instrumentos	214,8	466,4	887,6	904,4	932,3	935,7	958,9	963,0
Intercambiadores de calor	183,6	478,5	690,7	758,6	793,3	789,6	757,3	773,8
Promedio equipos miscel.	198,8	423,8	851,1	879,5	903,5	904,3	908,5	913,2
Componente de materiales	205,9	445,2	877,2	918,0	917,1	917,3	924,7	927,6
Componente de labores	258,8	729,4	1664,7	1708,1	1753,5	1772,6	1813,1	1817,0
Refinería (inflación)	237,6	615,7	1349,7	1392,1	1418,9	14305	1457,7	1461,3

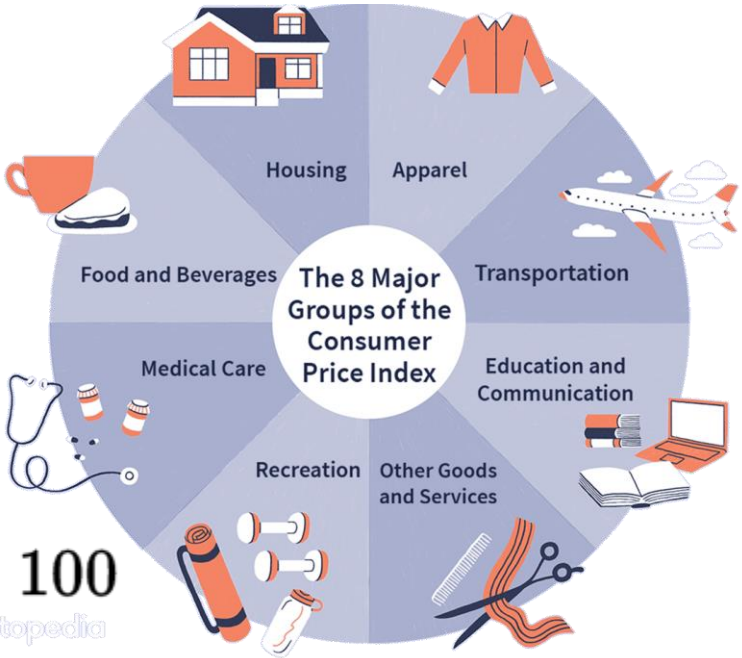
Refinería de operaciones (base 1956)

	1962	1976	1994	1995	1996	1996 Oct.	1997 Set.	1997 Oct.
Costo de combustible	100,9	384,5	447,7	461,6	546,7	576,8	516,6	562,8
Costo de trabajo	93,9	145,5	286,0	263,2	241,1	233,2	230,6	234,8
Salarios	123,9	314,3	903,2	900,5	884,3	872,7	926,6	930,1
Productividad	131,8	216,1	316,7	342,9	366,9	374,2	401,9	396,0
Investigación	121,7	252,6	539,9	561,3	567,6	572,2	578,5	579,9
Costo de productos químicos	96,7	195,2	213,9	245,4	252,7	252,8	254,9	255,3
Operaciones de refinería	108,7	209,3	405,8	410,6	413,3	415,1	411,6	418,0
Procesos unitarios	103,6	267,1	431,4	437,0	462,3	472,1	452,5	470,4

https://www.enr.com/economics/historical_indices/construction_cost_index_history

Is there any other type of Index/Indices?

- ✓ **Gross Domestic Product (GDP)**
  - ✓ a monetary measure of the market value of all the final goods and services produced and sold in a specific time period (Investopedia, 2023).
  - ✓ GDP is considered the preferred measure of headline inflation for forecasting purposes (Lochbryn, Oprisu & Wise, 2011).
- ✓ **Consumer price index (CPI)**
  - ✓ The price of a weighted average market basket of consumer goods and services purchased by households. Changes in measured CPI track changes in prices over time
  - ✓ CPI provides useful data to quantify inflation within certain sectors (Lochbryn, Oprisu & Wise, 2011).



$$CPI_t = \frac{C_t}{C_0} * 100$$

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Is there any other type of Index/Indices?

Raw Materials Price Index (RMPI)

✓ Measures price changes for raw materials purchased for further processing by manufacturers (operating in Canada).

Producer Price Index (PPI)

✓ Measures the average change over time in the selling prices received by domestic producers for their output.

Construction materials price index (IPMC)

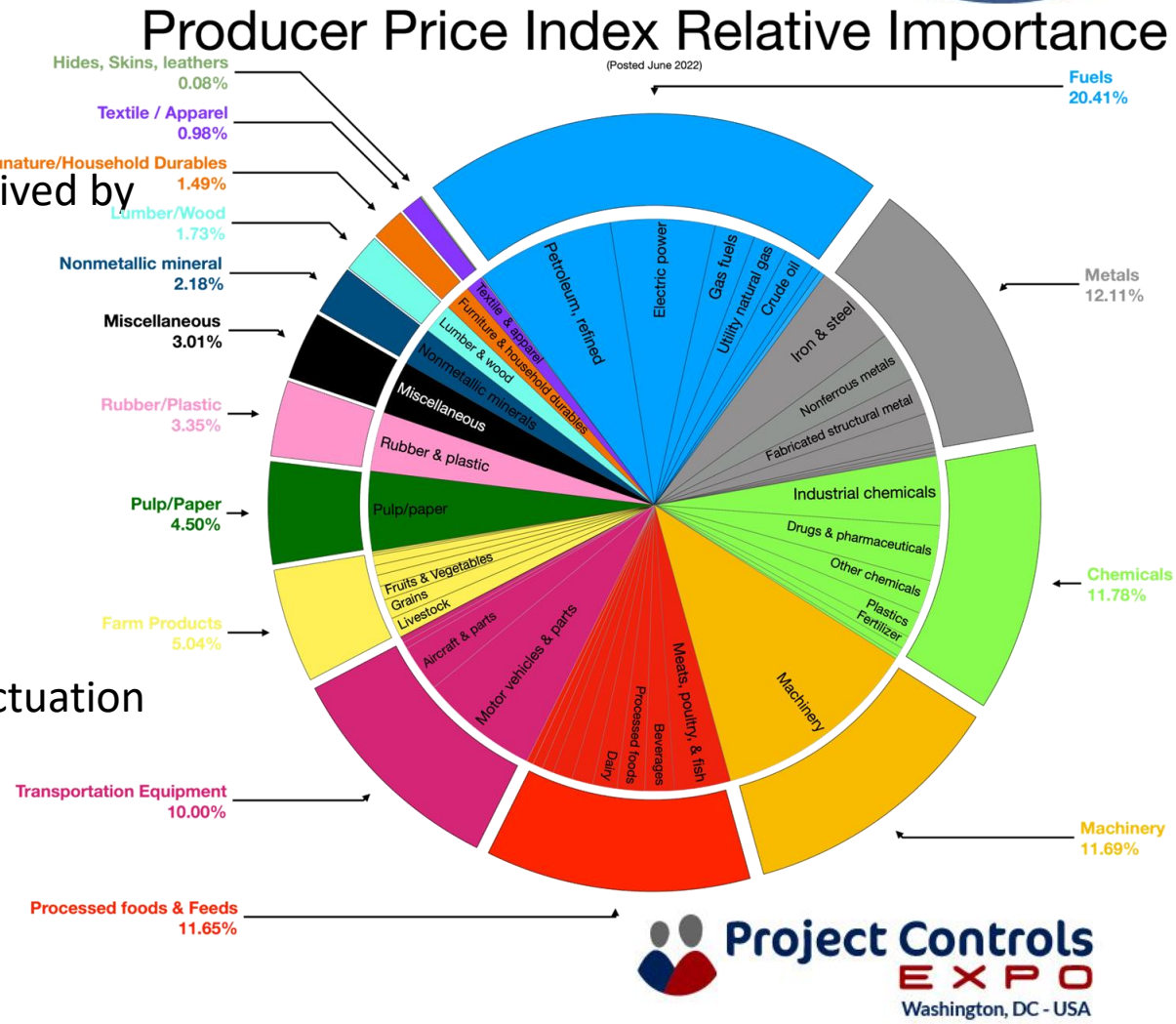
✓ (Mexico) indicator (typically monthly) of price developments.

✓ At different levels (producer, importer, etc…)

Unified construction price indices (IUPC)

✓ (Sth Am) Economic indicators that seek to reflect the average fluctuation of prices involved in the cost of civil construction work materials.

Etc…



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In 2017, the machinery and equipment for the ethylene glycol plant cost a total of $2,325,430. How much will this machinery cost in 2022?

A. US$ 3,600,000

B. US$ 4,600,000

C. US$ 4,650,870

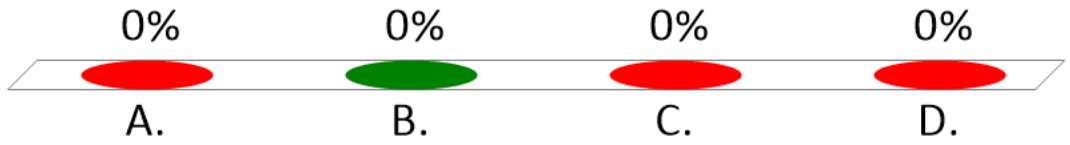
D. US$ 1,150,000

ENR'S CONSTRUCTION COST INDEX HISTORY (1908-2023)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
2023	13175.03	13175.93						
2022	1255						84	13171.07
2021	1162							12463
2020	1139							11455
2019	1120							11311
2018	1087							11124
2017	10542	10559	10667	10678	10692	10703	10789	10826

2017 – 4000

2022 – 8000



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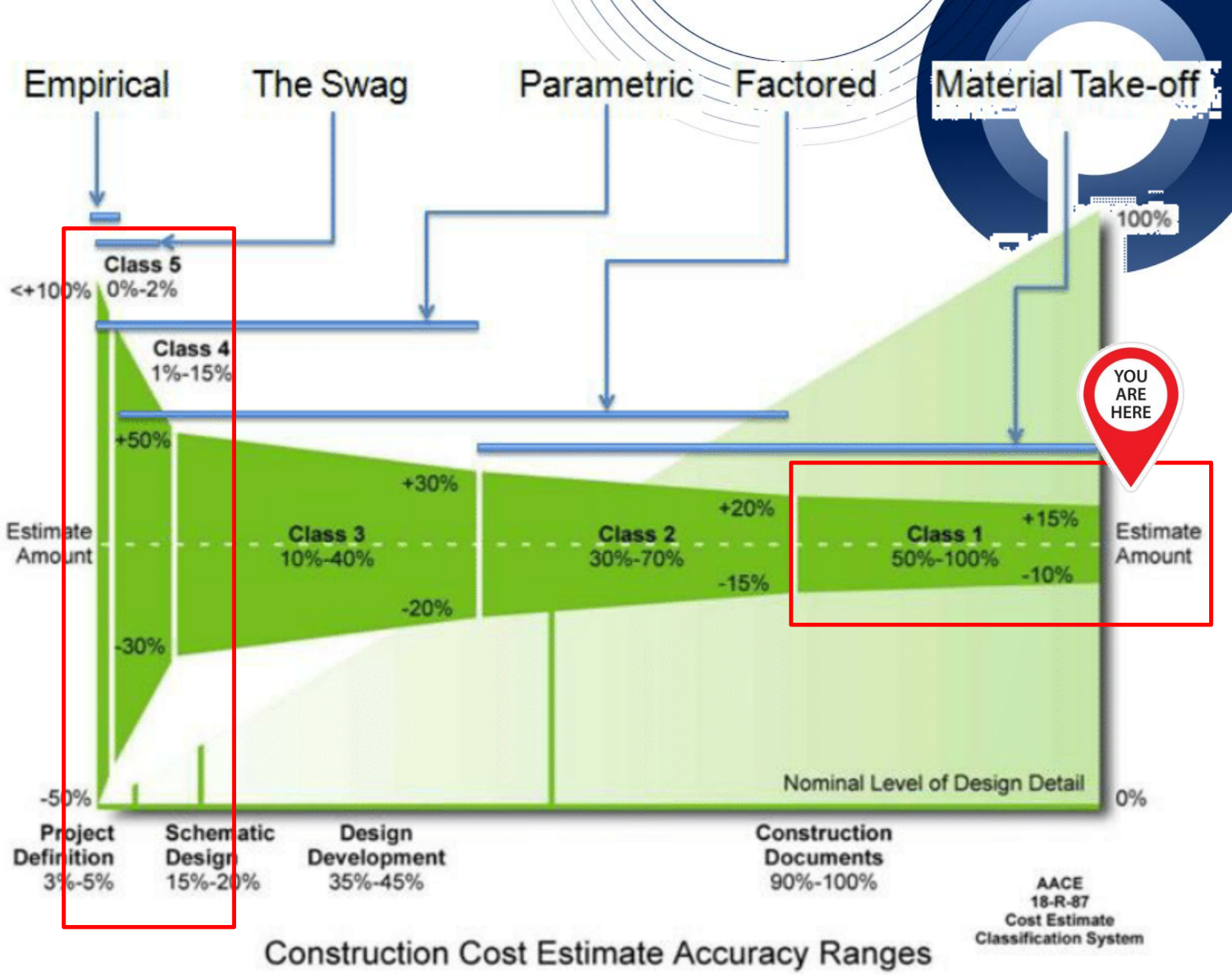
About the example…

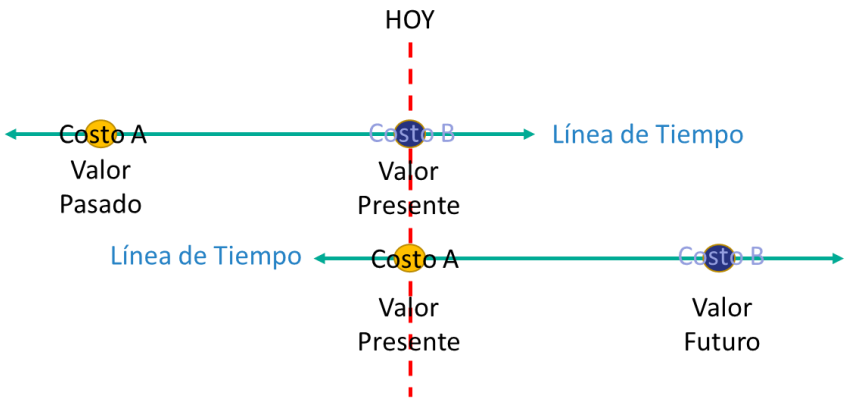
- ✓ **The multiplying factor (AF) will increase with the distance between the periods...**
  - ✓ Is not the same 2017 – 2019 as 2012 – 2019 (obvious reasons?)

BTW…

- ✓ **For this example, this is a CLASS 5 Technique…**
- ✓ **The case scenario will be in CLASS 1.**
  - ✓ That means even decimals matter...



Time PAF… what does the “authority” say about it ?



"a recognition of the variation in the costs of inputs, whose objective is to eliminate the effect of the increase or decrease in the amount of the contract, through compensation thereof, maintaining the offer in the same conditions in which it was presented”

Mexican Chamber of the Construction Industry [CMIC]

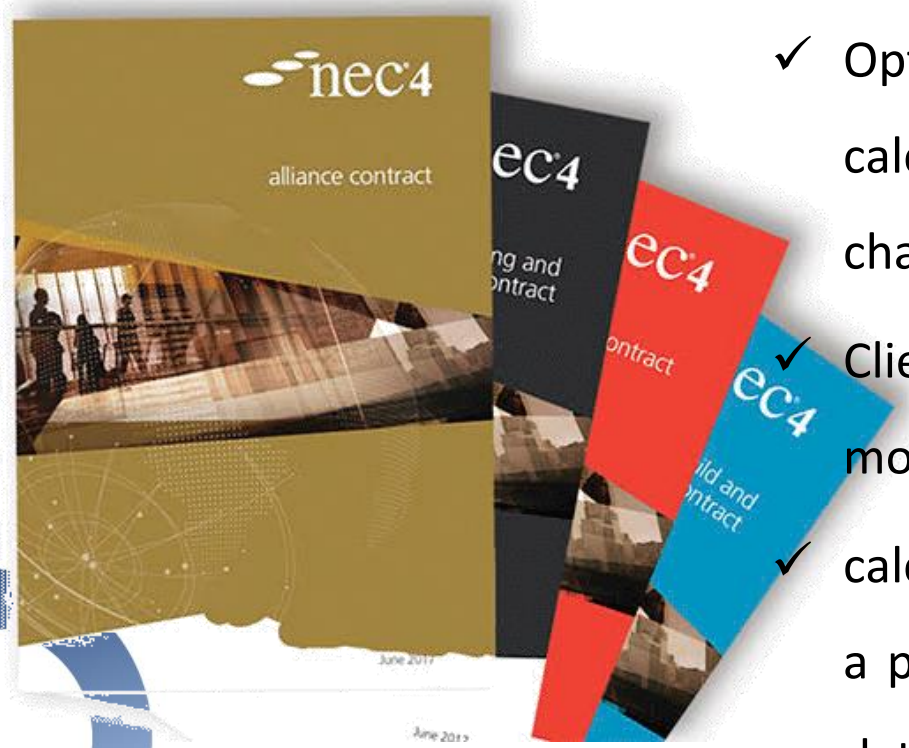
“A number which relates the cost of an item at a specific time to the corresponding cost at some specified prior time”

Association for the Advancement of Cost Engineering International [AACEi]

“inflation adjustments (…) adjusting for inflation correctly is necessary if the cost estimate is to be reliable”

U.S Government Accountability Office [GAO], Cost Estimating and Assessment Guide

PAF… what about NEC International Model Contract?



- ✓ Secondary option X1 on price adjustment for inflation can be used in NEC4 ECC, PSC and TSC. It can also be included as an additional condition of contract in the shorter NEC contracts.
- ✓ Option X1 involves setting a base date **before the tender date**, then calculating the price adjustment before each assessment date based on the changing value of an agreed prices index or indices.
- ✓ Clients need to choose the prices index or indices with care to ensure the model of inflation is appropriate for the contract.
- ✓ calculates a ‘Price Adjustment Factor (PAF)’ based on the changing values of a prices index or a series of indices and weightings set out in the contract data. These are normally chosen by the client.

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PAF… what about FIDIC International Model Contract?

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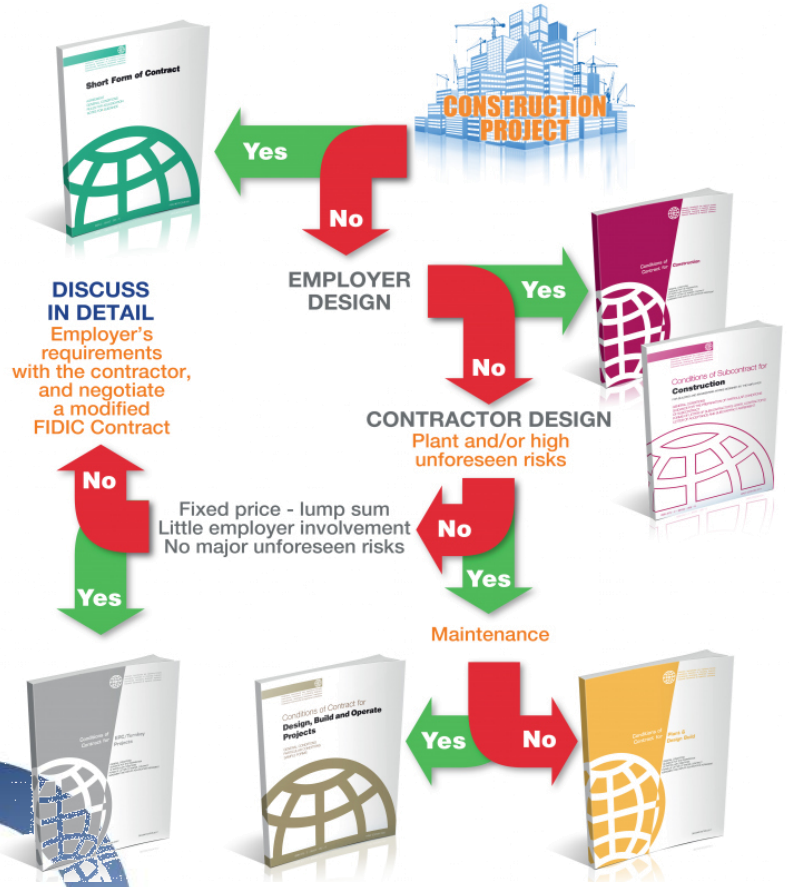

- ✓ Price adjustment is a contemporary and new clause in contract management of construction industries. It appears in contract management with FIDIC Red Book and the World Bank and United Nation Office for Project Service practice for small and large work.
- ✓ Adjustments for Changes in Cost (Price Adjustment) in FIDIC Red book explained under clause 13 (Variations and Adjustments) subclause 8 (Adjustments for Changes in Cost).
- ✓ Price adjustment equations involve fixed or nonadjustable and customizable cost parts.
- ✓ Let's talk about more about FIDIC…

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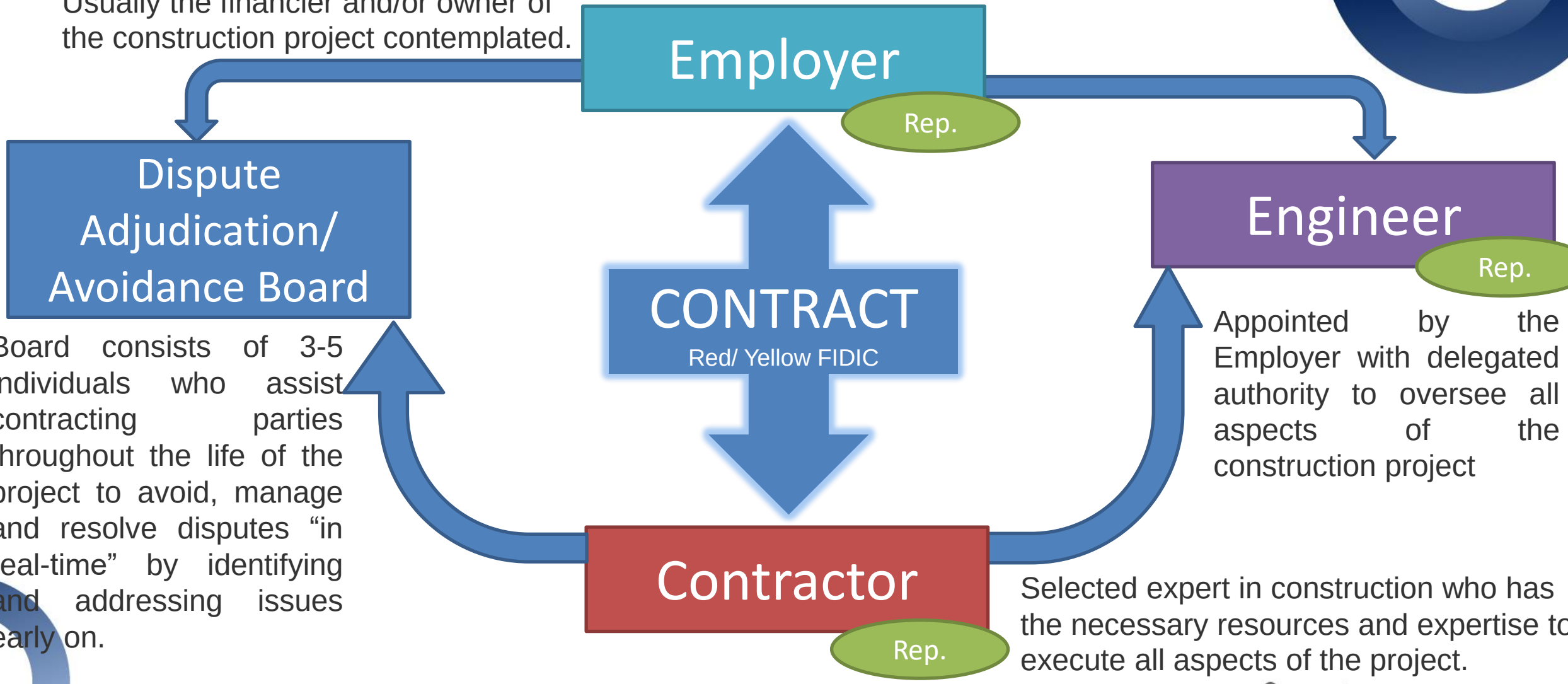
Parties in a FIDIC International Model Contract?

Usually the financier and/or owner of the construction project contemplated.



Board consists of 3-5 individuals who assist contracting parties throughout the life of the project to avoid, manage and resolve disputes “in real-time” by identifying and addressing issues early on.

Appointed by the Employer with delegated authority to oversee all aspects of the construction project

Selected expert in construction who has the necessary resources and expertise to execute all aspects of the project.

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FIDIC, let's talk about some important details…

13.8

Adjustments for Changes in Cost

In this Sub-Clause, "table of adjustment data" means the completed table of adjustment data included in the Appendix to Tender. If there is no such table of adjustment data, this Sub-Clause shall not apply.

If this Sub-Clause applies, the amounts payable to the Contractor shall be adjusted for rises or falls in the cost of labour, Goods and other inputs to the Works, by the addition or deduction of the amounts determined by the formulae prescribed in this Sub-Clause.

Contract Price and Payment

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The Global Voice of Consulting Engineers

14.1

The Contract Price

Unless otherwise stated in the Particular Conditions:

(d) the Contractor shall submit to the Engineer, within 28 days after the Commencement Date, a proposed breakdown of each lump sum price in the Schedules. The Engineer may take account of the breakdown when preparing Payment Certificates, but shall not be bound by it.

The FIDIC PAF Formula…

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} + \cdots + f$$

- ✓ Some called: “The polynomial formula” or “Fórmula Polinómica” (Spanish)
- ✓ Helps to obtain the "multiplying factor" called the readjustment coefficient of (work valuation) Payment Certificate.
- ✓ Adjustable cost component (green box), this will be obtained based on its proportional value of the total amount of established cost.
- ✓ Non-adjustable cost component (blue box), this is determined according to the relationship of a coefficient, made up of the same type of index but corresponding to different periods.
- ✓ “*f*” is a constant or the non-adjustable portion of Price adjustment factor (to be specified in Appendix).

About the polynomial formula as an element of Time Price/Cost Adjustment Factor, I can say…

A. Is the first time that I've seen this.
B. I've seen this, but I've never used it.
C. I've seen this, I used it before, but I've received it as part of the contract.
D. I've seen this, I used it before, and I was responsible for developing the formulae.

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Time Price/Cost Adjustment Factor – rules:

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

- ✓ **a, b, c, d…** incidence rate from the cost of the work *(weighted coefficients).*
- ✓ **Jo, Mo, Eo, Vo…**price index refers to the base date.
- ✓ **Jr, Mr, Er, Vr…**price index refers to the Payment Certificate Period (date).
- ✓ The Indexes used to calculate the non-adjustable cost component (black box) are developed by government entities:
- ✓ Colombia, National Institute of Statistics and Geography (INEGI) to publish the Producer Price Index (IPP)
- ✓ Mexico, Bank of Mexico(BMX) to publish the National Producer Price Index (INPP),
- ✓ Peru, National Institute of Statistics and Information Technology (INEI) through the Technical Directorate of Economic Indicators (DTIE), to publish the unified construction price indices (IUPC) on a monthly basis.

Failure to meet these

Time Price/Cost Adjustment Factor – rules:

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

The sum of the weighted coefficients must be equal (or pretty close) to one (1.000).

- ✓ Statistical term called relative frequency of class… cost – items.

The elements that make up the weighted coefficients they should always have a verifiable relationship/consistency.

- ✓ Relative frequency of class... they must be part of the same class.
- ✓ Combining elements that do not have a verifiable relationship/coherence within the same class will distort the use of the polynomial formula

Failure to meet these

Time Price/Cost Adjustment Factor – rules:

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

The numerator and denominator they must always be associated with the same type of index.

- ✓ If it is determined, for example, to use the "consumer price index (CPI)" for the numerator, the denominator must be the same index and not another.

The denominator index must always correspond to the period/date associated with the 28 days after the commencement date.

- ✓ The denominator is an index that is used to define the moment in which the original amounts for the execution of the project were presented by the contractor.

The numerator index must always correspond to the period/date of the developed work.

- ✓ It will not make sense to use indices in the numerator that differ from the payment certificates date.

Failure to meet these

By the way…

There is no single best way to quantify risk, including escalation. Each method has advantages and disadvantages and its advocates.

However, there is general agreement that any (…) method for estimating or forecasting the cost of uncertainty should address the *Contingency estimating: General Principles (RP 40R-08).*

- ✓ Leverage economist's knowledge…
- ✓ Use indices appropriate to each account…
- ✓ Apply in a consistent approach using a tool that facilitates best practice…

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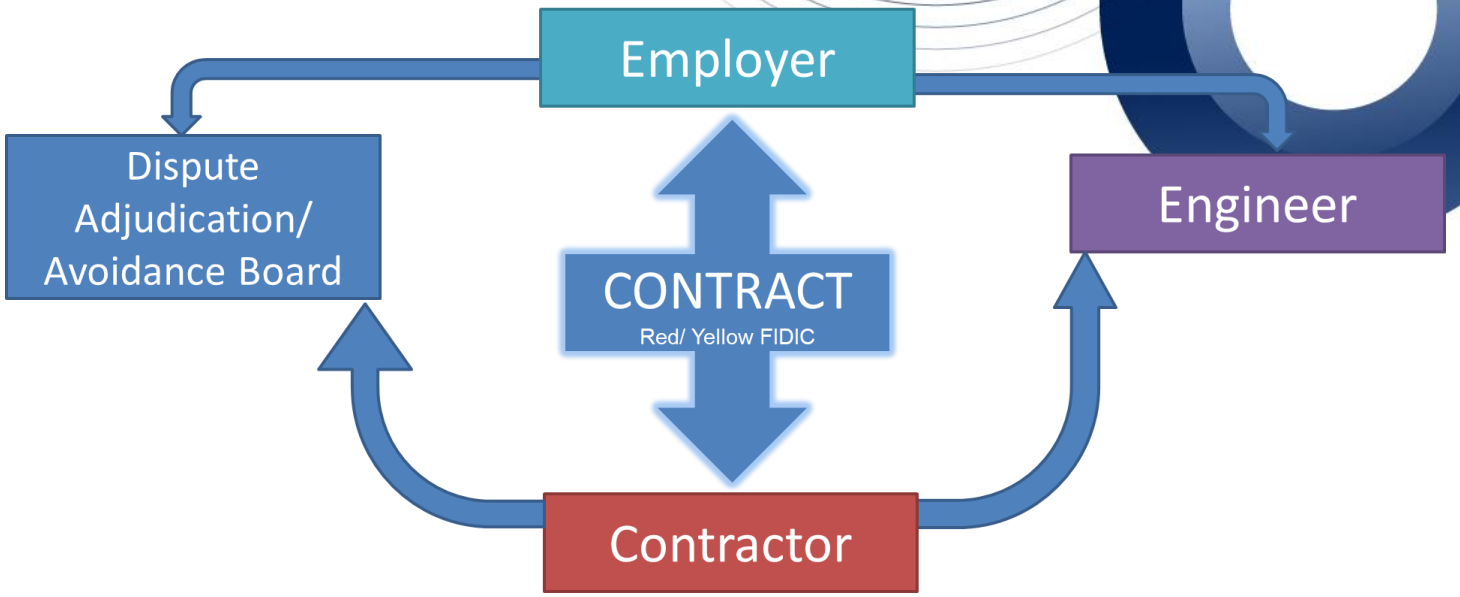
The case study: Infrastructure Project

100 Million USD FIDIC Contract*

The project

- ✓ Employer: The Government of a South American Country.
- ✓ Contractor: A big Infrastructure & Construction Company from Europe.
- ✓ Engineer: A Company of a South American Country.
- ✓ DAB: 2 Engineers (Local, Foreign from South America), 2 Lawyers (Local, Foreign from Europe), all experts with more 15 years experience in DAB under the FIDIC approach.



The project

- ✓ In light of his demonstrated ability to complete the entire project in 300 days, the Contractor decides to waive FIDIC clause 13.8 in accordance with his negotiation tactics and risk assessment. The project was divided into **seven** budgetable areas.
- ✓ The Employer and the Engineer agreed with that, and the project start on day 30 (day 1 Contractor Schedule).
- ✓ Everything was good (Payment certificates by monthly basis).
- ✓ …Until the month 3. Concurrent delays start to manifest.
  - ✓ Concurrent delays: Two or more delays that take place or overlap during the same period, either of which occurring alone would have affected the ultimate completion date. In practice, it can be difficult to apportion damages when the concurrent delays are due to the owner and contractor, respectively **(AACE RP 10S-90)**

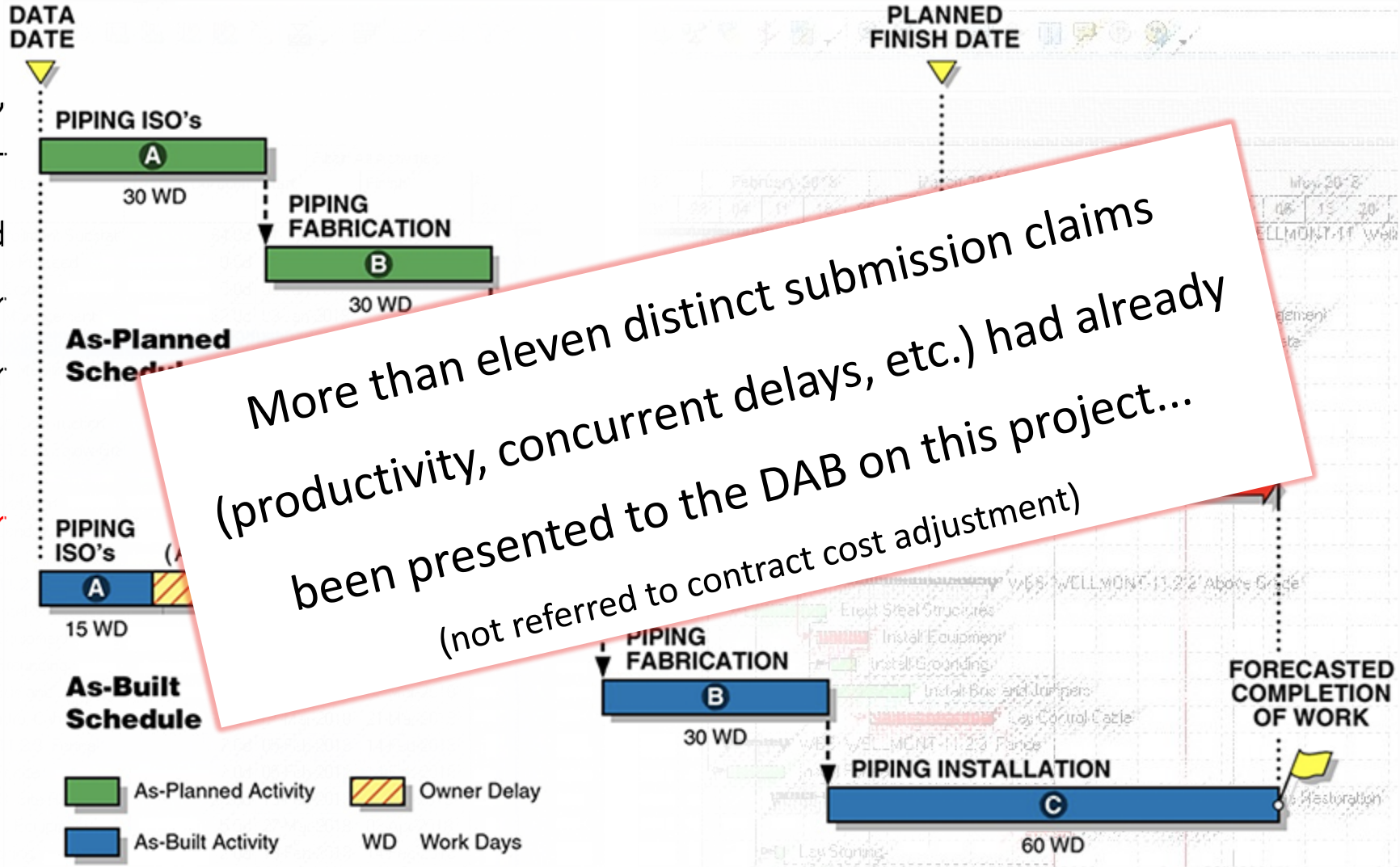
The project

Under a typical construction contract, the contractor would claim for an EOT and possibly damages for delay caused by an employer risk event. The employer would claim liquidated damages for delay caused by a contractor risk event…

But this does not include scaling and/or inflation adjustments.

The project is taking more than 300 days…

(and many more…)



More than eleven distinct submission claims (productivity, concurrent delays, etc.) had already been presented to the DAB on this project…

(not referred to contract cost adjustment)

(Image source: https://www.long-intl.com/articles/concurrent-delay/)

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The project after day 300… Long Story Short.

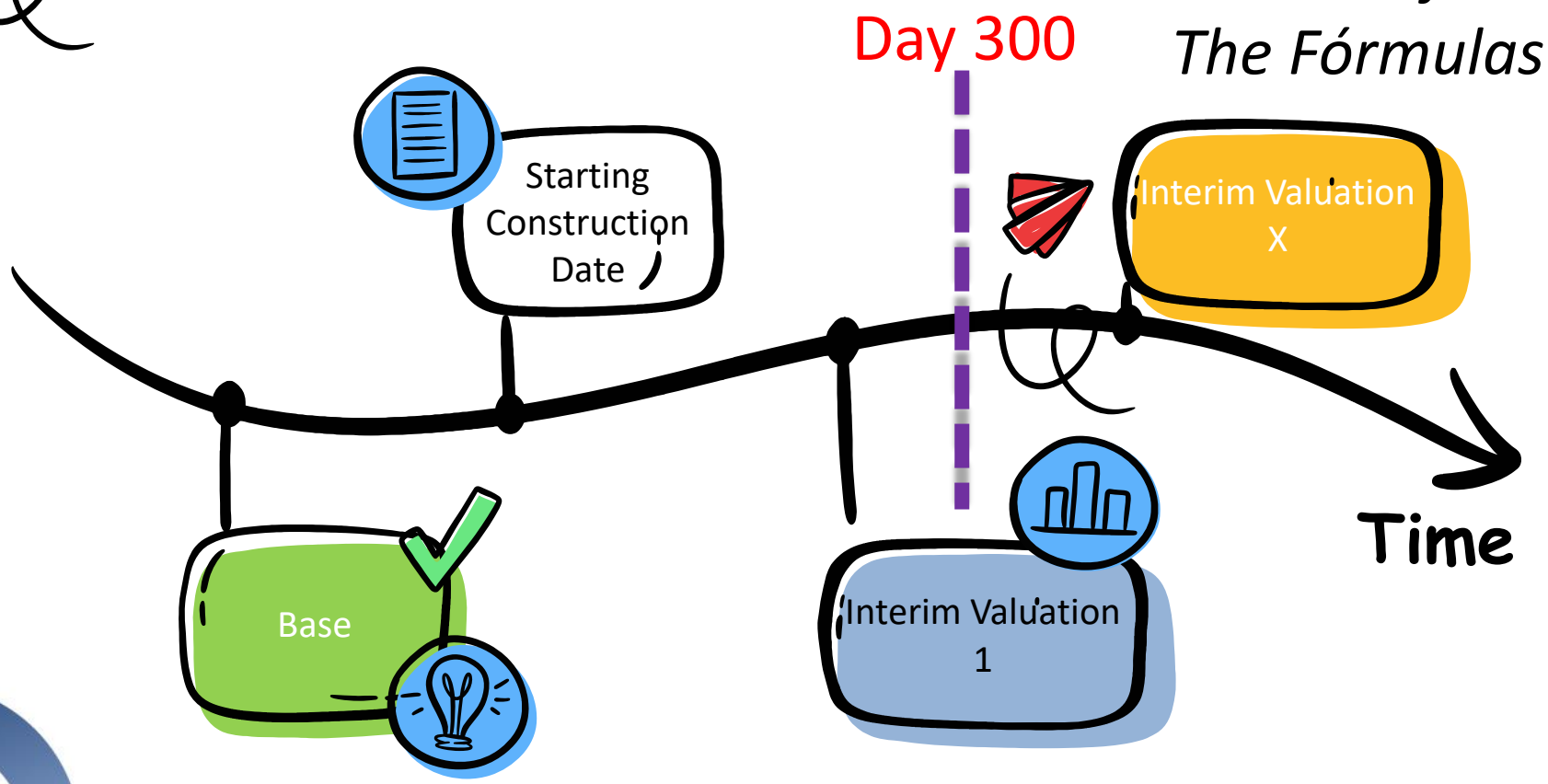
- ✓ **Submission 3**: The Dispute Adjudication Board after long process determine *"the use of the Formula Polinómica will be the best option for Price Adjustment Factors"* after the day 300…

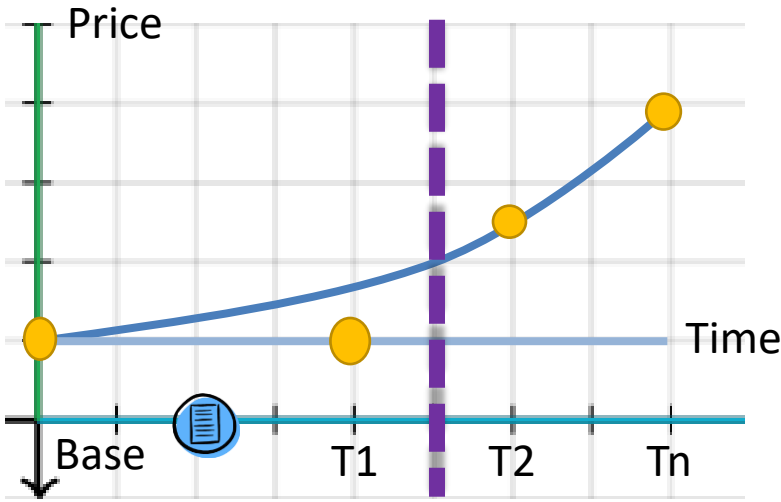
$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} + f + \cdots$$

Ok, so… where are we?

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

That's why we need the Time Price Adjustment Factor… The Fórmulas Polinómicas.





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The project after day 300… Long Story Short.

- ✓ **Submission 3**: The Dispute Adjudication Board after long process determine *"the use of the Formula Polinómica will be the best option for Price Adjustment Factors"* after the day 300…
- ✓ Contractor hires a *Subject Matter Expert* to determine the Formulas Polinomicas for each area (according to the Budget and Payment Certificates).
- ✓ After a very technical and detailed process, the SME obtains **eight** Formulas Polinomicas, that can be proven (technically) to be fair and realistic.
- ✓ These Formulas will be part of Submission 11

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} + f + \cdots$$

*The most complicated part will be determining the **weighted coefficients**, according to the **Unified construction price index** (IUPC)*

It is a challenge to determine the best way to apply disaggregated indices… (AACE RP 58-R10)

How to obtain the “formulas polinómicas”

- ✓ (Let’s use a very easy example) After organizing the unit price and re-organize the labor, material, equipment, overhead and profit, you are able to obtain a matrix like this…

Código	Descripción	Und.	Cantidad	Precio S/.	Presupuesto
0101010002	CAPATAZ	hh	36,037.6870	29.01	1,044,562.13
0101010003	OPERARIO	hh	102,540.3579	22.50	2,307,158.80
0101010004	OFICIAL	hh	132,890.4773	17.70	2,352,082.75
0101010005	PEON	hh	277,111.3220	15.99	4,431,082.62
01010100060004	OPERADOR DE EQUIPO TIPO 1B	hh	15,843.4676	26.06	412,962.51
01010100060006	OPERADOR DE EQUIPO TIPO 2A	hh	62,283.0439	24.87	1,548,484.73
01010100060009	OPERADOR DE EQUIPO TIPO 3B	hh	146,729.5329	23.69	3,476,528.80
01010100060030	RIGGER	hh	3,562.0582	17.70	63,048.42
0101030000	TOPOGRAFO	hh	6,623.6948	38.25	253,356.32
02010300010002	GASOLINA 90 OCTANOS	gal	37,534.3938	10.81	405,612.70
0201040001	PETROLEO D-2	gal	784,376.7078	8.75	6,860,096.97
02010500020002	EMULSION ASFALTICA CRS-1	l	91,762.7315	0.88	80,083.84
02010500020016	EMULSION ASFALTICA DILUIDA MC-30	l	374,439.4680	2.09	783,202.56
				TOTAL	**24,018,263.15**

Failure to meet these criteria will distort the use of the polynomial formula.

How to obtain the “formulas polinómicas”

- ✓ After that, you are able to determine the weighted coefficients, like this…
- ✓ CAPATAZ will be Red divided by Green… OPERARIO will be Blue divided by Green… and so on.

Código	Descripción	Und.	Cantidad	Precio S/.	Presupuesto	PONDERADO
0101010002	CAPATAZ	hh	36,037.6870	29.01	1,044,562.13	4.35%
0101010003	OPERARIO	hh	102,540.3579	22.50	2,307,158.80	9.61%
0101010004	OFICIAL	hh	132,890.4773	17.70	2,352,082.75	9.79%
0101010005	PEON	hh	277,111.3220	15.99	4,431,082.62	18.45%
01010100060004	OPERADOR DE EQUIPO TIPO 1B	hh	15,843.4676	26.06	412,962.51	1.72%
01010100060006	OPERADOR DE EQUIPO TIPO 2A	hh	62,283.0439	24.87	1,548,484.73	6.45%
01010100060009	OPERADOR DE EQUIPO TIPO 3B	hh	146,729.5329	23.69	3,476,528.80	14.47%
01010100060030	RIGGER	hh	3,562.0582	17.70	63,048.42	0.26%
0101030000	TOPOGRAFO	hh	6,623.6948	38.25	253,356.32	1.05%
02010300010002	GASOLINA 90 OCTANOS	gal	37,534.3938	10.81	405,612.70	1.69%
0201040001	PETROLEO D-2	gal	784,376.7078	8.75	6,860,096.97	28.56%
02010500020002	EMULSION ASFALTICA CRS-1	l	91,762.7315	0.88	80,083.84	0.33%
02010500020016	EMULSION ASFALTICA DILUIDA MC-30	l	374,439.4680	2.09	783,202.56	3.26%
				TOTAL	**24,018,263.15**	

Failure to meet these criteria will distort the use of the polynomial formula.

How to obtain the “formulas polinómicas”

- ✓ You need to be sure about CAPATAZ and OPERARIO are (or are not) included in the same **Unified construction price index (IUPC) and evaluate its reasonable cost-benefit ratio.**

Código	Descripción	Und.	Cantidad	Precio S/.	Presupuesto
0101010002	CAPATAZ	hh	36,037.6870	29.01	1,044,562.13
0101010003	OPERARIO	hh	102,540.3579	22.50	2,307,158.80
0101010004	OFICIAL	hh	132,890.4773	17.70	2,352,082.75
0101010005	PEON	hh	277,111.3220	15.99	4,431,082.62
01010100060004	OPERADOR DE EQUIPO TIPO 1B	hh	15,843.4676	26.06	412,962.51
01010100060006	OPERADOR DE EQUIPO TIPO 2A	hh	62,283.0439	24.87	1,548,484.73
01010100060009	OPERADOR DE EQUIPO TIPO 3B	hh	146,729.5329	23.69	3,476,528.80
01010100060030	RIGGER	hh	3,562.0582	17.70	63,048.42
0101030000	TOPOGRAFO	hh	6,623.6948	38.25	253,356.32
02010300010002	GASOLINA 90 OCTANOS	gal	37,534.3938	10.81	405,612.70
0201040001	PETROLEO D-2	gal	784,376.7078	8.75	6,860,096.97
02010500020002	EMULSION ASFALTICA CRS-1	l	91,762.7315	0.88	80,083.84
02010500020016	EMULSION ASFALTICA DILUIDA MC-30	l	374,439.4680	2.09	783,202.56
				TOTAL	**24,018,263.15**

Failure to meet these criteria will distort the use of the polynomial formula.

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But… Not all the time the indices will reflect the truth…

✓ Let's see the situation about the STEEL /STELL RODS (ACERO / VARILLAS DE ACERO in Spanish)

FECHA	PRECIO DE VARILLA 3/4	PRECIO por kg	VARIACION %
01/11/2020	62.82	3.32	0%
01/12/2020	62.59	3.31	0%
01/01/2021	72.3	3.82	15%
01/03/2021	80.46	4.26	28%
01/05/2021	83.36	4.41	33%
01/07/2021	83.35	4.41	33%
01/09/2021	90.6	4.79	44%
01/12/2021	89.58	4.74	43%
01/01/2022	94.99	5.02	51%
01/03/2022	78.71	4.16	25%
01/04/2022	114.59	6.06	83%
01/05/2022	106.95	5.66	70%
01/07/2022	95.32	5.04	52%
01/09/2022	86.61	4.58	38%
01/11/2022	86.1	4.55	37%
01/12/2022	85.9	4.54	37%

Sticky Prices? (AACE RP 58R-10)

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How to obtain the “formulas polinómicas”

Unified construction price index (IUPC) code table.

RELACIÓN DE ÍNDICES UNIFICADOS

CÓDIGO	ELEMENTO	CÓDIGO	ELEMENTO
A		L	
01	Aceite	40	Loseta
02	Acero de construcción liso	M	
03	Acero de construcción corrugado	41	Madera en tiras para piso
04	Agregado fino	42	Madera importada para encofrado y carpintería
05	Agregado grueso	43	Madera nacional para encofrado y carpintería
06	Alambre y cable de cobre desnudo	44	Madera terciada para encofrado y carpintería
07	Alambre y cable Tipo TW y THW	45	Madera terciada para encofrado
08	Alambre y cable tipo WP	46	Malla de acero
09	Alcantarilla metálica	47	Mano de obra (incluido leyes sociales)
10	Aparato sanitario con grifería	47-1	Mano de Obra - Región Grau (j) (n)
11	Artefacto de alumbrado exterior	48	Maquinaria y equipo nacional
12	Artefacto de alumbrado interior	49	Maquinaria y equipo importado
13	Asfalto	50	Marco y tapa de fierro fundido
B		P	
14	Baldosa acústica	51	Perfil de acero liviano
	Baldosa asfáltica (m)		
16	Baldosa vinílica		
17	Bloque y Ladrillo		
C			
18	Cable telefónico (d)		
19	Cable NYY-N2XY (g) y (p)		
20	Cemento asfáltico		
21	Cemento Portland Tipo I		
22	Cemento Portland Tipo II (t)		
23	Cemento Portland Tipo V		
24	Cerámica esmaltada y sin esmaltar		
	Cerrajería importada (Índice 30) (a)		
26	Cerrajería nacional	T	
D			
27	Detonante		
28	Dinamita		
	Dólar (e)		
30	Dólar más Inflación mercado USA (f)		
	30-1 % vigente del MUC según Resolución Cambiaria		
	30-2 % vigente del MUC según Resolución Cambiaria (l)	69	Tubería de concreto simple
	30-3 % vigente del MUC según Resolución Cambiaria	70	Tubería de concreto reforzado
	30-4 % Dólar oferta y demanda (i)	71	Tubería de fierro fundido
31	Ducto de Concreto	72	Tubería de PVC para agua
F		73	Ducto telefónico de PVC (h)
32	Flete Terrestre		Tubería de PVC para electricidad (SAP) (Índice 72) (c)
33	Flete aéreo		Tubería de PVC para electricidad (SEL) (Índice 72) (b)
G		V	
34	Gasolina		Válvula de bronce importada (Índice 30) (a)

Código	Presupuesto	Indice Unificado
01010	1,044,562.13	47
01010		
01010		
01010		
01010		
01010		
01010		
01010		
01010		53
02010	80,083.84	13
02010	783,202.56	13
	24,018,263.15	

In fact, you should additionally consider the location factor, although some indexes provide information based on geographic region...(and makes life easier) but makes the process more complex...

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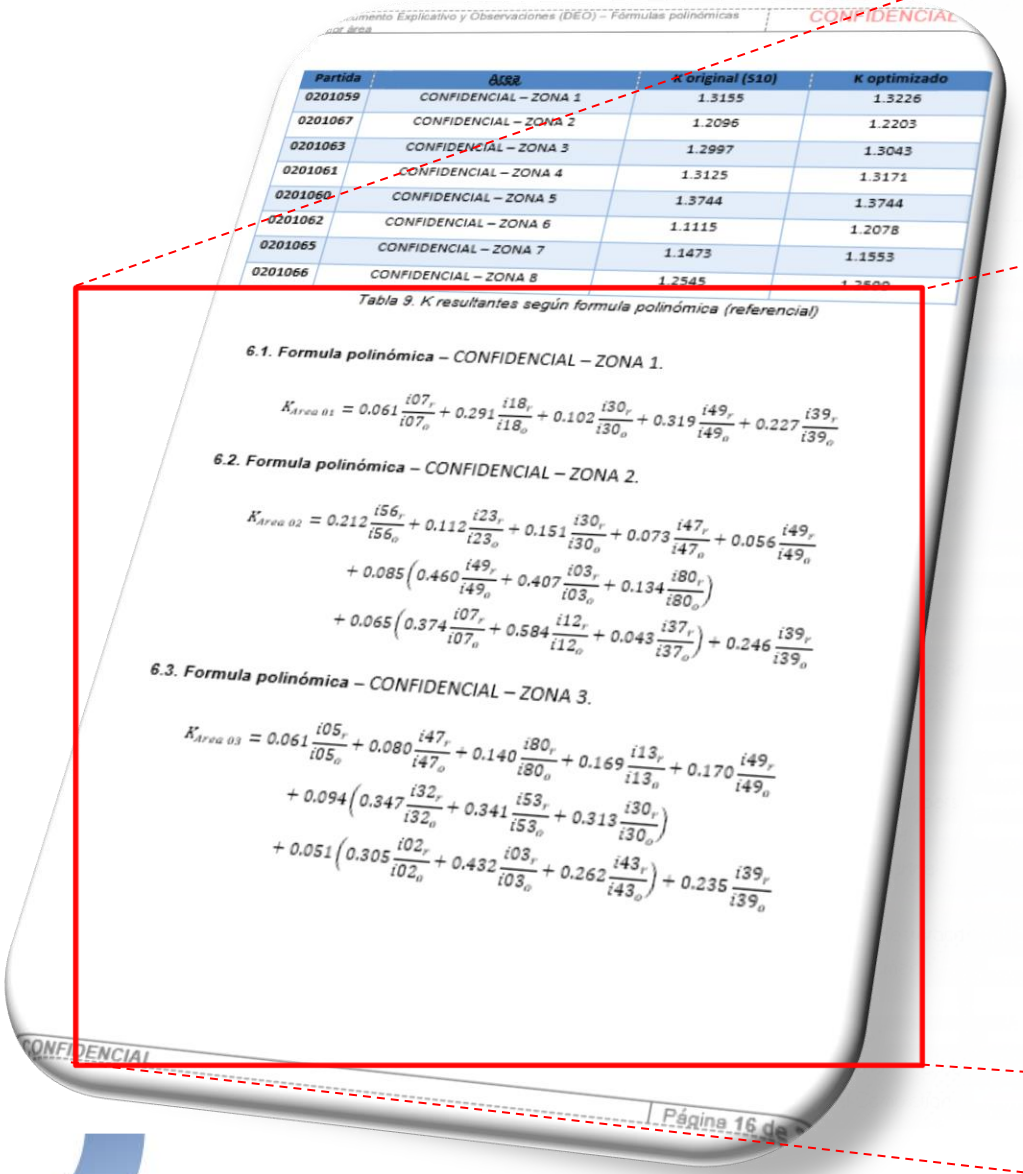
And Finally… (Long story short)



Partida	Area	K original (S10)	K optimizado
0201059	CONFIDENCIAL – ZONA 1	1.3155	1.3226
0201067	CONFIDENCIAL – ZONA 2	1.2096	1.2203
0201063	CONFIDENCIAL – ZONA 3	1.2997	1.3043
0201061	CONFIDENCIAL – ZONA 4	1.3125	1.3171
0201060	CONFIDENCIAL – ZONA 5	1.3744	1.3744
0201062	CONFIDENCIAL – ZONA 6	1.1115	1.2078
0201065	CONFIDENCIAL – ZONA 7	1.1473	1.1553
0201066	CONFIDENCIAL – ZONA 8	1.2545	1.3500

Tabla 9. K resultantes según formula polinómica (referencial)

6.1. Formula polinómica – CONFIDENCIAL – ZONA 1.

$$K_{Area\ 01} = 0.061\frac{i07_r}{i07_o} + 0.291\frac{i18_r}{i18_o} + 0.102\frac{i30_r}{i30_o} + 0.319\frac{i49_r}{i49_o} + 0.227\frac{i39_r}{i39_o}$$

6.2. Formula polinómica – CONFIDENCIAL – ZONA 2.

$$K_{Area\ 02} = 0.212\frac{i56_r}{i56_o} + 0.112\frac{i23_r}{i23_o} + 0.151\frac{i30_r}{i30_o} + 0.073\frac{i47_r}{i47_o} + 0.056\frac{i49_r}{i49_o} + 0.085\left(0.460\frac{i49_r}{i49_o} + 0.407\frac{i03_r}{i03_o} + 0.134\frac{i80_r}{i80_o}\right) + 0.065\left(0.374\frac{i07_r}{i07_o} + 0.584\frac{i12_r}{i12_o} + 0.043\frac{i37_r}{i37_o}\right) + 0.246\frac{i39_r}{i39_o}$$

6.3. Formula polinómica – CONFIDENCIAL – ZONA 3.

$$K_{Area\ 03} = 0.061\frac{i05_r}{i05_o} + 0.080\frac{i47_r}{i47_o} + 0.140\frac{i80_r}{i80_o} + 0.169\frac{i13_r}{i13_o} + 0.170\frac{i49_r}{i49_o} + 0.094\left(0.347\frac{i32_r}{i32_o} + 0.341\frac{i53_r}{i53_o} + 0.313\frac{i30_r}{i30_o}\right) + 0.051\left(0.305\frac{i02_r}{i02_o} + 0.432\frac{i03_r}{i03_o} + 0.262\frac{i43_r}{i43_o}\right) + 0.235\frac{i39_r}{i39_o}$$

6.1. Formula polinómica – CONFIDENCIAL – ZONA 1.

$$K_{Area\ 01} = 0.061\frac{i07_r}{i07_o} + 0.291\frac{i18_r}{i18_o} + 0.102\frac{i30_r}{i30_o} + 0.319\frac{i49_r}{i49_o} + 0.227\frac{i39_r}{i39_o}$$

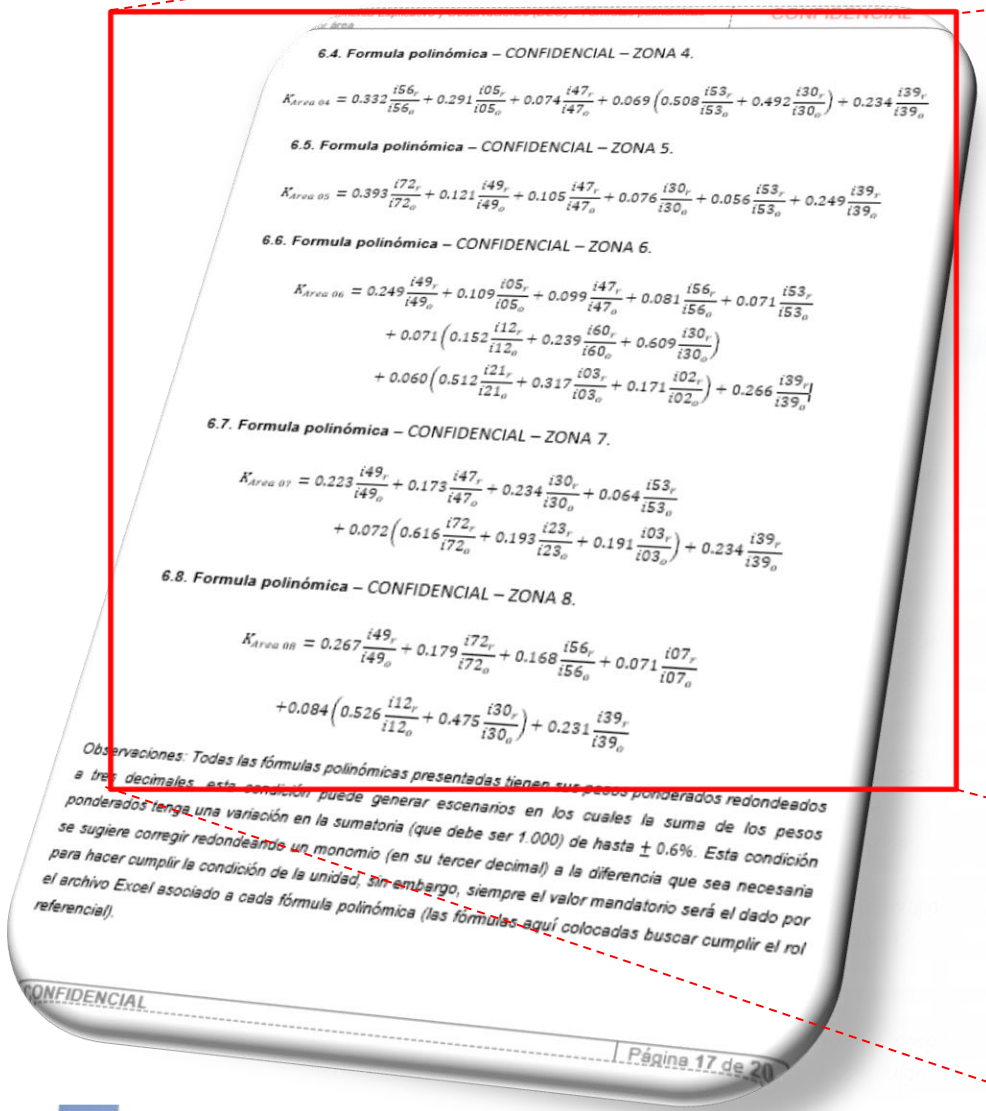
6.2. Formula polinómica – CONFIDENCIAL – ZONA 2.

$$K_{Area\ 02} = 0.212\frac{i56_r}{i56_o} + 0.112\frac{i23_r}{i23_o} + 0.151\frac{i30_r}{i30_o} + 0.073\frac{i47_r}{i47_o} + 0.056\frac{i49_r}{i49_o} + 0.085\left(0.460\frac{i49_r}{i49_o} + 0.407\frac{i03_r}{i03_o} + 0.134\frac{i80_r}{i80_o}\right) + 0.065\left(0.374\frac{i07_r}{i07_o} + 0.584\frac{i12_r}{i12_o} + 0.043\frac{i37_r}{i37_o}\right) + 0.246\frac{i39_r}{i39_o}$$

6.3. Formula polinómica – CONFIDENCIAL – ZONA 3.

$$K_{Area\ 03} = 0.061\frac{i05_r}{i05_o} + 0.080\frac{i47_r}{i47_o} + 0.140\frac{i80_r}{i80_o} + 0.169\frac{i13_r}{i13_o} + 0.170\frac{i49_r}{i49_o} + 0.094\left(0.347\frac{i32_r}{i32_o} + 0.341\frac{i53_r}{i53_o} + 0.313\frac{i30_r}{i30_o}\right) + 0.051\left(0.305\frac{i02_r}{i02_o} + 0.432\frac{i03_r}{i03_o} + 0.262\frac{i43_r}{i43_o}\right) + 0.235\frac{i39_r}{i39_o}$$

And Finally… (Long story short)



6.4. Formula polinómica – CONFIDENCIAL – ZONA 4.

$$K_{Area\ 04} = 0.332\frac{i56_r}{i56_o} + 0.291\frac{i05_r}{i05_o} + 0.074\frac{i47_r}{i47_o} + 0.069\left(0.508\frac{i53_r}{i53_o} + 0.492\frac{i30_r}{i30_o}\right) + 0.234\frac{i39_r}{i39_o}$$

6.5. Formula polinómica – CONFIDENCIAL – ZONA 5.

$$K_{Area\ 05} = 0.393\frac{i72_r}{i72_o} + 0.121\frac{i49_r}{i49_o} + 0.105\frac{i47_r}{i47_o} + 0.076\frac{i30_r}{i30_o} + 0.056\frac{i53_r}{i53_o} + 0.249\frac{i39_r}{i39_o}$$

6.6. Formula polinómica – CONFIDENCIAL – ZONA 6.

$$K_{Area\ 06} = 0.249\frac{i49_r}{i49_o} + 0.109\frac{i05_r}{i05_o} + 0.099\frac{i47_r}{i47_o} + 0.081\frac{i56_r}{i56_o} + 0.071\frac{i53_r}{i53_o} + 0.071\left(0.152\frac{i12_r}{i12_o} + 0.239\frac{i60_r}{i60_o} + 0.609\frac{i30_r}{i30_o}\right) + 0.060\left(0.512\frac{i21_r}{i21_o} + 0.317\frac{i03_r}{i03_o} + 0.171\frac{i02_r}{i02_o}\right) + 0.266\frac{i39_r}{i39_o}$$

6.7. Formula polinómica – CONFIDENCIAL – ZONA 7.

$$K_{Area\ 07} = 0.223\frac{i49_r}{i49_o} + 0.173\frac{i47_r}{i47_o} + 0.234\frac{i30_r}{i30_o} + 0.064\frac{i53_r}{i53_o} + 0.072\left(0.616\frac{i72_r}{i72_o} + 0.193\frac{i23_r}{i23_o} + 0.191\frac{i03_r}{i03_o}\right) + 0.234\frac{i39_r}{i39_o}$$

6.8. Formula polinómica – CONFIDENCIAL – ZONA 8.

$$K_{Area\ 08} = 0.267\frac{i49_r}{i49_o} + 0.179\frac{i72_r}{i72_o} + 0.168\frac{i56_r}{i56_o} + 0.071\frac{i07_r}{i07_o} + 0.084\left(0.526\frac{i12_r}{i12_o} + 0.475\frac{i30_r}{i30_o}\right) + 0.231\frac{i39_r}{i39_o}$$

Observaciones: Todas las fórmulas polinómicas presentadas tienen sus pesos ponderados redondeados a tres decimales, esta condición puede generar escenarios en los cuales la suma de los pesos ponderados tenga una variación en la sumatoria (que debe ser 1.000) de hasta ± 0.6%. Esta condición se sugiere corregir redondeando un monomio (en su tercer decimal) a la diferencia que sea necesaria para hacer cumplir la condición de la unidad, sin embargo, siempre el valor mandatorio será el dado por el archivo Excel asociado a cada fórmula polinómica (las fórmulas aquí colocadas buscar cumplir el rol referencial).

CONFIDENCIAL

Página 17 de 20

Conclusions

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} + f + \cdots$$

1. **Take the time that you need to organize the data properly… Garbage IN / Garbage OUT.**
2. **In order to create the Time/Location PAF, you must adhere (obey) to the theoretical/mathematical approach.**

✓ **a, b, c, d…** incidence rate from the cost of the work *(weighted coefficients)*

- ✓ The sum of the weighted coefficients must be equal (or pretty close) to one (1.000).
- ✓ weighted coefficients they should always have a verifiable relationship/consistency

✓ **The numerator and denominator they must always be associated with the same type of index.**

- ✓ **Jo, Mo, Eo, Vo…**price index refers to the base date… always.
- ✓ **Jr, Mr, Er, Vr…**price index refers to the Payment Certificate Period (date)... Always

3. **Consider the many indices you have at your disposal for your PAF equation or formula and select (if appropriate) the best one for the project (RMPI, PPI, IPMC, etc.…)**

Failure to meet these criteria will distort the use of the polynomial formula.

Conclusions

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} + f + \cdots$$

4. **If you were hired by the Contractor, it will not be the same as if you were hired by the Employer…**
   - ✓ The "system" is not perfect: a variety of manipulations are possible, which the SME should be able to detect....
   - ✓ The identical scenario is feasible with the indexes. Regardless of the formula employed, certain indices will favor you more than others... Evil exists.
5. **We wise: Since you cannot predict the future, you should never waive the price adjustment factor clause.**
   - ✓ Remember/consider the environmental factors that you cannot manage/control…
6. **Remember: We exclude Black Swan Theory…**
   - ✓ Unknow ~~Unknow~~ risks, RAND Model (RP – 119R-21), QRA…

Hey!… what happens with the project and the whole "Spanish soap opera" involving the Employer, the contractor and the others, after day 300?

Failure to meet these criteria will distort the use of the polynomial formula.

The project after day 300…

- ✓ Contractor submits to the Employer and the Engineer the Formulas polinómicas (Submission 11) across the DAB.
- ✓ After several evaluations, the DAB considers **fair and appropriate the eight formulas**. The Employer accepted them all, reluctantly... The Engineer choose to made “administrative silence”.
- ✓ But… (there is always a but) Employer rejected (to death) just one detail… the date for the BASE index…
- ✓ According to FIDIC the date for the BASE index would be…

Contract Price and Payment

FIDIC™ International Federation of Consulting Engineers
The Global Voice of Consulting Engineers

14.1
The Contract Price

Unless otherwise stated in the Particular Conditions:

(d) the Contractor shall submit to the Engineer, within 28 days after the Commencement Date, a proposed breakdown of each lump sum price in the Schedules. The Engineer may take account of the breakdown when preparing Payment Certificates, but shall not be bound by it.

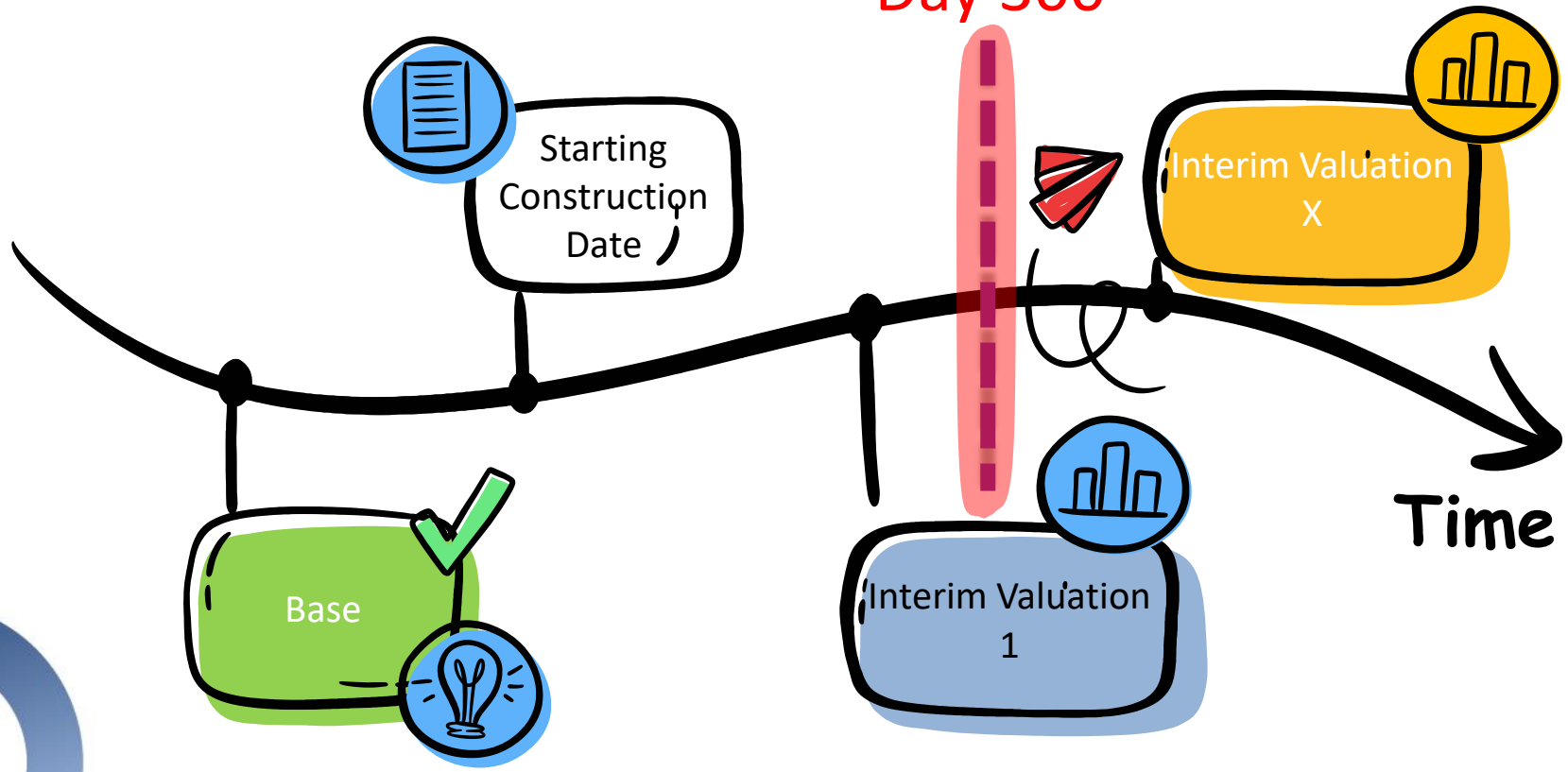
What was the proposal of …

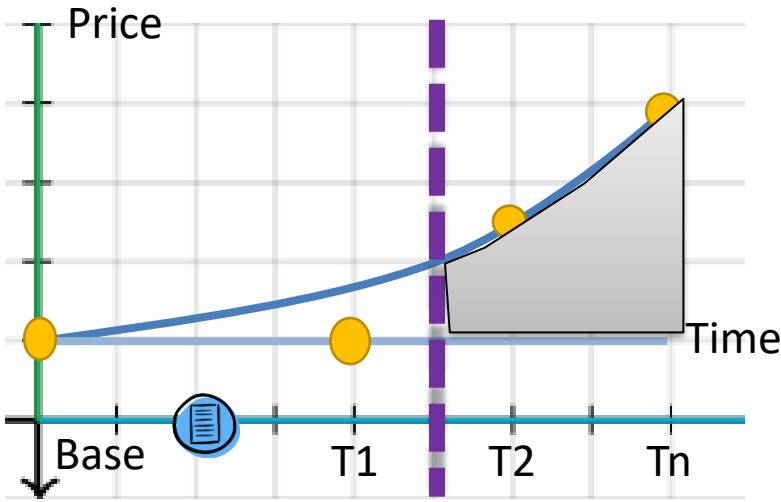
$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

The Contractor

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

The Employeer





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What was the proposal of …

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

The Contractor

≈11,460,000 USD

¿ ?

$$K = a\frac{J_r}{J_O} + b\frac{M_r}{M_O} + c\frac{E_r}{E_O} + d\frac{V_r}{V_O} \ldots$$

The Employeer

≈1,970,000 USD

TO BE CONTINUED...

Thank you for your time!

This concludes the educational content of this presentation

Questions?

MBA BSEE David Chigne, CCP™, CEP™
PMP ®, RMP ®, ACP®
Senior Project Controls Manager
dchigne@alphathree.com

YouTube https://www.youtube.com/c/Chignedavid/

LinkedIn https://www.linkedin.com/in/davidchigne/

Project Controls EXPO
Washington, DC - USA

THANK YOU

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Washington, DC - USA