Incentives & Restraints in Transmission & substation projects[1, 2]

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ABSTRACT

Contractor lives and dies for their cash flow. Incentives, the carrot that an Owner dangles before a Contractor when the project begins to float off track to bring things back in line. Regularly a framework is immediately cobbled together as a handy solution, often leaving the two arrangements of supervisory groups who are controlling it with varying perspectives with respects accomplishment of the money related reward. The US Department of Transportation's report "Work Zone Road User Costs Concepts and Applications" addresses the ideas of incentives and disincentives for their traffic project. It is this idea that this paper addresses by substituting "Lost Opportunity costs" instead of the "Road User Costs Concept" and testing against an oversimplified reasonable Transmission & Substation project. It investigates the underlying idea, applies this to a comparable model grew explicitly for undertaking and touches base at an incentives/disincentive plan for acceleration or lost opportunities which can be implemented amid the contract improvement stage sketching out the "day by day rewards or punishments" to be connected.

Keywords: Project Scheduling, Accuracy, Duration, Cost Estimation, Planning, Crash Cost[3], liquidated damages, Lost Opportunities, Opportunity cost[4].

INTRODUCTION

One of the key components to choose the accomplishment of a project is time or duration. Some Individuals say time is cash and this is certainly the situation with regards to project management. Diminishing both construction projects' expense and time is critical in present market-driven

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[2] How to cite this paper: Shil, S. (2019). Incentives & Restraints in Transmission & substation projects, *PM World Journal*, Vol. VIII, Issue IV (May).

[3] Project Crashing, and Time-Cost Trade-Off. (n.d.). Retrieved from http://www.prenhall.com/divisions/bp/app/russellcd/PROTECT/CHAPTERS/CHAP17/HEAD05.HTM

[4] Investopedia. (2017). Opportunity cost. Retrieved from http://www.investopedia.com/terms/o/opportunitycost.asp

economy. This relationship between construction projects' time and the cost is called time cost trade-off[5] decisions which has been researched widely in the development administration writing.

The impact of delays on different types of costs

Firstly, indirect costs[6], which are otherwise called overheads. The settled expenses of general offices, administrations, convenience, organization, and management will happen each day, independent of whether the work is done or not. They just stop once the venture is finished.

Secondly, direct costs or variable expenditure, incorporate materials and manpower. These costs are time-related in various diverse ways.

A basic portrayal of the possible connection between the duration and its direct cost are:

- Project acceleration requires additional labor, materials, and equipment and therefore, costs more money.
- Delaying the project beyond the normal completion time results in increased costs due to inefficient allocation and utilization of resources.
- The longer construction takes, the greater the road user costs and agency overhead costs will be.

This subject raised itself amid audit of the GPCCAR's "Module 08-7 Validate the Time and Cost Trade-offs" and was quickly attracted to the fascinating representation which delineated the schedule vs time optimization, the wellspring of which originated from the US Department of Transportation (DoT), Federal Highway Agency's archive "Work Zone Road User Costs Concepts and Applications"[7], Refer to figure 1. This model presents three cost curves: construction costs, road user expenses construction designing costs (consolidated for presentation purposes), and total project costs.

The construction cost curve illustrates to the contractor's expense for finishing the project. For each construction project, the construction cost is the most minimal at the pattern term (point C_L). Any deviation from this standard schedule will result in expanded construction costs. Work Speeding up requires extra contractor effort through the tighter schedule and extra time, additional resource mobilization and sending or potentially development, and causes extra expenses to the contractor. Expanding the project completion beyond the stipulated duration results in penalty and misallocation and underutilization of assets, and consequently brings about extra expenses to the contractor.

[5] Elbeltagi, D. E. (n.d.). PROJECT TIME-COST TRADE-OFF, Chapter 8. *Construction Management*. Retrieved from http://osp.mans.edu.eg/elbeltagi/CM%20CH8%20Time-Cost.pdf
[6] Lord, J. (n.d.). Time/Cost Relationship in Project Management. *Innovation enterprise channels*. Retrieved from https://channels.theinnovationenterprise.com/articles/time-cost-relationship-in-project-management
[7] Mallela, J., & Sadasivam, S. (2011). Work zone road user costs: Concepts and applications: final report. U.S. Department of Transportation, Federal Highway Administration Office of Operations (HOP).

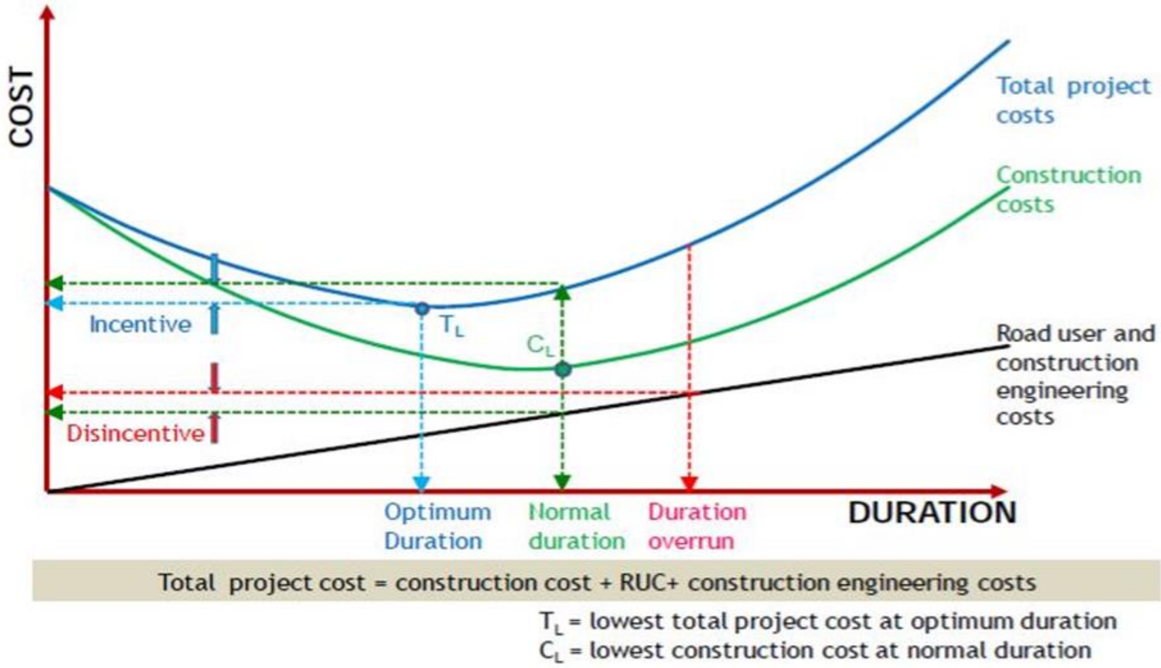

Figure 1 – Relationship between project cost and duration[8]

On the other side, the owner's construction oversight cost and WZ RUC increment directly with project duration. When these indirect costs are combined with the construction costs, the subsequent cost curve shifts to the left. The combined costs are most minimal at an optimal duration (point T_L) shorter than the ordinarily expected duration.

The foundation behind the reported improvement depended on the expansion of the traffic over several years alongside the measure of road traffic construction projects, a considerable lot of which experienced project delay and cost overwhelms because of different variables areas, safety, and effects to the neighborhood exchange and networks To address these, few activities were actualized with an objective to limit the effects of the delays and keeping in mind that not part of the agency's budgeted expenses in filled different needs in the decision-making process. These exercises were classified "work zone road customer costs" (WZ RUC) and despite the fact that their usage was not a new idea in the transportation decision-making process, is settled in zones, for instance, pavements and bridges, yet in the meantime creating inside various areas of the street frameworks. In any case, the consistency of the practices over the diverse US states was conflicting and the report recommended that the distinctions in methodology be address by issuing the updated direction to the assessing techniques. Besides, the report inquiries about and analyses the expenses related with the delay components, creating key parameters, the connection between project cost and duration, before finishing up with incentives/disincentives, and some case studies.

[8] Mallela, J., & Sadasivam, S. (2011). Figure 15 - Work zone road user costs: Concepts and applications: final report. U.S. Department of Transportation, Federal Highway Administration Office of Operations (HOP).

This paper needs to investigate the procedures contained in the WZ RUC report against a hypothetical undertaking, and with the assistance of a model decide the cost and duration of the curve appeared in figure 1.

In summary, there are five key questions that this report will ask:

- What is the incentive and disincentive zone?
- How to recover early delays?
- How to avoid liquidated damages?
- The lost opportunity costs
- What are the key challenges to Improve project cash flow?

The WZ RUC Methodologies

The WZ RUC report was a thoroughly considered investigation taking a gander at all parts of the everyday activity of the streets and transport framework, assessing things, for example, 'travel delay costs', 'vehicle operating costs', 'expenses of accidents', 'fuel emission costs', and in addition 'non-monetary quantitative and qualitative factors' to assess the impact to the public and the assigned contractor performing the works. To encourage this evaluation, six things of information were recorded as key prerequisites; hourly traffic demand, traffic composition, work zone design, work zone limit, travel speed and the technique for the maintenance of traffic. This data enabled the advisors to survey existing frameworks around the diverse US states, contrasting them against one another as various US states were utilizing different traffic examination instruments to show their work zone systems.

The report furnishes specialists with a cost model using a polynomial equation created to evaluate development costs

$$CC = 1.0059 * C_O - 0.1048C_O\left(\frac{D-0.8875*D_O}{D_O}\right) + 0.4657C_O\left(\frac{D-0.8875*D_O}{D_O}\right)^2$$

where,
CC= actual project cost
C_o = contractor bid price
D = actual days used by the contractor
D_o = contract time specified in the bid

Equation 1 – DoT Construction Cost Formula[9]

To test the formula to decide how the construction curve would look like for a Transmission and Substation project, the accompanying information has been utilized:

C_0 = \$55 million
D = D_0 + 10%
D_0 = 30 months in days = 900 days

[9] By Author

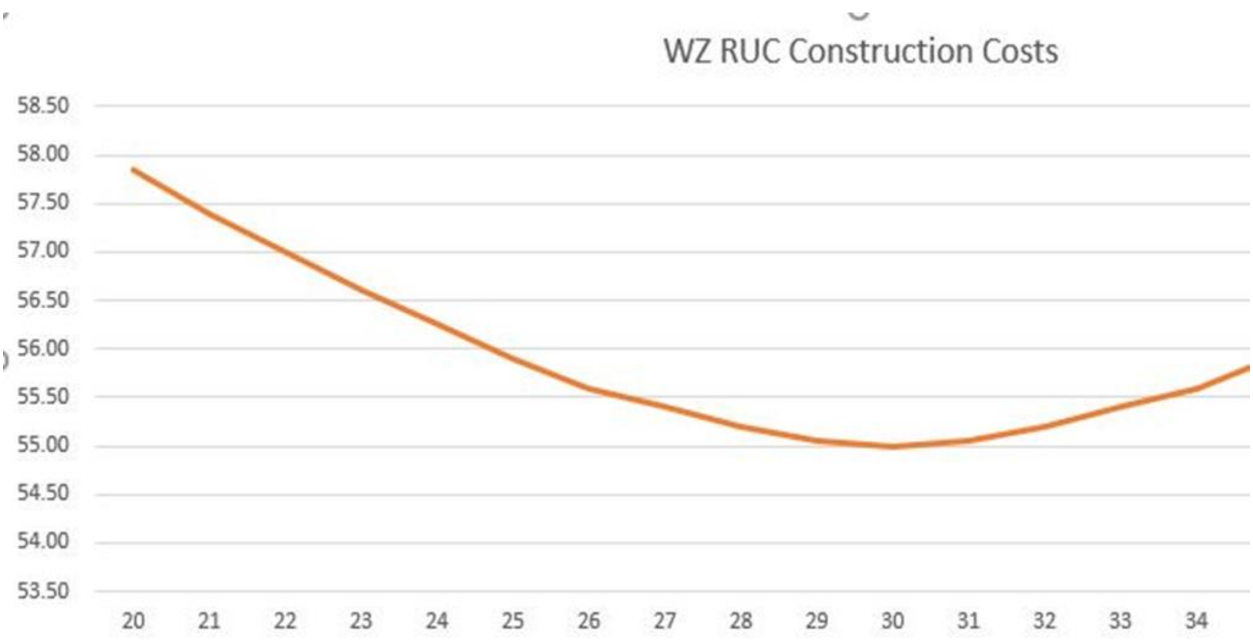

Figure 2 – Construction curve using WZ RUC formula[10]

The curve may be appropriate to a roadworks project; be that as it may, it doesn't meet what is required for a large-scale Transmission project. In the business, it is difficult to finish the project in half the duration of the contract stipulated duration, because of site conditions even with the unlimited supply of resources this issue will be examined later in the paper.

The equation and curve as exhibited don't give a precise depiction of the contractor's acceleration and delay costs for the kind of project(s) this paper would like to adapt it for. In this way, the advancement of a model to meet these prerequisites is required.

Defining the Model

The representation underneath originates from the GPCCAR's "Module 08-7 Validate the Time and Cost Trade-offs"[11] and delineates how the owner's optimum cost and duration are not the same as that of the contractors, and how differences can be impartially accommodated. As referenced in the introduction this idea originated from the US Department of Transportation, the Federal Highway Agency's archive "Work Zone Road User Costs Concepts and Applications".

[10] By Author
[11] Guild of Project Controls. (n.d.). 08.7.3 – Cost vs Time Trade-Offs (Optimization) - Guild of project controls compendium and reference (CaR) | Project controls - planning, scheduling, cost management and forensic analysis (Planning Planet). Retrieved September 5, 2017, from http://www.planningplanet.com/guild/gpccar/validate-the-time-and-cost-trade-offs

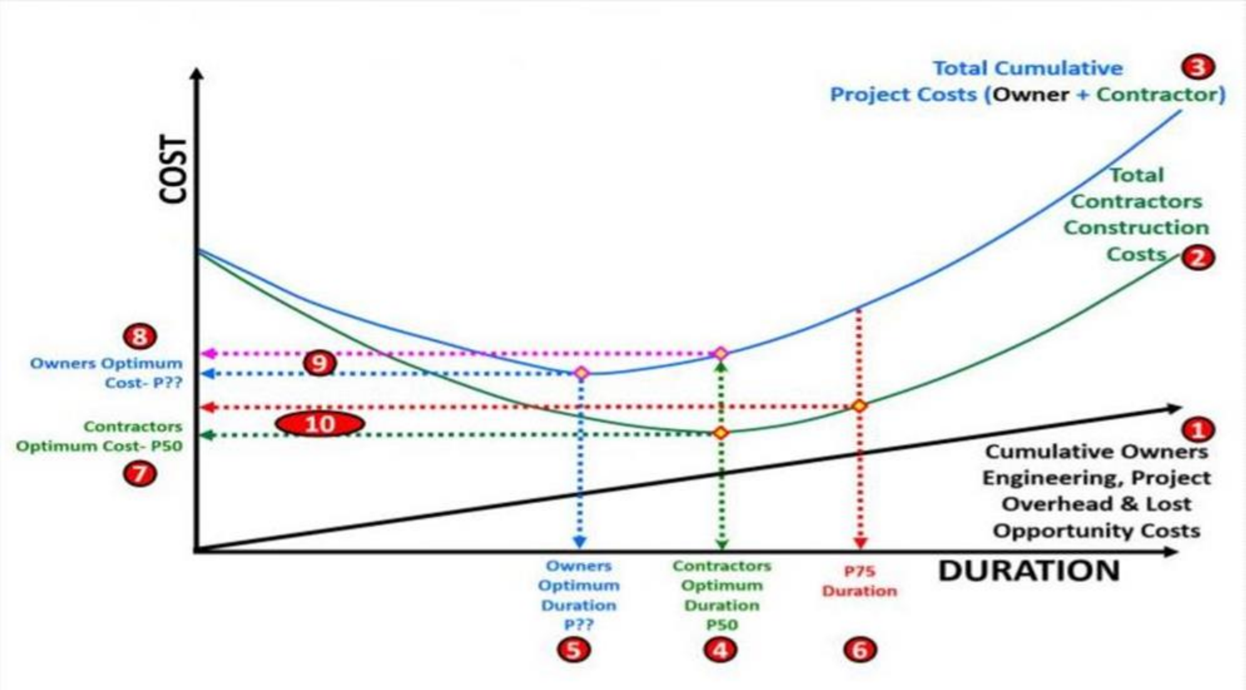

Figure 3 - Schedule vs Time Optimization[12]

Having officially tried the curve equation mentioned in the report and discovered it was not appropriate, the need to characterize a model which can give both Owner and Contractor cost and duration. To do this, the advancement of an estimate and schedule for a theoretical project and a model to test this on is required.

However, the key segment of the model is the way the curve is developed as the DoT construction curve, which incidentally for the Transmission and Substation Project will be the Contractor's Engineer, Procure and Construct (EPC) costs, was not reasonable as it isn't steep enough with respect to speeding up or delay costs. Traffic projects rarely procurement huge cost things of equipment like Transformers, Conductor drums, PLC and Relay Panels, Transmission Towers, which makes the Transmission and Substation curve aggressive looking when compared with the WZ RUC curve.

The shape of the curve is expected to be an exponential decay type, and the author proposes to adopt an incremental unit time or cost approach or Crawford's model[13]which means that each time the duration halves the costs increase by 531%. [Equation 2: $Y_x = aX^b$].

The Contractor's EPC curve development requires a mix of two segments; I) left-hand side is the learning curve and adapt which gives the acceleration costs and depends on indistinguishable equation from that utilized for Learning Curves, and ii) right-hand side is a curve (or line) that

[12] Guild of Project Controls. (2015, November 2). 08.7.3.5 Cost vs time trade-offs (optimization) - Figure 6 - Guild of project controls compendium and reference (CaR) | Project Controls - Planning, scheduling, cost management and forensic analysis (Planning Planet). Retrieved September 25, 2017, from http://www.planningplanet.com/guild/gpccar/validate-the-time-and-cost-trade-offs
[13] Martin, J. R. Not dated. What is a learning curve? Management And Accounting Web. http://maaw.info/LearningCurveSummary.htm

shows to the delay expenses and comprises just of the contractor extended overhead expenses. The mid-point ought to be the Contract duration settled upon. Figure 4 underneath graphically clarifies the two segments of the curve.

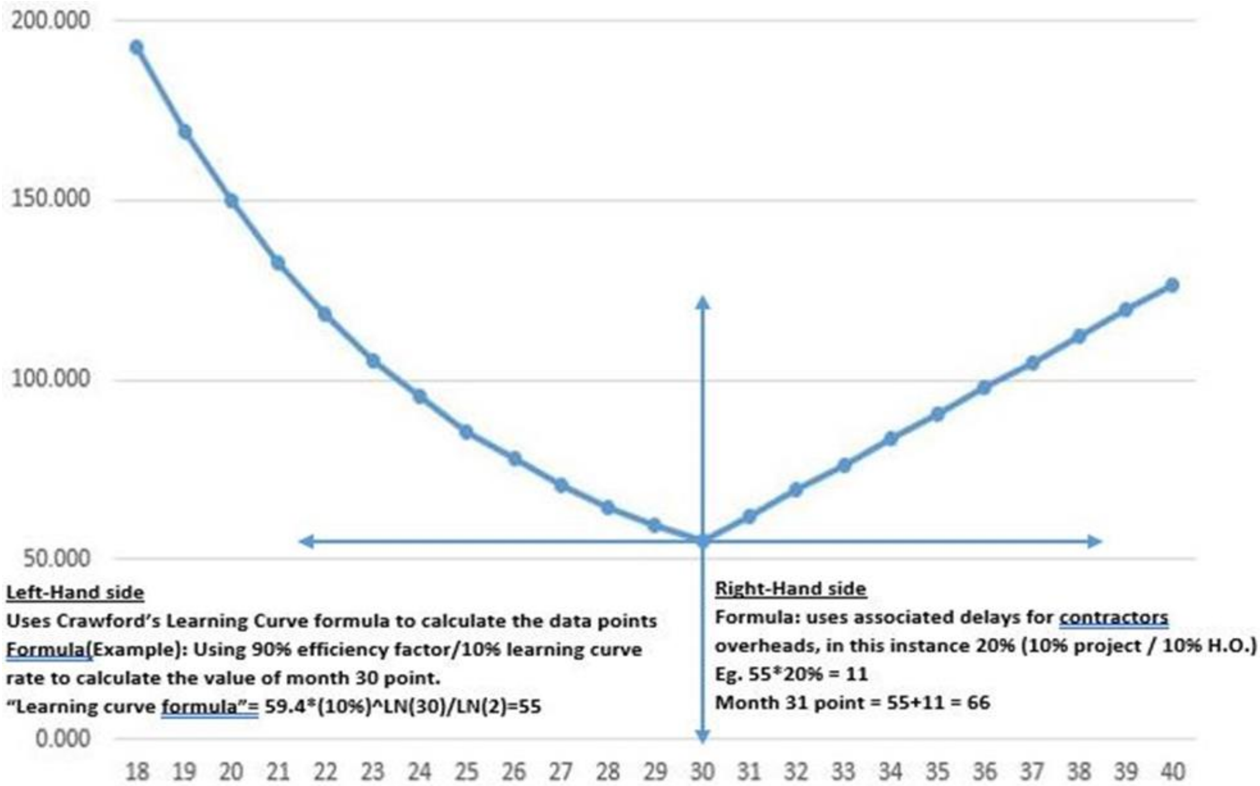

Figure 4 – Components of the Models Contractor's Curve[14]

The curve in figure 4 is for explanation purposes only, the final curve will be developed in the 'Model development' section of this paper, as there are many options available between 80%-20% and 99%-1% that will be evaluated to select the curve most applicable and matching criteria.

The Conceptual Project

The project to be used for this concept is the following:

A Transmission and Substation project of 220 kV Power Transmission Line of length 200 KM with two 220/110 kV substation. The Transmission line consists of 500 towers. The Transmission line passes through a terrain of 90% hilly area. The survey for this Transmission Line project included in the scope of work.

Each project office depends on an Engineering, Procurement, and Construction (EPC) theory for configuration, acquire and develop of each bit.

[14] By Author

Likewise, incorporated into the approximation alongside the EPC, are the Owners costs for land buy for the substation and transmission line course, and the related owner's Project Management Team (PMT) and workplaces.

Contractor Estimates	(US$ million)
Foundation	**11**
Engineering	0.5
Procurement	2.5
Construction	8
Erection	**19**
Engineering	4
Procurement	9
Construction	6
Stringing	**25**
Engineering	5
Procurement	13
Construction	7
Sub-Total	**55**
Owner's Cost	
PMT & Support	4
Office cost	2
Right of way	6
Sub-Total	**12**
Total Costs	**67**

Figure 5 – Conceptual Project Cost Estimate & Schedule[15]

Developing the Model

With the Cost Estimate ($67 million) and Schedule duration (30-months) and the Type of curve selection complete, the next step is to build the model to test the information.

There are three data series on the illustrations shown;

- Total Cumulative Project Costs (Owner and Contractor)
- Total Contractor's EPC Costs
- Cumulative Owner & Contractor's Overhead

Each line will be developed independently with the final product for each incorporated into the model to be used for the analysis but before that, the key assumptions need to be documented.

Key Assumptions

- Contractor's $55M Bid cost incorporates 13% indirect costs (40.8% for Project overheads/Home Office overheads on Labor costs – see breakdown later in this paper).
- The cost estimate incorporates the Owners costs for the 30-month plan. In any case, the Owner's underlying timetable length was two years, some a half year shorter than the

[15] By Author

contractor presented the 30-month plan which was acknowledged as the Contract standard term.

- The revenue/profit generated during the operation phase will be used in future calculations regarding opportunities or lost opportunities.
- The Owner has offered an incentive to finish the project in front of the 30-month standard, this has is incorporated into the Contractor choices in the Contract, however, get it:
  - This sort of office, even with the ideal job site conditions and a boundless supply of assets, would be difficult to toss costs at it and assemble it into equal parts the agreement stipulated span. Best case scenario projects could be structured, secured and developed in 30 months if there were no costly bits of hardware, yet it would come at a hazard. The Owner's two-year estimate is sensible and won't make the Contractor take superfluous alternate ways while planning and acquiring the offices which could influence development later in the task.
  - The Owner has topped the number of assets accessible to be spent in increasing speed at $2M ($55M + $2M = $57M) should the Contractor choose to practice the choice and arrange extra costs/motivating forces dependent on the investigation area of this paper.

The Contractor's EPC curve

The initial step is to construct the curves and afterward figure out which Efficiency Factor/Learning Curve Rate is most appropriate for the model. As recently referenced, the Contractor's EPC curve will be produced utilizing the "Learning curve" methodology, yet it should be an exponential decay curve that reaches a point at month-30 which is $55M, at that point climbs upwards again with the contractor delay costs due to of expanded overheads in extra.

The complete curve has 40 points on it, and the cost curve goes to infinity as each time the duration is halved, the costs increase exponentially by 531%. From a "presence of mind" approach, it would be physically impossible do the large-scale project in 10 months regardless of what number of assets you could allocate to it.

LEARNING CURVE CALCULATOR		
EFFICIENCY FACTOR		90%
LEARNING CURVE RATE		10%
Project duration in months	Accelerated cost to COMPLETE in any given month (million USD)	Marginal cost to crash 1 month
1	66982.028	0.000
2	26792.811	40189.217
3	12178.551	14614.261
4	6310.130	5868.421
5	3756.030	2554.100
6	2504.020	1252.010
7	1788.586	715.434
8	1315.136	473.449
9	993.305	321.831
10	768.218	225.088
11	607.767	160.451
12	492.917	114.850
13	406.698	86.220
14	341.763	64.935
15	292.105	49.658
16	252.905	39.200
17	219.917	32.988
18	192.910	27.007
19	169.219	23.691
20	149.751	19.468
21	132.523	17.228
22	118.324	14.199
23	105.647	12.678
24	95.177	10.470
25	85.745	9.432
26	77.844	7.901
27	70.767	7.077
28	64.746	6.021
29	59.400	5.346
30	55.000	4.400
31	52.250	2.750
32	49.376	2.874

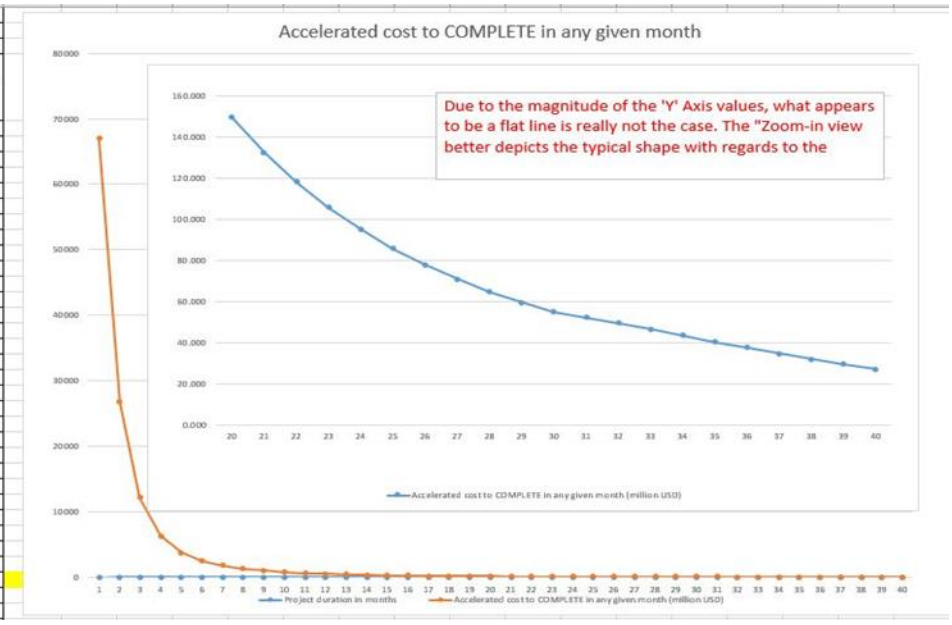

Figure 6- Complete Learning Curve with Overlay of Partial Curve[16]

As Figure 6 demonstrates the size of the 'Y-axis is extremely large as it heads to infinity, and what resembles a level line running over the 'X-axis is an aggressive curve when the 'X-axis' scale is zoomed-in to the months that are entered in the development of this paper. The embedded graph indicates what the genuine curve resembles.

From this point forward, the utilization of incomplete curves that better reflect the shape of the curves and at more realistic axis scales will be received.

Contractor delay costs (appeared as the right-hand side of the bend in Figure 4) depend on the overhead expenses of the $55M; these eventual against the labor portion only, utilizing RS Means (2008 edition) the fixed overhead % = 16.8% and the overhead expense is 16.0%, these are Project overheads, so assuming there is also Home Office overheads to consider a recompense of 8% has been considered for this. In this way, 40.8% is the overhead rate to be utilized on the work expenses of the project.

The labor costs of the project are estimated as being;

- 100% of Engineering costs $9.5 M
- 10% of Procurement costs $2.45 M
- 40% of Construction costs $8.4 M

A total of $20.35 M which attracts 40.8% which equals $7.15 M or 13% of the $55M. Therefore, in the calculations from month-31 onwards the addition of 7.15 for delay costs.

To select the learning curve, given there is no empirical data upon which to base the curve development, there is a need to experiment with several different criteria selections to develop the one which is most "realistic" based on the author's 3+ years of experience (See Figure 8);

[16] By Author

Efficiency Factor	80%	90%	91%	92%	93%	94%	95%	96%	97%	98%	99%
Learning Curve Rate	20%	10%	9%	8%	7%	6%	5%	4%	3%	2%	1%

Table 1 – Criteria to be used in Learning Curve development[17]

Using the criteria selection and inputting into a spreadsheet utilizing the Crawford formula, the key step is to ensure that the value of month-01 provides a value of $55 M on month-30, thereafter the formula uses the delay cost additions. The results of the formulas are shown in table 2.

Ta Acceleration (up to 30) & Delay Costs

Project duration in months	80% EF / 20% LCR	90% EF / 10% LCR	91% EF / 9% LCR	92% EF / 8% LCR	93% EF / 7% LCR	94% EF / 6% LCR	95% EF / 5% LCR	96% EF / 4% LCR	97% EF / 3% LCR	98% EF / 2% LCR	99% EF / 1% LCR
12	334.408	492.917	522.788	558.390	601.721	655.936	726.449	823.067	966.857	1213.12	1788.01
13	283.888	406.698	429.554	456.573	489.355	530.069	582.705	654.203	759.464	937.255	1342.8
14	245.097	341.763	359.432	380.315	405.492	436.593	476.497	530.294	608.724	739.357	1030.96
15	215.020	292.105	306.009	322.319	341.916	366.021	396.767	437.833	497.203	594.754	807.854
16	190.929	252.905	263.906	276.837	292.257	311.079	334.938	366.690	412.013	485.64	643.279
17	170.135	219.917	228.670	238.868	251.003	265.737	284.285	308.819	343.499	399.181	516.061
18	152.812	192.910	199.874	207.969	217.494	229.108	243.587	262.612	289.267	331.528	418.654
19	137.119	169.219	174.736	181.096	188.575	197.646	208.911	223.535	243.944	275.901	340.517
20	123.997	149.751	154.109	159.087	165.005	172.034	180.791	192.090	207.745	231.948	280.077
21	112.156	132.523	135.942	139.871	144.431	149.919	156.636	165.298	177.166	195.379	230.918
22	102.198	118.324	120.987	124.023	127.583	131.831	136.999	143.630	152.607	166.265	192.502
23	93.114	105.647	107.696	110.044	112.740	115.942	119.872	124.847	131.564	141.668	160.765
24	85.537	95.177	96.738	98.518	100.557	102.971	105.895	109.602	114.567	121.979	135.738
25	78.521	85.745	86.886	88.206	89.697	91.473	93.604	96.310	99.8634	105.126	114.798
26	72.623	77.844	78.669	79.598	80.664	81.898	83.405	85.290	87.7978	91.4414	97.9977
27	67.218	70.767	71.334	71.961	72.659	73.488	74.480	75.738	77.3592	79.7109	83.9196
28	62.593	64.746	65.070	65.454	65.873	66.386	66.964	67.701	68.6619	70.042	72.4234
29	58.401	59.400	59.554	59.709	59.894	60.110	60.393	60.707	61.1436	61.7367	62.7677
30	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000
31	62.150	62.150	62.150	62.150	62.150	62.150	62.150	62.150	62.150	62.150	62.150
32	69.300	69.300	69.300	69.300	69.300	69.300	69.300	69.300	69.300	69.300	69.300
33	76.450	76.450	76.450	76.450	76.450	76.450	76.450	76.450	76.450	76.450	76.450
34	83.600	83.600	83.600	83.600	83.600	83.600	83.600	83.600	83.600	83.600	83.600
35	90.750	90.750	90.750	90.750	90.750	90.750	90.750	90.750	90.750	90.750	90.750
36	97.900	97.900	97.900	97.900	97.900	97.900	97.900	97.900	97.900	97.900	97.900
37	105.050	105.050	105.050	105.050	105.050	105.050	105.050	105.050	105.050	105.050	105.050
38	112.200	112.200	112.200	112.200	112.200	112.200	112.200	112.200	112.200	112.200	112.200
39	119.350	119.350	119.350	119.350	119.350	119.350	119.350	119.350	119.350	119.350	119.350
40	126.500	126.500	126.500	126.500	126.500	126.500	126.500	126.500	126.500	126.500	126.500

Using this values and inputting to chart give a better understanding of how the curves look, refer to figure 7**.**

[17] By Author
[18] By Author

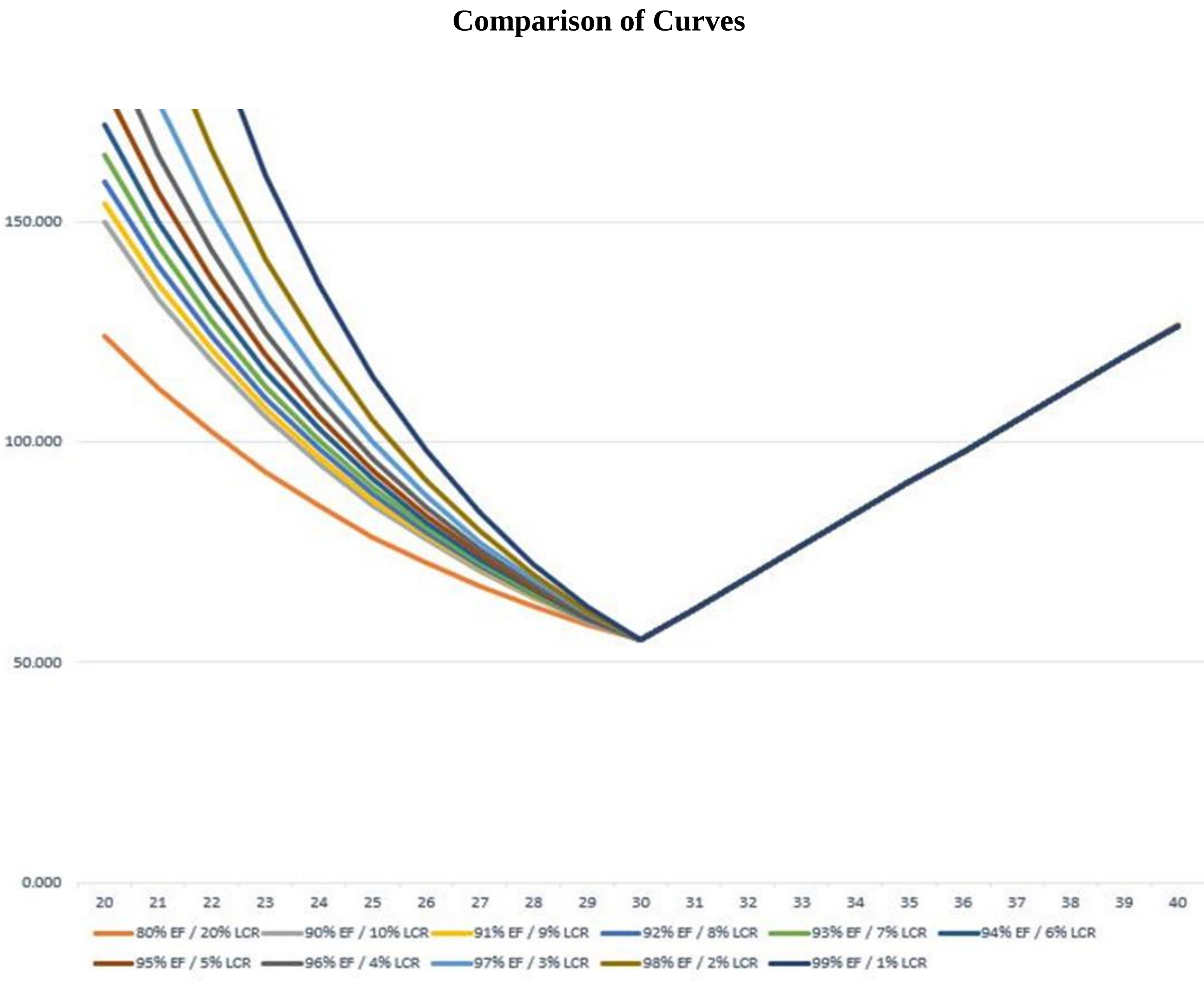

Figure 7 – Comparison of evaluated learning curves[19]

As can be found in figure 7, the higher the learning curve rate the lower the rate of the decay curve becomes. Clarified regarding cost, the lower the learning curve rate, the lower the inefficiency/acceleration costs turn out to be, on the other hand, the higher learning curve rate, the more the expenses of acceleration/inefficiency increment. From the eleven-curve appeared on the graph, one should be chosen for use in this activity, so it is critical that the curve meets some key criteria;

- The best duration this project could be structured, obtained and developed would be 23-months, expecting flawless conditions – no engineering hitches, optimum procurement cycles of heavy equipment, no Right of issues, the abundance of labor and equipment resource to construct the facilities.

[19] By Author

- The crash cost for the above would be in the order of magnitude of 2 times the current estimated cost.
- The cost for accelerating to a duration closer to the contractual duration i.e. 24-months would be at a much lower value.

Reviewing figure, there are 4 curves that meet that criteria 90%EF/10%LCR, 91%/9%, 92%/8% and 93%/7%, so need to review them in more detail to determine which to use. See figure 8 below.

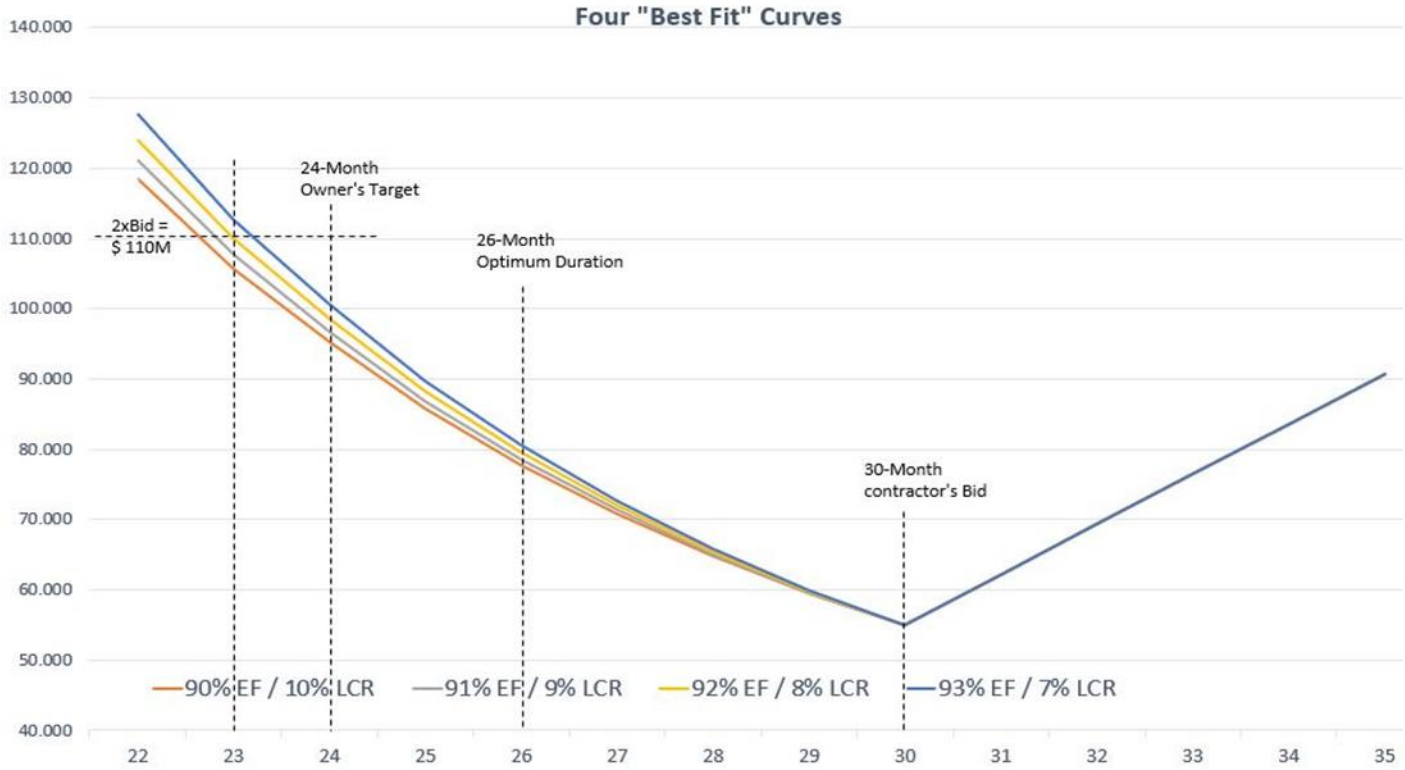

Figure 8 – Best of evaluated learning curves[20]

The best curve to use for the model is the 90%EF/10%LCR as provides the closest cost to both the 24-Month option and the 23-month option.

The Cumulative Owners Project Overhead and Lost Opportunity line

This line incorporates the month to month cost of the Owner's PMT and Office costs from month-01 onwards. Alongside the expenses for "Lost Opportunities" from month-24 onwards. Figure 9 clarifies the development incentive to the both, and figure 10 gives the development of qualities at key focuses.

[20] By Author

Owner's Cost	**(US$ million)**
PMT & Support	4.00
Office cost	2.00
Right of way	6.00
Total	12.00
Monthly cost is Total /30	
Monthly Cost =	**0.400**

Figure 9 – Owner's Costs build-up for chart[21]

Cost Type	01	02	03	04		24	25	26	27		30	31	32	33
Overheads + Opportunity	0.4	0.8	1.2	1.6		13.6	16	18.4	21.8		38	42.4	46.8	51.2

Figure 10 – Owner's costs at Key Months[22]

Figure 10 indicates how the owner's expenses are united into an aggregate figure. The actual graph has 40 information focuses, yet the figure just demonstrated a couple; beginning of the project, when Lost opportunity costs begin influencing the curve, and qualities at month-30 and past.

Plotting all the owner's cost numbers from month-01 to month-50 provides the following chart:

Figure 11 – Owner's Costs Chart[23]

[21] By Author
[22] By Author
[23] By Author

The Total Cumulative Project costs curve

Each project office depends on an Engineering, Procurement, and Construction (EPC) theory for configuration, acquire and develop of each bit.

Likewise, incorporated into the approximation alongside the EPC, are the Owners costs for land buy for the substation and transmission line course, and the related owner's Project Management Team (PMT) and workplaces.

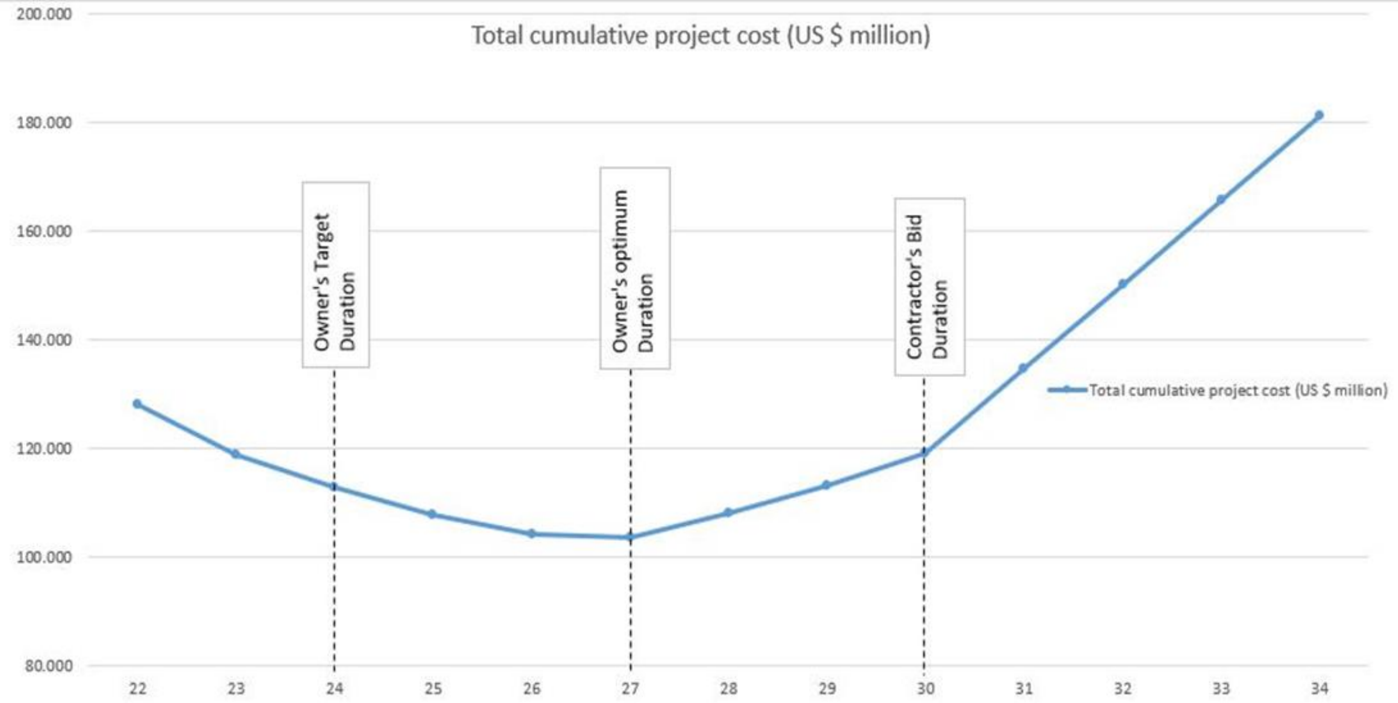

Figure 12 – Total cumulative project costs curve[24]

In Summary, the three curves have been created so all that is required to finish the model is to put them all on the one graph and investigate the diagram.

[24] By Author

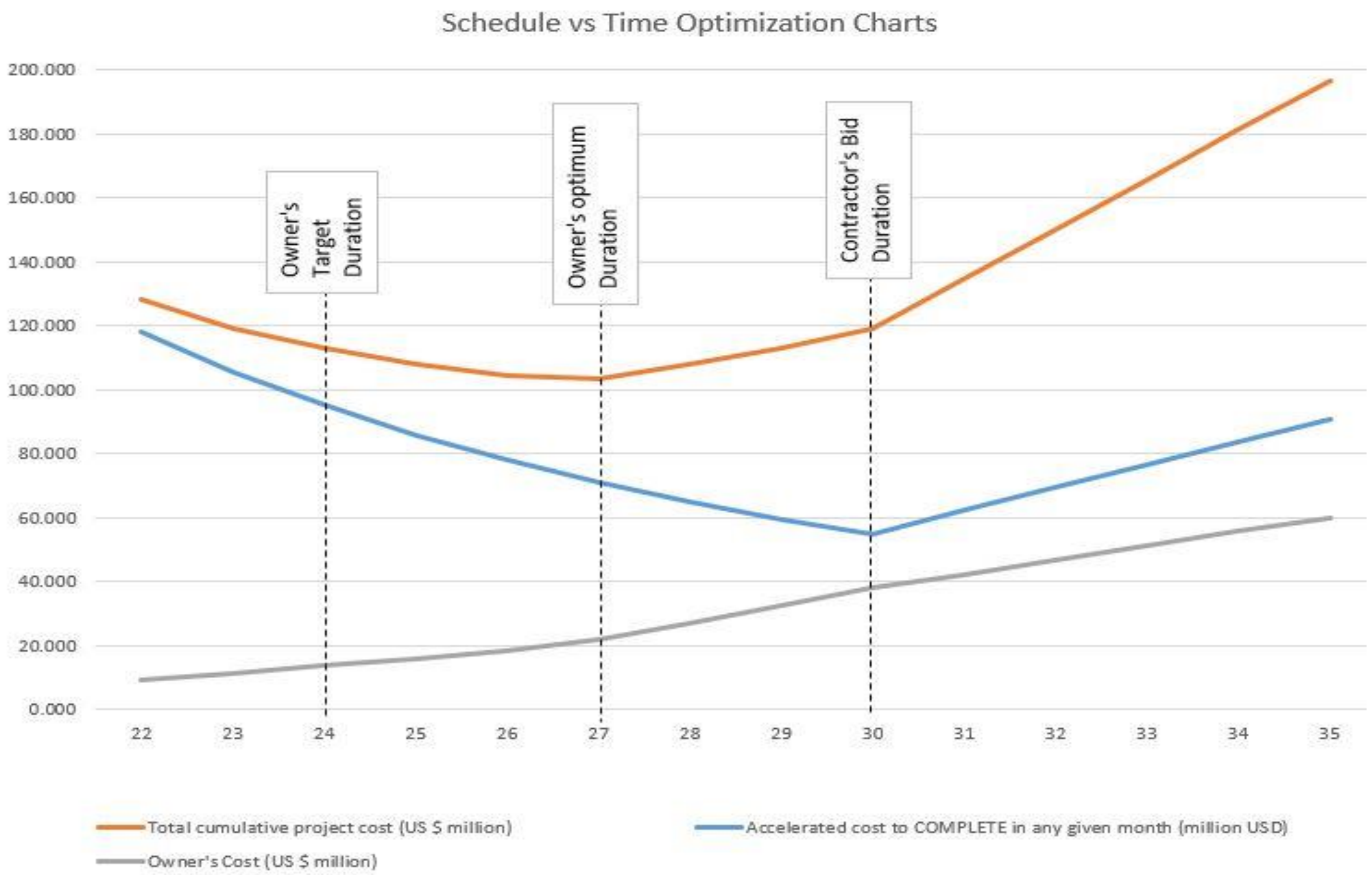

Figure 13 – Schedule vs Time optimization Model[25]

Analysis and Results

With the model complete analysis needs to determine the Owner's and Contractor's optimum points as demonstrated in figure 3. The points that need to be determined are:

- Contractor's Optimum Duration
- Contractor's Optimum Cost
- Owner's Optimum Duration
- Owner's Optimum Cost
- Maximum Duration Overrun
- Incentive Zone & Disincentive Zone

Deciding the Contractor's optimum cost and duration depends on the concurred schedule and cost in the Contract, there for this case, it would be a) $55M and b) 30-months.

The Owner's optimum cost is the place the cost curve is the least and when it happens, in the model, this is a) $103.6M and b) 27-months.

[25] By Author

To decide the maximum duration overrun the author felt that it would just be reasonable for utilize the ordinary procedure of permitting one month for every year of the project, in this manner with a 30-month standard duration the greatest over-run duration ought to happen between month-32/33, the premise of the investigation is utilizing month-33.

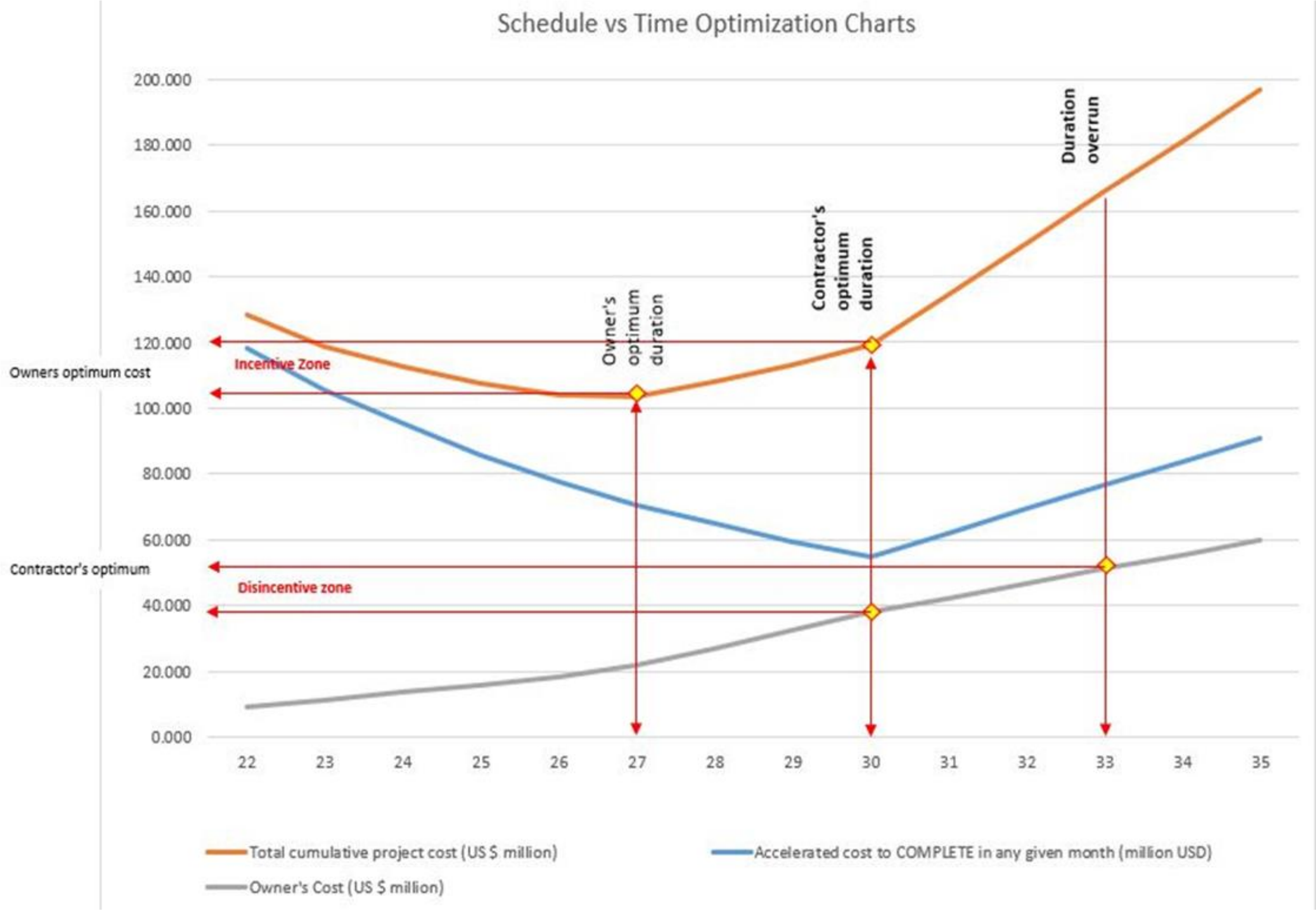

Figure 14 – Model's results[26]

From figure 14 over, the Owner's optimum duration and the cost are at month-27, and notwithstanding the Owner inclination for a 24-month plan. It would be normal that any specialist exhorting the Owner would unequivocally prescribe a technique update to focus on the 27-month which gives the optimal acceleration cost to execute the work.

The assurance of the 'Incentive Zone' obtained by slanting the data points from the Contractor's optimum duration and the Owner's optimum duration on the Total Cumulative Cost curve across

[26] By Author

over to the 'Y-axis'. The upper value being $120M and the lower value being $103.6M, accordingly, the incentive is $16.4M which ought to be isolated into a $/day basis. To be clear here the incentive would be 100% to the contractor to take care of the costs/inefficiencies aspects viewpoints related with increasing pace to complete the project earlier, the advantage to the contractor is the shortening of the duration which in this manner would diminish their overheads. [Equation 3: Daily Incentive Cost = Total Incentive esteem/Number of days] For this circumstance there are 3 months at 30 days of the month, which squares with 90 days. Using the $16.4M or $164,00,000 separate the figure by the total aggregate of days to give a step by step figure of $1,82,222/day. This is the incentive figure should be mentioned in the Contract.

Similarly, the 'Disincentive Zone' is dictated by utilizing the distinction in the other two points on figure 14, the higher data-point purpose of the Duration overrun, which for this situation is on month-33 crossing point with the 'Owner's overhead and opportunity' line equivalent to $51.2, and the Contractors optimum cost which is the bid estimation of $38M. The disincentive zone esteem is equivalent to $13.2M which additionally should be changed over into an everyday rate, this time the quantity of days is 3 months multiplied by 30 days/month which equals 90 days, giving a day by day disincentive rate of $1,46,667/day for any delivery after the end of the 30th month.

There are no firm standards for the advancement of incentives in an agreement, and as referenced over the $16.4M incentive value is to purely cover the costs and inefficiencies aspects related with the acceleration, and in like manner the $13.2M penalty is to take care of the lost opportunity costs. Any increases to the contractor would be because of sparing of overheads. The wording for this sort of incorporation in a contract needs the full focus from both Owner and Contractors legal teams to guarantee there are no ambiguities and the expectation clear, rather than endeavoring to give lawful provisions to incorporation in the contract, the author provides some thought focuses;

- Both 'Incentives' and 'Disincentive' day rates require consideration in the proper pay area of the contract, alongside any computation equation to process the incentives/disincentive expenses.
- The extent of work related with an 'Incentive' or 'Disincentive' is plainly distinguished, to guarantee that the full goal of the acceleration or lost opportunity isn't vague and left to future translation.
- Careful consideration should be given to guarantee the contractor finishes the full extent of the contract to accomplish the full incentive sum and not an incomplete degree.

The WZ RUC report gives to figure the incentives dependent on contractor cost every day except depends on having real information to process the values, this isn't doable on vast Transmission and substation extends because of a large amount of revenue involved.

Numerous bigger projects are generally organizations between several worldwide organizations, therefore any incentive scheme conspire needs the full understanding between all gatherings preceding usage. Utilizing the model created above and adjusting it to project explicit, enables an incentive plan to be produced in the meantime as the principal contract with or without admonitions for its usage dependent on an arrangement of rules. This acquires all Partner/Stakeholder buy-ins in front of the project initiation and permitting the Project's managing partner to actualize any pre-concurred design at the time the alternative is worked out, rather than holding up inward plugs to defer usage.

CONCLUSION

The WZ RUC likely could be a record that functions admirably for the DoT, anyway looking at the curve created for the Construction Costs' appeared in figure 1, it appears to be endless that the left-hand side of the curve does not drift upwards to infinity, after all, there must come a phase whereby a road or bridge project has a minimum duration for construction given perfect conditions. The adaption of the standards for the curve dependent on a reasonable Transmission and Substation project has been exhibited and that it's anything but a "one cure fits all" way to deal with building up a task explicit model. What works for the conceptual project; a 90%EF/10% LCR, might be distinctive for another project to utilize the model. This is indistinguishable to the improvement of the projects itself, as each project is exceptional. A key issue identified during the analysis of the conceptual project that while the Owner initially had a 24-month target, the optimal duration was 3 months later in month-27, with those three months having an increased cost impact.

The ability to develop an "Acceleration / Lost Opportunity – Incentive / Disincentive" based on the Contractor's bid and Owner's opportunities prior to Contract award, should be an opportunity. It allows the Contract to be prepared and includes clauses to advise "All parties" that for each day the contractor completes the project before month-30 there is "Bonus" and outline any "Penalties" for each day the project completes after month-30. Everyone is aware of upfront what is at stake.

This paper set out to determine if the WZ RUC method was adaptable to other applications by substituting "Lost Opportunity Costs" (LOC) in place of WZ RUC and create the appropriate incentive or penalty for a contractor. The author believes that the analysis as presented above has demonstrated that it is indeed adaptable but requires the development of a different model to suit the application. In doing so, it also brings into to question whether the WZ RUC construction curve formula truly represents reality the closer the curve gets to the minimum duration.

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Souvik Shil is a multilingual project management professional, specialising in Transmission & Substation construction sector with more than 4 years of experience in project execution. Born in the eastern part of India, he holds a Bachelor of Technology majoring in Electrical Engineering in the India. Presently he is pursuing MSc in Project and Programme Management & Business Development from SKEMA Business School (a top tier school in France and globally). Also, Souvik is PRINCE2 and AgilePM Credentialed.

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