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ESTIMATION OF THE PROJECT COST BY NONLINEAR METHOD ACCORDING TO DIFFERENT MANAGERIAL ATTITUDES

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Abstract

Minimalizing the error between estimated cost in the earlier time of the projects with actual one at the end of the projects by intervening the managerial belief and unexpected risks in new method (nonlinear regression) that has structured for estimation of the cost in the project according to all of the possible subjective risks may happen during the project timeline,

Since in describing Roles of the risks in estimating project cost, decision of the individual managers concerning forecasting cost is so determinant factor, so according to this issue, the attitude of the managers can be classified generally in three sub categories, managers that are optimistic and in opposite manner managers that are pessimistic about their estimation of actual cost of the project, and also we can have logical one as middle managers that they are not optimistic and not pessimistic, and lastly we can assign specific formula but in common method for each group, and compare expected costs of each other, obviously each expected cost represent specific attitude of the manger, and this view gives the manager to be so flexible about his or her forecast of the cost during project scheduling, if we consider and intervene kind of the managers attitudes including being pessimistic or optimistic viewpoints in our forecasting way of the cost, amount of the error (APE) decrease considerably because By doing this method we can translate subjective risks to objective one.

Key words: *cost estimation-nonlinear method-managerial belief-earlier time of the project*
JEL Code: *G17*

Introduction

Since long time ago up to now a lot of modifications are made in order to have better estimate of the cost such as considering time scheduling beside the cost scheduling in order to find formula that could be valid for entire project including also late project, however as time goes by highlighting role of the risk in the project, better estimation of cost done with understanding effects of the different situations in the different projects concerning critical activities and uncompleted task as another factors of the risk.

These studies are strengthened by using software tools as main tool for estimation of the cost and decision support system (DSS) as computer-based systems that support decision making by combining and analyzing data and providing analytical models and tools that contribute to the selection of alternatives.

But in today's rapidly changing, competitive environment, organizations faces to manage portfolios of projects ,they are not enough and it is needed to find other methods except to IB method which demonstrate expected variable in the proper way. Monte Carlo simulation has been widely used in the literature. The reviews of Kwaka and Ingall (2007) and Vanhoucke (2013) summarized the advantages and disadvantages of using Monte Carlo simulation to model projects, especially for risk analysis and control, But we need to find new dynamically equations that works in the easier way and better ways Among the different equations and

simulations, ciofffi paper is pioneer in this way that introduce growth model (S-curve) as nonlinear regression model of EAC. He proposed a parameterized S-curve tool for managing the cost of an ongoing project; Regression techniques (EAC) that have been regarded as an alternative to traditional IB methods are improved significantly by paper "An earned schedule-based regression model to improve cost estimate at completion Timur Narbaev, Alberto De Marco" (Narbaev T., De Marco A., 2014, p. 10).

However main problem in nonlinear regression method in EAC is that we could have a lot of subjective parameters that should be chosen by different managers, on the other hand lack of the distinctive managerial belief is the main drawback.Furthermore the most significant factor in determining risk related to EAC is managerial attitude which is actually dynamic decisions are done by managers regarding to dynamic risks happen during the project, Managerial belief as dynamic decisions are made according to unexpected risks happen during the project timeline, these decisions have significant influence on the outcome of project respect to the cost and time scheduling, lack of the formulas that could characterize managerial opinions in the our estimation of the coast(EAT) is desired strongly these days.

This paper is structured to intervene managerial belief as main factor of the risk in estimation of the cost project by using nonlinear method the basic concept that can help us related to have better illustrations about the risk and unexpected happening, is the confidence level, the scope that is extended and limited by subjective decisions and is done arbitrary by cost estimators and managers, concept of the confidence level gives us wide area of personal decisions in order to have better exploratory studies about managerial belief and different point of the views.

Nonlinear Cost estimate at completion methods

Providing appropriate context for managerial attitudes

In order to interfere managerial belief in the cost estimation at competition(CEAC)formulas, firstly we need to have appropriate procurement method that provide proper context for characterizing managerial view points, this provision is created by nonlinear regression method and growth models, which have also more precise outcome for CEAC, there is no doubt that index-based methods for CEAC (cost estimate at completion) forecasting is widely accepted formulas and is proper, but according to primary limitations, as follows: (1) reliance on past cost performance only, (2) unreliable forecasting in early stages of a project life, and (3) no count of forecasting statistics (Flemingand Koppelman 2006; Kim and Reinschimdt 2010; Tracy 2005; Zwikael et al. 2000), nonlinear regression is absolutely preferred to traditional method, moreover, concerning to" Combination of Growth Model and Earned Schedule to Forecast Project Cost at Completion Timur Narbaev,and Alberto De Marco," new regression based nonlinear in CEAC methodology is proposed that integrates a growth model with earned schedule (ES)concepts. This methodology provides CEAC computations for project early-stage and middle-stage completion.

To this end, this paper establishes to continue this way by innerving managerial attitudes in the most logical possible way, which is exactly nonlinear method and using growth model.

But firstly, summarization of new regression based nonlinear cost estimate at completion (CEAC) methodology should be described. Before going analysis, it should be noted that Based on statistical validity analysis of the four growth models and comparison of CEAC errors, the

CEAC formula based on the Gompertz model is better-fitting and generates more accurate final-cost estimates than those computed by using the other three models and the index-based method:

$$\mathbf{GM(X) = \alpha e^{[-\exp(\beta - \gamma X)]}} \quad (1)$$

(GOMPERTZ_Bates) growth model is selected for main formula forr estimation of the cost.

The CEAC methodology proposed in this paper integrates ES concepts into its equation to take into account the project work progress. The ES technique overcomes limitations inherent to the EVM method when it comes to computing Expected Duration at Completion (EDAC) or time estimated at completion (TEAC) of a project (Lipke, 2003). It measures the schedule progress in time units and eliminates a deficiency of EVM-based SPI, which tends to unity as the project approaches its completion, regardless of any early or late finish. As far as the accuracy of the ES method in computing EDAC is concerned, comparative studies with EVM methods show that the ES technique provides more accurate estimates than SPI-based calculations (e.g., Vandevoorde and Vanhoucke, 2006).

The value of ES is obtained by projecting to actual date the EV curve onto PV curve assuming that the current EV should actually have been earned at that projected time. Therefore, the ES is defined as per Eq :ES(x)=C(x)+I(x)

Where C denote the number of total time units for which EV exceeds PV and the incremental portion I(x) = (EV(x) - PVc)/(PVc+1 - PVc) which is more or equal to 0 and less than 1.00. As a consequence, a time-based SPIt can be defined as per Eq : SPIt(x)= ES(x)/AT

Thus, the resulting TEAC when the project is at time (x) is the ratio of Planned Duration (PD) to SPIt(x). As the proposed approach utilizes the ES concept to consider schedule impact in CEAC, the model uses the inverse of SPIt(x), which is the ratio of TEAC, to PD.

For the purpose of better understanding the proposed equation, this inverse ratio is referred to as Completion Factor (CF). The CF indicates EDAC yielded to unity and it can also be defined as inversely related to SPIt(x):

$$\text{CF(x)} = \frac{\boldsymbol{TEAC(t)}}{\textbf{Planned Duration (PD)}}. \qquad \text{TEAC(t)} = \frac{\text{Planned Duration (PD)}}{\text{SPI(t)}} \quad (2)$$

If the value of the CF, based on work progress to date, is greater than 1.00 it indicates that a Project is likely to be delivered late, whilst less than 1.00 shows an early finish.

The proposed CEAC model*:*

This section develops the new methodology following three steps. First, the values of the three parameters of the GGM (Eq. (1)) are found through nonlinear regression analysis.

Then, the new CEAC formula is introduced with integrating parameter and the new CEAC formula is introduced with integrating parameters of GGM to calculate CEAC.

Finally, the CEAC formula is modified by the purpose of reflecting schedule progress on the cost performance. To this end, the ES-based CF is integrated into the formula. Here, the CEAC equation has two variants: a base one without integrating the CF, and an ES-based one that interpolates the value of the defined CF.

Narbaev and De Marco (2013) provided comparative study on this CEAC methodology integrating four growth models (Bass, Gompertz, Logistic, and Weibull) into its equation. They

found that GGM is the best statistically valid model converging to approximate values of its parameters in nonlinear regression curve fitting. In addition, the GGM generates more accurate CEAC for early and middle stages of the project life. This work provides further extended applicability and reliability of the previous model by providing accurate late estimates, analysis of forecast precision, model timeliness, and integration of the influence of schedule progress on the CEAC computation.

The first step in developing the methodology is to find the three GGM parameters through nonlinear regression curve fitting. For this, both time (a predictor variable) and cost (a response variable) units are normalized to input into the GGM equation. The normalization of all the values of time points to unity (1.00) assumes a project is 100 percent time complete (i.e.,PD=1.00). Each next time point is a cumulated portion of this unity with the final time point representing PD (1.00) of a project. These values represent a predictor variable (x) of the GGM.

Each time point (x), a value of the predictor variable, has a corresponding cost point, a value of the response variable. These corresponding cost points are formed as follows. The values of AC from time zero (x=0) to AT are normalized to unity (i.e., BAC=1.00) while the values of PV from AT onto project completion with the final value of the normalization representing BAC (1.00, i.e., 100 percent complete). Then, the normalized values of to date AC and PV are combined to form the values of the response variable (y) in the GGM.

Finally, each time point (x) of the GGM equation (Eq. (1) has its corresponding cost value (y) to run the nonlinear regression with the GGM. This allows finding the values for the three fitting parameters. Both time and cost units have final values equaling 1.00 (PD=1.00 for time and BAC=1.00 for cost).

The following requirements are taken into account for the GGM equation in the nonlinear regression curve fitting: the normalization of the predictor and response variables and what the three parameters represent an initial value for these parameters is 1.00 with the confidence level 95% and the approximation algorithm the Gauss-Newton (which converges the parameter values not heavily depending on their initial values). Then, via running this regression procedure, the values of the three parameters are obtained: α asymptote, the y-intercept β, and γ-scale. The Minitab® software tool is used for this task.

The second step requires computing CEAC by using Eq. (3). This equation is the refined version of a classical IB formula as previously given in Eq. (5). The difference is that Eq. (3) calculates the remaining expected cost by regression analysis, while the IB formula adjusts it with a PI. The second summand is an estimate to complete a project. It is equal to the product of BAC times the difference of the two values of GGM (Eq. (1)): when a project is 100 percent time complete (the result of the GGM function when time (x) is 1.00) and at AT (the result of The GGM function when time (x) is at AT).

$$CEAC(x) = AC(x) * [GGM(1.00) - GGM(x)] \, BAC \qquad (3)$$

Finally, the GGM is modified to consider possible influence of work progress on CEAC. The Main assumption of this refinement is that favorable schedule efficiency tends to improve the Final cost, while a poor schedule progress may increase the final cost. To this end, in Eq. (4), the Value of x=1.00 (which implies that a project finishes on time) is replaced by the CF (the ratio of TEAC to PD). This is less than1.00 if a project is ahead of schedule and greater

than 1.00 if a Project is behind schedule. This modification represents a cost-schedule integrated approach because the cost estimate considers the schedule impact as a determinant factor of cost behavior.

The refined CEAC formula is given in Eq. (4).
CEAC(*x*) = AC(*x*) *[GGM (CF(*x*)) -GGM(*x*)] BAC (5)

Minitab developed Equation from growing model based on the options the writers set for the nonlinear regression analysis, as discussed next. The writers define good starting values for the three parameters. Taking into account the normalization to unity of both the predictor and response variables the writers define 1.0 as a starting value for all parameters.

This method (nonlinear) is done successfully while resulting better estimation of the cost compare to traditional approach (IB),non-linear method approach has more accuracy and also better precision of the IB cost estimation, these results are proven by measuring parameters like APE(Absolute percentage error) which defines level of the outcome accuracy respect to actual cost at completion and SD(Standard Deviation, which is an indicator of a statistical dispersion of the values of prediction errors from the average forecast within the population).

Up to now we reached more précised and accurate formula for estimation of the cost, but how managerial ideas are combined with that method and how it is possible minimizing absolute percentage error (APE)?

Firstly it could be better if we have exploration about kind of the managerial belief and ideas, in order to have better concept about this idea, again we refer to paper from the Denis F. Cioffi (tool for managing projects: an analytic parameterization of the S-curve), they concluded from population growth method equations such as below and regarding to them we are able to determine cost of the project:

ln(&+2)=8rb(1/2) (6)
Y (b) =Y (1) *(1-exp (-8rb)/1+&exp (-8rb)) (7)

For any project, the manager can choose values for b (1/2) and r, then calculate & from Eq. (6), after the normalization factor (y1), plots the desired evolution curve with Eq. (7).and calculate cost growth Y (b) according to the Growing model. But main question is that how it all is used?

As you read from cioffi paper; selecting parameters like r is subjective choice that are made by different managers, So we can detect this fact that, decisions of the managers related to the parameters is the key in determining cost of the project, furthermore every manager can arbitrarily choose values for b and r, so what is obvious is that, those formulas are dependent strongly to the subjective decisions are made by different managers in the different situations, so in the logical point of the view ,they could not be used for general cases totally and it should be restricted to limited cases.

Another example is the paper from: “A Bayesian Approach to Improve Estimate at Completion in Earned Value Management Franco Caron" again in that paper writer refers to subjective choice of values such as Alpha and Beta, alpha and beta are inputs to the model.

Every manger can select values according to his or her idea about the project and there is no logical concept behind their choice, selecting the values is made only according to their

experience and expectation about the kind of the project execution and actual past data of the project.

Furthermore, extreme complexity in calculations of the cost makes this method to somehow difficult to analysis, if we want to characterize managerial attitude in the formula related to cost estimation, it is needed having distinctive definition of the kind of managerial belief. actually it is subjective decision, millions of the mangers think in million ways, in addition in nowadays practical projects, every project has its own culture and past experience of the mangers may cannot be exactly and correctly related to the new project because structure and culture of every project differs by kind of the circumstances happen during the projects.

What is most important for us is that we need to know before that one manger how should think logically and properly about Executive progressive of the project in order to have better estimation of the project cost and having accurate CEAC with lowest amount of the error.

On the other hand, according to the psychological studies, no one can deny this fact that that managers thought is limited in the area between; pessimistic, optimistic and logical one, is obvious, although there are so tolerance between each attitudes and ideas, but all of them is arranged and limited in these three though stream ;pessimistic, logical and optimistic

Methodology

What is obvious is that in the previous paper, regression model is created according to the real past data and some points as expected point data. So we can conclude this decision that there are only two parts that they are not considered as fixed items for us. First is the way that expected points of the cost and time are selected, which is completely done arbitrary by the different managers, and second is choosing in the way that which formula of the growing model should be selected. And after that next question is what is the reason for considering 95 percent of the confidence level as probability of the simulation? On the other hands, it is intended to improve this method for subjective risks or unexpected risks and dynamic decision which made by mangers in different situations. Main factor in this research is attitude of the managers, and knowing that attitude of the managers is affected by kind of the their specific visions to the projects, furthermore it could be optimistic or pessimistic or middle point of the view, the basic concept that can help us related to have better illustrations about the risk and unexpected happening, is the confidence level, the scope that is extended and limited by subjective decisions and is done arbitrary by cost estimates and managers, concept of the confidence level gives us wide area of personal decisions in order to have better exploratory studies about managerial belief.

Logical solution could be considering positions of the points in the cost curve in the confidence level area resulting from nonlinear regression by using growth model formula, points of the cost curve could be divided in the three categoryies, furthermore, we can select points below the main line (center line in the confidence level) of the cost curve as cost that is less than expected one (trend of the past performance) so it could be considered as optimistic view to the cost performance, Consequently points upper than center line are considered as pessimistic view because cost is more than expected, and points that are exactly on the centerline as middle viewpoint. Results of calculations are shown in Minitab software, author also describe them totally in this research, but first of all, it is needed to explain a little about what have done up to now. In the results of the (ListOfProjects_r03_1-3_BaseWith0_EV), in

the project execution we have 7 time points including ACWP, BCWS and BCWP and it is normalized fraction of the unity.

Among the growth models that could be taken in to account, author has selected growth model which is advised (GOMPERTZ_Bates), time units normalizing (predictable variables) and cost units normalizing (response variables) are selected as input for nonlinear regression in the growth model.

The Outcome of the regression in the growth model (GOMPERTZ_Bates) according to the time units and cost unit gives us 3 main parameters: α (final value asymptote), B(y (cost normalized) intercepts -initial size) and γ (as scale, governing rate of the growth), these parameters are main factors of the growth model equation, $\mathbf{GM(X) = \alpha e^{[-\exp(\beta - \gamma X)]}}$ α (GOMPERTZ_Bates).

After defining parameters of the Gompers model equation, two variables are selected as input X (normalized time) to the growth model equation, first is the time that we expect project would be finished and second is the time that we are now in the project, and then output of the this equation(Gompertz) is replaced in the CEAC formula according to the Regression-Based Method in order to find cost estimation at completion:

$$\mathbf{CEAC(X) = AC(X) + [GM(1) - GM(X)] * BAC} \quad (8)$$

Before analyzing these data as author has mentioned in the beginning of this research, all of the phases together should be included in order to estimate the cost, for example result from previous paper dictated us this fact that TEAC should be considered (time of the completed project considering real time scheduling) as input, then we have to calculate the cost related to that time.

For example, According to the result from (List of Projects miafiori3_BaseWith0_EV) we observe that plan duration related to BI method is 6.20 while actual duration of the project is 7, And strong point about TEAC is that, when the one third of the project progress occurred, it is estimated 7.02 that is so close to actual one, this is why author emphasize on this issue. For explanation our procedure, firstly Data table as cost report of the project is illustrated below:

Table 1

Cost report of the project

Time	PV(BCWS)	EV(BCWP)	AC(ACWP)
1	370,220	124,120	535,000
2	2,080,080	1,333,220	2,461,000
3	5,730,920	4,442,640	4,562,480
4	9,625,720	7,201,100	7,468,600
5	16,050,000	11,249,980	11,936,920
6	19,688,000	14,768,140	15,729,000
7	21,400,000	21,400,000	21,913,600

Source: author's calculations based on the Mirafiori Industrial Facility Project (MIFP) by Timur Narbaev, (Narbaev T., De Marco A., 2014, p. 10)

Table 1 shows Cost data about the project, we are in the month 3, so from time zero up to third month actual cost (AC) or EV is considered, since 4th month expected points is forecasted and we use PV instead of the AC, then both time (a predictor variable) and cost (a response variable) units are normalized as input in to the GGM equation, (Table 2) and after replacing new parameters in the CAEC formula, new estimation of the cost would be achieved

Table 2

Cost report of the project

Time	Cost	Growth
0.000	0.000	0.000
0.143	0.006	0.006
0.286	0.062	0.057
0.429	0.208	0.145
0.571	0.450	0.242
0.714	0.750	0.300
0.857	0.920	0.170
1.000	1.000	0.080

Source: author's calculations based on the MIFP by Timur Narbaev

Outcome of the Regression method considering predictable variables(time) and response variables (cost) in the GOMPERTZ model equation could be shown as Fitted line plot (cumulative-growth curve) in the figure 3, as you see it is resulted from mirafiori industry report; (calculations is done by Ali Bargrizan regarding to MIFP.)

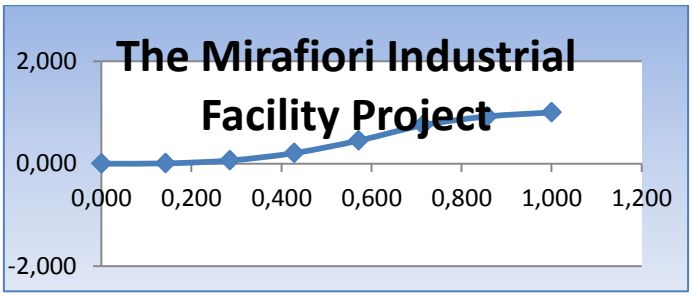
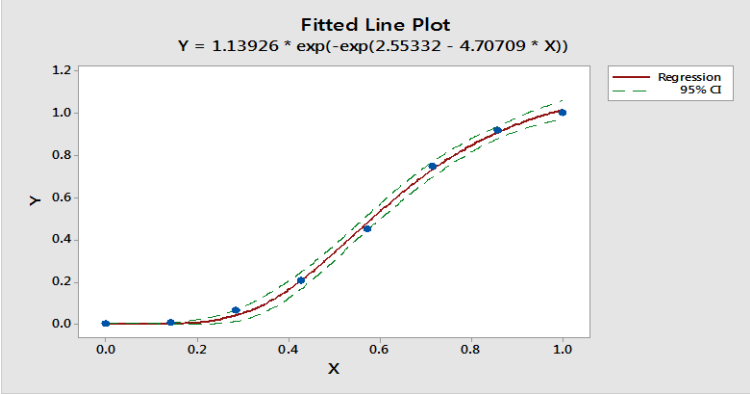


Figure 1. **The Mirafiori Industrial Facility Project**

Source: Author's construction

While demonstrating this curve considering 95 level confidence levels (resulted from gauss-newton distribution from Minitab software), it could be demonstrated as below in figure 2:



α =1.139β =2.553γ =4.707.

Figure 2. **Gauss-newton distribution from Minitab software**
Source: Calculations is done by Ali Bargrizan regarding to MIFP in Minitab software)

These parameters (α, β, γ) are achieved by outcome of the regression model of cost and time from minitab). As you see, in this case, after gauss-newton distribution and having area of the confidence level, we can compare situation of the blue points (response variables across predictable variables) to the red center line (outcome of the regression),

Regarding the note that author described earlier; three categories of the points could be selected, first, the points that are under the main line (center line in the confidence level in red color) of the cost curve as cost that is less than expected one (trend of the past performance) so it could be considered as optimistic view to the cost performance, And secondly points that are upper than center line considered as pessimistic view because cost is more than expected one and consequently points that are exactly on the line as middle view point.

For this purpose, points 1, 2,3,6,7 are considered in the upper points as pessimistic point of the view, because the related cost is more than middle one and points: 1,2,4,5, are supposed as lower point of the center line as optimistic view point since the cost is lower than middle one, And then we can make new nonlinear regression of them again with same equation and the itineration and compare result of the new regression with privies one.

This idea is tested in mirafiori industry report, wonderful results is achieved, If we consider pessimistic stream which means selecting points such as: 1, 2,3,6,7 (they are in the position that are upper than mean cost curve from gauss-newton distribution) and then make new nonlinear regression according to the Gompers formula with same itineration, we reach to the new parameters of the growth model and parameters like α (final value asymptote), B(y (cost normalized) intercept -initial size) and γ and change consequently as below,

X-upper	Y-upper	
0.000	0.000	α= 1.11193
0.143	0.006	B= 2.40275
0.286	0.062	γ= 4.68896
0.714	0.750	
0.857	0.920	
1.000	1.000	

Figure 3, demonstrate Pessimistic view, selecting points that are upper than mean line of the gauss-newton distribution Method:

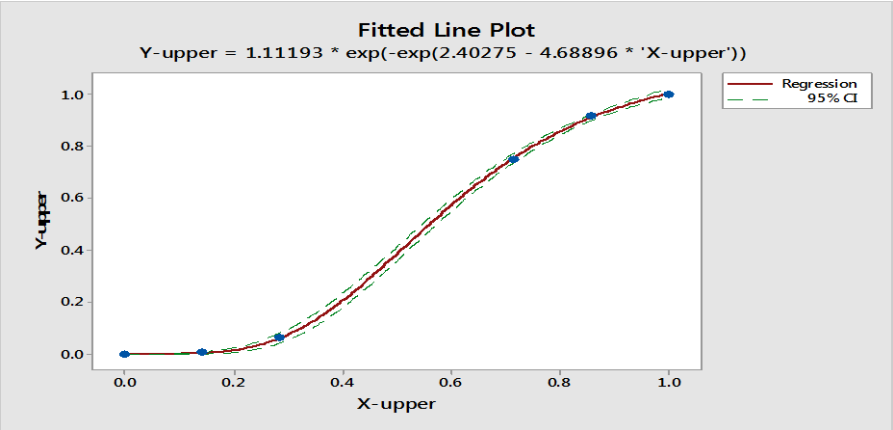


Figure 3. **Pessimistic view**

Source: Calculation is done by Ali Bargrizan regarding to MIFP in Minitab software)
Pessimistic view, Algorithm Gauss-Newton Max iterations: 200 Tolerance: 0.00001

By replacing these new parameters in the CEAC formula (while we consider TEAC not planed duration) amounts of the APE (absolute percentage error) decrease significantly from the 5.22% to 1.02%. For more explanation, actual cost of the project at completion is 21,913,600 and cost estimation of the project in the third month considering all point is 23,058,536 with has 5.22% error with privies number. While estimation of the cost according to the pessimistic point view is 21,690,209 which have 1.02% error compare to actual one.

On the other hand, if at the beginning we compare earn value (BCWP) points with actual one (ACWP), we realize that in the project work executed, actual cost is always more than budget cost (planed) in the first three month of the project execution, So it dictate us this idea that being pessimistic about the cost estimation, could be beneficial and logical.

Implications, Limitations, and Future Research

3 main findings can be extracted, first of all is that nonlinear method is preferred way compare to other methods such as CPI method, because it has more accurate outcome with more degree of the precision, especially if growth model equations are selected.

Secondly, considering time estimation at completion (TEAC) along with considering nonlinear method together is good way for estimating the cost.

Lastly and main conclusion is mixture of the those formulas(nonlinear) with attitude of the managers in the different situations, as you see, amount of the error (APE) decrease considerably, if we consider and intervene kind of the managers attitudes including being pessimistic or optimistic viewpoints in our forecasting way of the cost, one of the these views helps us more than before in order to expect cost at completion in the perfect way, this method was tested on three practical projects and checking outcomes demonstrated us this fact that selecting different viewpoints of the managers rise the accuracy of the results unbelievably,

In the reports that tested, if we select the points that shows only pessimistic attitude, APE decrease more than 50 percent, initial actual data of the project also help us in choosing that

which viewpoint is selected, but author has chosen only Gompertz growth model in the calculations.

Nevertheless what is so interesting for me is that, we can repeat this method again and again, furthermore, after dividing points in to the two categories and selecting accurate one of those groups, we have to face only pessimistic points or optimistic one, it means we can remove improper groups(points) and work on only remaining points, and in the next step we can again repeat previous method for remaining point and generating again pessimistic points and optimistic points, this method can be repeated up to reach exactly the best accurate expected points that are so close to actual one, this fact that how we realize which upstream of the thought is correct is achieved by comparing time by time expected points with actual one,so it is needed reporting of the project costs continuously respect to the time progress.

Regarding what discussed up to now, what is important is that you have to test and compare your data regularly in order to realize which group points gives you smaller amount of the APE, however, these precise estimates are achieved only by checking reports continuously respect to the time. If we combined two last implications together, we will reach to great achievement about having proper precaution about the project costs, firstly, a manager can estimate CEAT at the beginning time of the project according to his personal vision to the project, and then after passing initial time of the project when actual data of project for earlier time are achieved, secondly manager could compare amount of the his or her estimation with actual one, but what gives him more forecasting accuracy is that at that time, 3 expected value of CEAC (pessimistic-optimistic-middle) are available for calculation and not only one point ,that give managers more general view about estimate of the project cost.

And lastly manager can estimate expected values according to the kind of the thought stream happening during the project execution, moreover, being pessimistic or optimistic is investigated Every moment by the manager, and anticipated points that have behavior in opposite to the actual data can be removed easily from our estimation and only expected points (pessimistic or optimistic or middle) that are close to actual data can be remained for further calculations and again in the remaining points we can repeat same method, dividing points to the 3 categories(pessimistic-optimistic-middle) in contrast to each other and compare them with next actual data. Certainly we could have best estimation of the cost at completion with lowest error, because at that moment we know exactly which subjective risks exist in the project and how we can behave with those risks in order to have proper forecasting of the cost at completion.These precise estimates are achieved only by checking reports continuously respect to the time, otherwise we couldn't reach accurate outcome.

Main feature of this method is simplicity in calculation, managers can calculate without using complex formulas, it is trait that needed these days particularly in the practical projects especially in construction projects, since most experienced managers did not care about the theoretical methods and their trust to experiences is more than theoretical in estimation of the cost. Future study could be in the way that which formula of the growing models (logistic model (LM), Gompertz model (GM), Bass model (BM),and model(WM)should be selected for having better anticipation , For example in the logistic model we see better estimation compare to other models, but it not validated until now, what is Instead Question for author is difference in kind of the theory(opinion) in each formula, for instance, logistic model have the inflection point at 50% of total growth, it means in practical project we assume that when project reach to half of the project time line, exactly we reach to maximum cost of the project accumulation, in

contrast to Gompertz model that inflection point happens approximately at one third of the project scheduling, it means when we reach to the one third of project timeline, peak point of the cost happens, these differences in behavior of the these curves (logistic compared to Gompertz) can be influential in managerial attitudes, because these models dictates this fact to the manager that at which time of the project scheduling maximum point of the cost occurred.

Conclusions

Several steps should be done chronologically together in order to create the best method for estimation of the cost while minimizing the error.

First step is that nonlinear regression model is dominated way compare to traditional method including index based model, in fact nonlinear methods and growth models provide the best provision for combining managerial attitudes with CEAC formula, in addition other method(IB) cannot be appropriate bye characterizing managerial belief.

Second one is that among the nonlinear growth models, Gompertz model is preferred one in contrast to another 3 models, especially in construction projects, also other growth models should be tested for other kinds of the project, there is no certainty about this subject, although, Future study could be in the way that which formula of the growing models should be selected according to kind of the project for having better prospect of the cost.

Third step is that considering time estimation at completion (TEAC) gives more reality to the our forecasting of the cost, because time is selected as input in CEAC formula and cost is function of these inputs (time) since time and cost are related to each other entirely.

Fourth step and last one is the fact that, CEAS methods could be improved significantly in way that minimizing distance between anticipated costs with actual one by combining managerial belief in the formulas, and one of the these ways in order to put these ideas in the practical projects and characterizing them in the CEAC formulas is considering positions of the points in the fitted cost curve in the area of confidence level by using nonlinear method.

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