Earned Value Forecast Accuracy and Activity Criticality

By Mario Vanhoucke[1] and Stephan Vandevoorde[2]

Abstract

This paper presents new simulation results on the forecast accuracy of earned value based metrics to predict a project's final duration. This is the second paper in a series of papers based on the simulation study initially proposed by Vanhoucke and Vandevoorde (2007a). In a previous manuscript published in the Measurable News (Vanhoucke and Vandevoorde, 2007b), it has been shown that the earned schedule method outperforms, on average, the more traditional earned value based methods to predict the final duration of a project, both for early and late projects. In the current manuscript, the simulation study is extended to new simulation scenarios that measure the influence of inaccuracies in the planned duration estimates for critical and non-critical activities on the accuracy of forecasting methods.

Since the introduction of the earned schedule method, initially proposed by Lipke (2003), both researchers from the academic world as well as managers dealing with real-world practical projects have critically analyzed the forecasting power of the new method for predicting a project's final duration.

Most research analyzed data from real-life projects and concluded that the earned schedule method can better predict the total duration of a project [see e.g. Vandevoorde and Vanhoucke (2006); Henderson (2004, 2005)]. In a previous edition of the Measurable News [see reference Vanhoucke and Vandevoorde (2007b)] we have tested the forecast accuracy of three methods to predict the final project duration on a large and diverse set of fictive projects. We basically reviewed the results of the simulation study published in Vanhoucke and Vandevoorde (2007a) and concluded that the earned schedule method outperforms, on average, the two other methods [the planned value method (Anbari, 2003) and the earned duration method (Jacob, 2003)].

In this paper, new results from the same simulation study are presented. These results focus on the accuracy of the three methods for different scenarios measuring the activity criticality. The outline of the paper is as follows. Section 2 reviews the results of the previous simulation study and presents four new simulation settings. Section 3 compares the new forecast accuracy results with the ones previously discussed in Vanhoucke and Vandevoorde (2007b).

Simulation Scenarios

The simulation study uses fictive projects for which an initial baseline schedule is constructed based on the straightforward critical path based calculations. The set of projects is the same as used in the Vanhoucke and Vandevoorde (2007a) research and contains 4,100 project networks with 30 activities and a varying number of precedence relations. During the simulation runs, the actual activity durations may differ from their original planned values, leading to an overall project finishing early or late. During each simulation run, the final project duration is predicted along the review periods during the life of the project by means of the EAC(t) formulas of the three forecasting methods, i.e. the planned value method PV (Anbari, 2003), the earned duration method ED (Jacob, 2003) and the earned schedule method ES (Lipke, 2003). Each simulation run contains 100 repetitions to guarantee convergence. Table 1 shows the four simulation scenarios used in the current paper. The second and third columns describe the change in the original planned duration for critical and non-critical activities (increase, no change or decrease), while the last column shows the simulated effect of these changes on the real project duration.

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Table 1: Four simulation scenarios for critical and non-critical activities.

Simulation Run	Critical activities	Non-critical activities	Ahead or delay?
1	Decrease or no change	Decrease or no change	Project ahead of schedule
2	Increase or no change	Increase or no change	Project delay
3	Decrease	Increase	Project ahead of schedule
4	Increase	Decrease	Project delay

Scenario 1: When both the critical and non-critical activities are performed faster than expected or without any change compared to the planned duration, the SPI and SPI(t) indicators will report an excellent performance (i.e. SPI > 1 and SPI(t) > 1) and the project will end sooner than expected.

Scenario 2: Similar to scenario 1, a project with delays for all activities will end later than expected and the schedule performance indicators will report a project delay during project execution.

These two scenarios have been tested in the study of Vanhoucke and Vandevoorde (2007b) and the results have shown that the earned schedule method outperforms both the planned value and earned duration method for early (scenario 1) and late (scenario 2) projects. Moreover, the study has shown that the best forecast accuracy can be reached when the EAC(t) is calculated under the assumption that future project performance follows the current SPI or SPI(t) trend. Last, the results have also shown that the earned schedule method is stable along the progress of the project, and certainly at the end of the project, where the other methods show an unreliable trend.

The two following scenarios have not been simulated yet and can be interpreted as follows:

Scenario 3: when critical activities are performed faster than expected and non-critical activities show delays, it might be possible that the schedule indicators report a low project performance (SPI < 1 and SPI(t) < 1) although the project finishes sooner than expected. In this case, many non-critical will be delayed within their activity slack (such that it does not lead to an overall project delay) while only a few critical activities are performed slightly faster than expected. Consequently, the schedule performance indicators will report a false warning signal predicting a project delay which turns out to be the opposite at the end of the project (project ahead of schedule).

Scenario 4: Similar to scenario 3, this scenario simulates project progress where the schedule performance indicators report a false warning signal. Tiny delays in only a few critical activities combined with faster performance in many non-critical activities obviously leads to a total project delay, while the schedule performance indicators might report the opposite.

These last two scenarios have been inspired by Jacob and Kane (2004) who argue that earned value management indicators have to be calculated at the activity level and not at higher WBS levels. They illustrate their statement with a simple example and conclude that small delays in critical activities combined with much faster progress in non-critical activities can result in a false SPI value (in this case, SPI > 1), and hence, the SPI reports can possibly mask potential problems leading to wrong forecasts. Hence, the authors claim that the only way to obtain accurate schedule forecasting results is by applying the predictive methods on a single activity rather than on groups of activities. In the current study, we measure the earned value based metrics at the activity level, but the schedule performance indicators are calculated at the project level (e.g. the SPI is equal to the total earned value divided by the total planned value of all activities at the current review moment). Although we realize that this approach might potentially mask certain project problems or opportunities (cf. scenarios 3 and 4), it is our goal to test the influence of these false SPI values on the accuracy of the three forecasting methods. The results of the scenarios are discussed in the next section.

Simulation Results

Figure 1 displays the forecast accuracy results of the simulation runs for all four scenarios. The accuracy has been measured as the percentage deviation between the actual project duration, measured at the end of each simulation run, and the average of all duration forecasts EAC(t) measured during the progress of the project. Positive percentage deviations denote an average overestimation of the real duration and negative percentages denote an average underestimation of the real project duration.[3]

The results in the figure confirm the previously reported results that the earned schedule method (ES) outperforms on average both the planned value (PV) and earned duration (ED) methods. Both scenario 1 and scenario 2 clearly show a better forecast accuracy close to 0%.

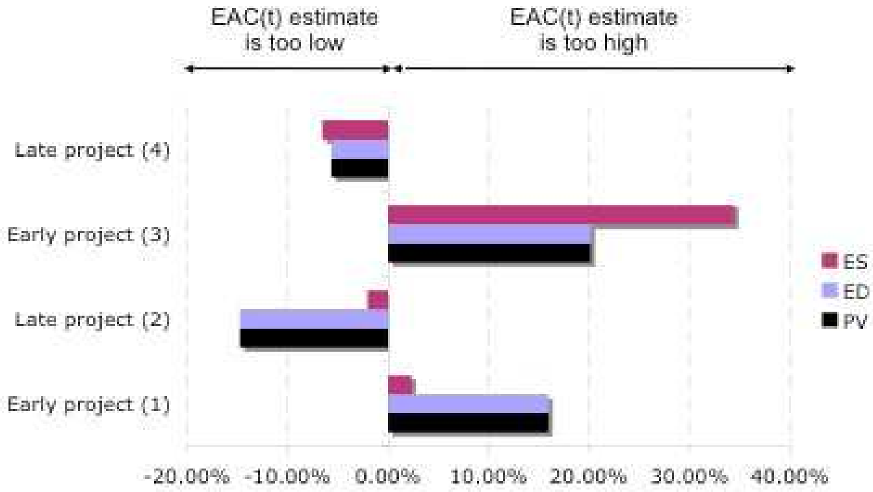

Figure 1: Forecast accuracy (EAC(t) under- or overestimations) for the four scenarios.

Scenarios 3 and 4, however, clearly show the power of the ES method, compared to the PV and ED methods. These scenarios have been simulated as special scenarios where the schedule performance indicators report a false warning signal. Figure 1 shows that this false warning signal has an immediate effect on the accuracy of the EAC(t) measures, with the ES method showing the lowest accuracy. Scenario 3 reports a project delay during its progress, although the project ultimately finishes early. Hence, the indicators clearly show an overestimation (due to the false SPI and SPI(t) warnings). In these cases, the forecasts are no longer reliable, which explains the low performance of the ES method. Scenario 4 is similar, but opposite, leading to an underestimation of all forecasting methods, where the ES method has the lowest performance illustrating the unreliable character of the method for this scenario. Consequently, since the SPI(t) indicator is a reliable measure for the project performance along all stages of the project life cycle, the forecast accuracy is eventually determined by the reported SPI(t) values along the life of the project. In case the SPI(t) reports false warning signals (cf. scenarios 3 and 4), the forecast accuracy suffers from this error, resulting in a poor predictive quality of the EAC(t) for the ES method. Since the SPI indicator is less reliable compared to the SPI(t) (certainly at the late stage of the project, where the SPI indicator tends to go to one, regardless of the real project performance), the forecast accuracy is more a random guess having an average forecast accuracy which does not vary as much between the four scenarios as for the ES method. Hence, the difference between correct SPI reports(scenarios 1 and 2) and false SPI reports (scenarios 3 and 4) is less than for the SPI(t) indicator in the ES method.

Conclusions

In this paper, the forecast accuracy of three methods has been simulated under four different scenarios. The results show that under 'normal' circumstances the earned schedule method has the best performance, leading to small deviations between the duration forecast and the final project duration. Normal circumstances are defined as project progress where the schedule performance indicators report reliable results during the life of the project.

However, special scenarios have been simulated to force the schedule performance indicators to report unreliable results. Under these 'unreliable' circumstances, the earned schedule method performs worse than other methods. This illustrates the power of the earned schedule method, as the method's forecast is strongly based on the schedule performance indicator SPI(t). Consequently, the ES can be considered as a good forecasting predictor, forecasting the final project project duration in an accurate way

[3] *and hence, there was no difference between under- and overestimations.*

when the schedule performance indicator SPI(t) reports a correct warning signal about the current project performance.

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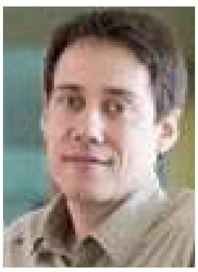
Author Biographies



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