



# Revisiting the golden triangle of cost, time and quality: the role of NPV in project control, success and failure

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## Abstract

The paper examines the relationship between project budgets, cash flow, cost control and time schedules. It considers the theoretical effect that each can have on the net present value (NPV) of a project. The paper proposes that investment appraisal techniques, such as NPV, can and should be used as an ongoing monitor of project health. Finally, the theoretical points are tested on a small sample of project managers. In conclusion, the research indicates that some project managers' claims that they have "delivered" their project successfully may be false. © 2000 Elsevier Science Ltd and IPMA. All rights reserved.

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## 1. Introduction

How many times has it been stated that the project was delivered "on time, to budget and at the required quality"? So often now that project managers and project sponsors really just do not believe it anymore. There is a plethora of reports on project overruns and it would be a conservative estimate to state that approximately 50% of construction projects overrun and approximately 63% of all information systems projects encounter substantial budget overrun, with overrun values "typically between 40 and 200 percent".[1] Project sponsors claim that although, "most projects are eventually completed more or less to specification", they are "seldom on time and within budget".[2] It has even been suggested that a "good rule of thumb is to add a minimum of 50% to every time estimate, and 50% to the first estimate of the budget".[2] If this is to be believed then the measures "on time", "to budget",

and "of the required quality" cannot be an appropriate or a satisfactory measure of project success.

Almost all project managers understand the consequences of varying the project plan. Project managers also need to understand what the benefits and/or penalties are in cost terms of delaying a project.

When a project is completed and the facility commences its useful life, the operations manager typically needs to know the value of the asset for which he/she is responsible. This is necessary as the operations manager is now responsible for generating the revenue that forms the positive side of the NPV calculation for the project. We define NPV as equal to the present value of future returns, discounted at the marginal cost of capital, minus the present value of the cost of the investment.

This paper reveals that some project managers' claims of delivering "on time, to budget and at the required quality" may actually be false and what sometimes appears to be a successful project can in fact represent a reduction in shareholder value. To reduce shareholder loss in these circumstances the authors propose that the concept of NPV should be used as an ongoing control mechanism which is closely linked to

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the health of the project. Examples to illustrate this point are given later in the paper.

A number of project managers believe that monitoring and project control are one and the same thing, and that monitoring revolves around budgets and plans. This is not the case. Reports are for the project manager and sponsor to have summary details on what has happened thus far on the project. By implication, they deal with the history of the project, no matter how recent. On the other hand, control is taking action in response to these reports.

Monitoring is important for example to establish if the project is performing in accordance with plans and budgets with the sole purpose of invoking controls necessary to re-establish the project. Therefore monitoring exists to establish the need to take corrective action, whilst there is still time to take such action.[3]

Control on the other hand is management, not paperwork. Control involves analysing the situation, deciding what to do and actually doing it. Control is the crux of project management, however, it is often misunderstood by project stakeholders.[4]

## 2. NPV as a control mechanism

Surprisingly few authors allude to the role of NPV even when acknowledging the importance of time and budget on project success: "we can all measure if the job is completed to specification, the cost can be computed, and it is very obvious if the target date has been met".[2] Most project managers recognise the need for project control as it applies to budgets and plans, but fail to make the connection between these two elements and how project control can affect the project NPV as a result of the time effect on cash.

To look at a simple example: assume that progress reports show that a project has to absorb a delay to a deliverable on the critical path. Most project managers will without much thought reach the following options:

1. move the milestone date;
2. reduce the scope of the deliverable;
3. reduce the quality of deliverable;
4. apply additional resource (generally manpower/or money);
5. rearrange the workload;

but very few will carry out another investment appraisal to assist in determining what the most *appropriate* action is.

Some of these options may be constrained by logistical problems on the ground, e.g., unavailability of suitable manpower to be assigned to the project when they would be required. However, in many cases the project manager has to use instinct as to what is the

appropriate course of action. If the project manager has actually reviewed the investment analysis, this would show the impact of delaying the project or of consuming resources earlier on the NPV.

The basic point here is that logistical problems and political thinking do exist within a project and the project manager should not ignore these facts but should understand the implication of the action that is about to be taken and *not* ignore the effect their action will ultimately have on the final outturn of the project.

It is not a good thing if a plan is off schedule and nobody realises before it is too late. However, this is not the main problem. The problem revolves around the fact that the stakeholders know the project is behind programme, but do not know the best approach to take under the circumstances. As any project manager will affirm, reporting is tedious, especially when the project is not going to plan. This is exacerbated if the project manager either does not have a solution or if he/she has a solution but no empirical evidence to support it. In this instance the project manager will benefit from analysing the impact each alternative will have on the project's NPV.

Even in projects that are progressing well, reporting is often seen as bureaucratic and tedious. This view is probably correct. However, it is a necessity for major projects. Whilst this view cannot be changed it could be beneficial if, for example, as part of the reporting mechanism, a continuous review was made of the impact on the NPV as this could aid our knowledge and understanding of project dynamics.

The problem that exists within the field of NPV is not that project managers do not understand presenting a project's cash flow at the inception of the project. Rather, it is that after getting a project authorised there will be no further consideration given to the project's NPV until, and even then only in some cases, a post investment appraisal can be carried out. However, at this point the damage has been done.

The first question to ask is, how well do project managers understand the time effect on cash? Yes, they generally understand that they should slow down cash flow and pay as late as possible. However, many fail to understand what effect changes in budgets and/or changes in authorisation will ultimately have on the NPV of a project. Too many project managers believe that if their project has a contingency or if it is re-authorised, as long as that figure is less than the NPV then that would be an appropriate course of action. This could not be further from the truth. This view fails to take account of the time effect on cash. The project managers who were interviewed as part of this research had a very mixed understanding of the time effect of cash. This is an alarming situation when one considers that these project managers are commonly dealing with six figure sums of their company's money.

### 3. Survey methodology

A small survey was carried out to test these ideas using a semi-structured questionnaire and interview approach. Project managers from five organisations (representing utilities, financial, IT and shipbuilding sectors) were interviewed during the research. In addition to these interviews, two large projects, one from the utilities sector and one from the shipbuilding sector, were studied in depth, again by semi-structured interviews with specific project managers. The aim of the survey was to investigate the control mechanisms used in typical projects managed by the interviewees, and to establish their awareness and understanding of NPV, and its potential application in project control. The results in brief are presented below. A more detailed account of the questionnaire and interview technique used and analysis of the results can be found elsewhere.[5]

### 4. Survey results

A summary of the survey results are:

- All respondents confirmed they had been the project manager of one or more major projects of a value greater than £1m.
- When responding to the question "Did you deliver the project?" 90% of project managers replied "Yes". However, when the definition of "delivered" was probed more deeply:
  - only 50% stated that their project was "delivered on time";
  - all stated their project was delivered to the required quality;
  - 80% declared that their project was delivered "within budget" (however, the interviewer picked up several cues suggesting that a more accurate picture would require a knowledge of the available contingency funds).
- It is encouraging that 100% of the project managers carried out an investment appraisal for their project. However, when an attempt was made to establish if the project managers knew why an investment appraisal is important, 60% could not describe any reasons for carrying out an appraisal, other than that they were either expected or required to.
- 80% of the projects discussed had a positive NPV when they were presented for authorisation. However, 50% of the respondents stated that considerable emphasis had been given to the non-financial part of the appraisal, suggesting high regard to the non-financial elements of projects that may impact on the company's profitability.
- 90% of project managers stated that they had free-

Table 1

Simple cash flow 1. NPV = £0.25m

	Y0 £	Y1 £	Y2 £	Y3 £	Y4 £	Y5 £
Income			0.6m	0.65m	0.75m	1.2m
Outgoings	(1m)	(1.1m)				
Cash flow	(1m)	(1.1m)	0.6m	0.65m	0.75m	1.2m
Discounted cash flow	(1m)	(1m)	0.5m	0.5m	0.5m	0.75m

dom to change the project payment profile.

- When tested on what the effect of changing the payment profile would be on a project NPV, the majority of project managers answered this question incorrectly. This suggests that some project managers have the power to alter the project finances but do not understand the effect of such decisions on the NPV of their projects.
- 70% of the respondents appeared to understand the effect of spending more money on NPV.
- 40% of the project managers questioned had to re-authorise their project although none were required to redo the investment appraisal. This is interesting since when questioned all believed that to redo an investment appraisal was the correct course of action to take. However, none of them did.
- When asked, "How should sunk costs be treated in the event of redoing a financial appraisal?" 70% of the respondents replied they would ignore them.

### 5. Examples of NPV in action

The following examples will illustrate the importance of considering NPV in project control. Table 1 shows a simple cash flow and NPV for a project using the following equation and interest rate (*i*) of 10%:

$$NPV = CF_0 + \frac{CF_1}{(1+i)} + \frac{CF_2}{(1+i)^2} + \frac{CF_3}{(1+i)^3} \text{ etc.}$$

Let us assume there is a 3 month delay in delivery of the project toward the end of year 1 (Y1) with a pro rata decrease in Y2 revenues, i.e., from £0.6m to £0.45m. The project manager carries out an impact analysis and discovers that this delay will lead to an

Table 2

Simple cash flow 2. NPV = (£0.05m), i.e. negative

	Y0 £	Y1 £	Y2 £	Y3 £	Y4 £	Y5 £
Income			0.45m	0.65m	0.75m	1.2m
Outgoings	(1m)	(1.1m)	(0.2m)			
Cash flow	(1m)	(1.1m)	0.25m	0.65m	0.75m	1.2m
Discounted cash flow	(1m)	(1m)	0.2m	0.5m	0.5m	0.75m

increase in internal costs of £0.2m (see Table 2). A number of problems arise. If the project manager assumes that an increase in cost of £0.2m against a NPV of £0.25m is OK (without considering the effect of the delayed revenue) then the project manager has failed to understand the overall effect on the NPV. This is not an unreasonable example if the results of the questionnaire are to be believed, which show that 70% of the respondents are capable of making this kind of incorrect assumption.

What has really happened in this example is that the delay and overspend of £0.2m has turned £0.25m of shareholder value into a £50k loss. This is only apparent when discounted cash flows are used to establish the overall effect on the project.

There is another problem here. If the project manager was to follow the "rules" of discounted cash flow correctly when seeking to answer the questions: "Should I continue with the project?", and "What is the best way forward?" he/she would not actually carry out this sum. The reason for this being that one of the "golden rules" is "sunk" costs should be ignored. One of the surprising findings from the questionnaire was that over two thirds of the respondents knew this rule. Applying the rule to the example would result in Table 3.

What this cash flow shows is that in Y2 for a 3 month delay and an increase in cost of £0.2m the company appears to generate £1.95m profit. The problem is that when asking the question: "Will the project make a profit?" sunk costs should *not* be ignored. What could happen here is that a decision is taken with the results as presented in Table 3 when there may have been other (better) alternatives that could have been investigated at the same time.

At the end of the project a post investment appraisal, if carried out, would give the results as already presented in Table 2. This means that although Table 3 can help answer the question: "Should I continue with the project", it is by adopting Table 2 and not Table 3 at the decision point that the question: "What is the best way forward?" is answered. Only by doing this is the real impact of each alternative on shareholder value revealed. It may transpire that there are no other alternatives that could be taken. Even so, the overall effect on shareholder value should be understood. In

the example, project managers and sponsors should be aware that they have lost £50k of shareholder value, but that it was the best solution under the circumstances, as opposed to declaring that the project now has an NPV of £1.95m.

The converse can also be true. For example, assume that a project manager has a project with a cash flow as described in Table 1 (i.e., an NPV of £0.25m). The project manager is advised that there will be a £0.3m cost (say disposal costs) at the end of the project. In this situation the project manager compares this with the £0.25m NPV and declares that there is a problem. Again this is not the case as Table 4 shows.

In this situation there is still a positive NPV of £60k. Therefore the project manager failed to understand the time effect on cash. Again the results of the questionnaire would suggest that this is not an unreasonable example.

## 6. Discussion

In the light of the above findings, the authors believe it is time to re-write the old statement of "on time, to budget and of the required quality", to read, the project was delivered "with the best achievable NPV and to the required quality". This is true because if the project manager delivered the project on time but actually turned a positive NPV into a negative one then he/she actually failed to deliver the project. This would be equally true if the project was delivered within budget, since, as shown earlier, time delays can also turn a positive NPV into a negative one and as such would also mean that he/she failed to deliver the project.

Unfortunately there is no clear empirical evidence to prove that adopting NPV as a control mechanism will result in more projects actually being delivered. This will require project managers to recognise what their project's NPV is during the life cycle of the project and record the effect on the NPV as a result of decisions taken. Only from collecting this information will irrefutable evidence be obtained.

Another issue in the paper relates to investment appraisal. Should the capital cost of a facility escalate during design and/or construction beyond the point where the asset being provided would cease to be

Table 3  
Simple cash flow 3. NPV = £1.95m

	Y0 £	Y1 £	Y2 £	Y3 £	Y4 £	Y5 £
Income			0.45m	0.65m	0.75m	1.2m
Outgoings			(0.2m)			
Cash flow			0.25m	0.65m	0.75m	1.2m
Discounted cash flow			0.2m	0.5m	0.5m	0.75m

Table 4  
Simple cash flow 4. NPV = £0.06m

	Y0	Y1	Y2	Y3	Y4	Y5
Income			0.6m	0.65m	0.75m	1.2m
Outgoings	(1m)	(1.1m)				(0.3m)
Cash flow	(1m)	(1.1m)	0.6m	0.65m	0.75m	0.9m
Discounted cash flow	(1m)	(1m)	0.5m	0.5m	0.5m	0.56m

financially viable, work can and in some cases should be stopped. If this is the case, why did the project managers who admitted to overruns in the questionnaire not have to redo an investment appraisal? This kind of management decision making, or lack of decision making defies logic.

The authors found no primary or secondary evidence to suggest that NPV is monitored in project management on an on-going basis. From the questionnaire based survey, 40% of projects required re-authorising or were in budget overrun. None of these were subjected to another investment appraisal. It follows that NPV was not used to control these projects.

What about the question of failure and punishment? Many project managers are aware that some form of "punishment" may be applied in the event of failure. Whether it is or is not does not matter, it is enough that they believe it will be. Part of the problem here lies in the fact that the project manager can only control capital cost; operations people deliver the revenue. This raises the question, that even if the project manager does understand the principles described in this paper, why would he/she declare a failure if it was not being perceived as such by others? Perhaps we should expect that as professionals, project managers are concerned about their professional status, in which case being perceived to be successful will always tend to be the preferred option.

There is no evidence that project managers have formed any queues to declare failure when success was the common perception. This is consistent with the results of the questionnaire used in this research. Ninety percent of the project managers stated that they "delivered" the project, yet when asked for more detail on what "delivered" the project really meant proceeded to answer, "on-time", "to the required quality" and "within budget", *with varying degrees of qualification*.

Perhaps the most alarming fact here is that in many, if not the majority of cases, stakeholders (from many different backgrounds) do not really understand the principles of investment appraisal. This is borne out by the results of the questionnaire in which questions were asked to test the project managers' understanding of NPV; the results of which were so inconsistent that they strongly suggested that project managers, and sponsors for that matter, require further education on these issues.

## 7. Conclusions

The central point of the paper has been to establish the link between plans, budgets and the ultimate effect on NPV of any changes to either. This theme has been taken further by showing that NPV should be used

not just at the beginning of a project, nor at the end as a post investment audit, but as an ongoing monitor and control mechanism.

Unlike many project management tools, which are really only designed for monitoring purposes, an NPV model can actually be used as a control mechanism. It has a tendency to rank, in terms of financial impact, the results of potential alternative actions.

Therefore, the first major conclusion is to recommend changing the performance measures that are common today from:

- *the project was delivered, on time, to budget and of the required quality*

to:

- *the project was delivered with the best achievable NPV and to the required quality.*

The other major conclusion is that project managers should be required to redo an investment appraisal in the event of any budget overrun or re-authorising of a project's finances. This would also hold true when decisions are required that could affect the eventual NPV, e.g., concerning programme changes.

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