

Research Article

COMMENTS AND OPINIONS ON THE PROJECT MANAGEMENT TRIAD MODEL

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ABSTRACT

This article discusses the project management triad model. The idea is that by understanding and appreciating the triad model, project managers will be able to manage their projects effectively. First, it defines the project management triad model. Second, the various budgeting methodologies are highlighted. Third, the process of creating and estimating a project schedule is outlined, including the Program Evaluation Review Technique (PERT) and the Critical Path Method (CPM). Fourth, project management problems are briefly reviewed. Fifth, project performance and quality are summarized. Finally, the article concludes by reiterating that cost and time are essential ingredients in successful project management.

Keywords: Bottom-Up Budgeting, Critical Path Method, Iterative Budgeting, Measuring Project Performance, Program Evaluation Review Technique, Project Management Triad Model, Top-Down Budgeting.

INTRODUCTION

This article discusses the project management triad model. The idea is that by understanding and appreciating the triad model, project managers will be able to manage their projects effectively. First, it defines the project management triad model. Second, the various budgeting methodologies are highlighted. Third, the process of creating and estimating a project schedule is outlined, including the Program Evaluation Review Technique (PERT) and the Critical Path Method (CPM). Fourth, project management problems are briefly reviewed. Fifth, project performance and quality are summarized. Finally, the article concludes by reiterating that cost and time are essential ingredients in successful project management.

TTRIAD OF PROJECT MANAGEMENT

According to the Compact Oxford English Dictionary, a *triad* is a group or set of three connected people or things.¹ Meredith and Mantel observed that cost, time, and performance are the three prime project management factors.² The costs of a project are compared to budget limitations, the time expended on the project is judged against the project schedule, and the project's performance is directly related to the quality of the final outcome. According to Meredith and Mantel, there exists a function that relates these three variables, where performance is a function of cost and time, or $\text{Performance} = \text{Function}(\text{Cost}, \text{Time})$.³ The shape of the function varies from project to project, and from time to time for any given project. However, the key to a successful project is to manage the trade-offs to ensure that the project produces the expected results in a timely and cost-effective manner.⁴ Graphically, this looks like:⁵

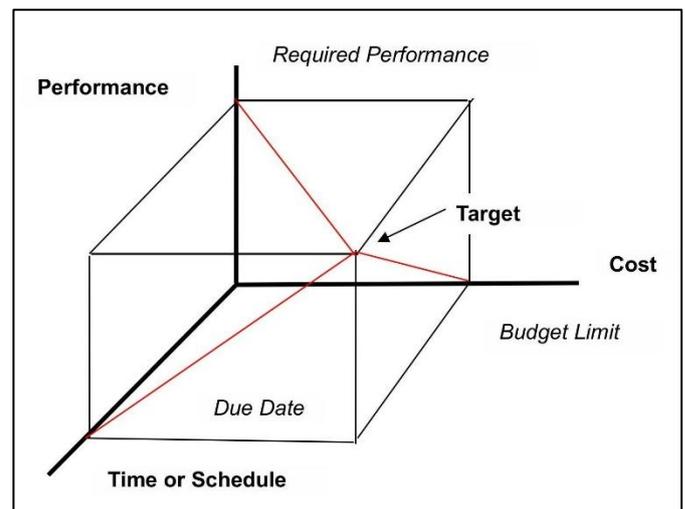


Figure 1. Project Targets – Performance, Cost, and Time

OTHER SO-CALLED PROJECT MANAGEMENT FACTORS

Gido and Clements observed that the keys to project success are the people, namely, the project manager, the project team, and project communication and documentation.⁶ Although strictly speaking, this constitutes a triad, it is not the classical triple as discussed by Meredith and Mantel.⁷ Furthermore, since the Gido and Clements triple deals exclusively with people involved in a project, and not the output produced by these people, it is not clear what the output is, except for possibly project communication and documentation.⁸ The problem with this classification is that even if communication and documentation are thought of as the dependent variable, it is the performance of the project, and not the communication and documentation, that really matter.

¹COMPACT OXFORD ENGLISH DICTIONARY (Oxford University Press 2nd ed. Revised 2003).

²JACK R. MEREDITH, & SAMUEL J. MANTEL JR., PROJECT MANAGEMENT: A MANAGERIAL APPROACH (John Wiley & Sons 5th ed. 2002).

³*Id.*

⁴*Id.*

⁵*Id.*

⁶JACK GIDO, & JAMES P. CLEMENTS, SUCCESSFUL PROJECT MANAGEMENT (Thompson Higher Education 3rd ed. 2008).

⁷Jack R. Meredith, & Samuel J. Mantel Jr., *supra*, note 2.

⁸Jack Gido, & James P. Clements, *supra*, note 6.

Shendaret *al.*, argued that the four dimensions to project success are project efficiency, impact on the customer, the business impact on the organization, and the opening of new opportunities for the future.⁹ The problem with this classification is that customer impact, business impact, and the opening of new opportunities are all outputs, while project efficiency is an input, something that is under the control of the project participants. Furthermore, it does not make sense to construe that customer impact, business impact, and the opening of new opportunities are independent variables to a function whose output is project efficiency. The problem with this classification is that the myriad forms of effectiveness are conspicuous by their absence.

Kerzner listed the following five objectives that must be achieved by successful project management:¹⁰

- Within time
- Within cost
- At the desired performance/technology level
- While utilizing the assigned resources effectively and efficiently
- Accepted by the customer

The good news about Kerzner's five objectives is that the first three can be considered to define the performance function defined above.¹¹ However, utilizing the assigned resources efficiently and effectively appears to be a mechanism employed in defining the function. It is essentially concerned with the planning, organizing, staffing, controlling, and directing of a project in a specific period.¹² Customer relations and acceptance of a project are the environment in which a project operates.¹³ It should be noted that without considering the environment, a project may not be successful.

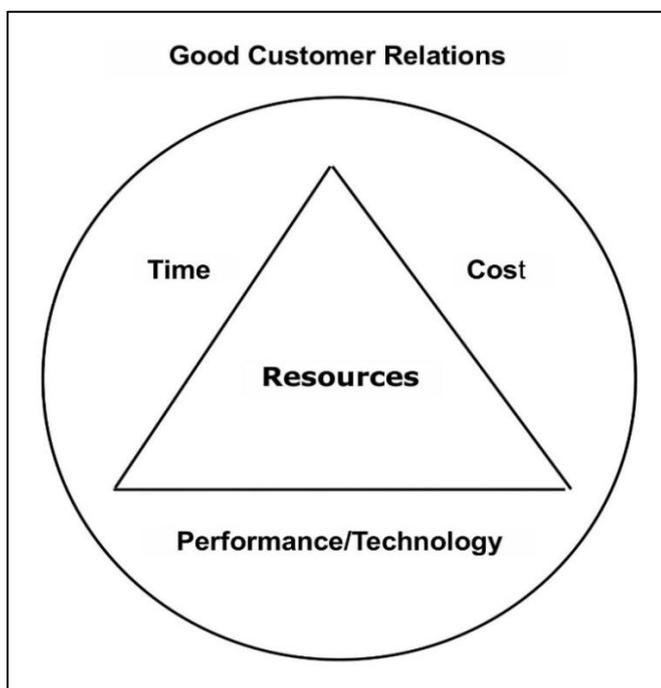


Figure 2. Kerzner's Perspective on Project Management

⁹Aaron J. Shendar, Ofer Levy., & Dov Dvir, Mapping the Dimensions of Project Success, 28 *Project Management Journal*, 5-13 (Jun. 1997), available at <https://www.wcu.edu/pmi/1998/J97JUN05.PDF>.

¹⁰HAROLD R. KERZNER, PROJECT MANAGEMENT: A SYSTEMS APPROACH TO PLANNING, SCHEDULING AND CONTROLLING (John Wiley & Sons, Inc. 7th ed. 2000).

¹¹*Id.*

¹²*Id.*

¹³*Id.*

Gray and Larson observed that project management should be viewed from a strategic perspective, where management strategies must:¹⁴

- Be specific in targeting objectives;
- Establish measurable indicators of progress;
- Make the object assignable to one person for completion;
- State what can be realistically done with the available resources; and
- State the duration or when the objective can be achieved.

Under this perspective, the problems with effective project management stem from the inability to implement what is required, the myriad levels of organizational politics, and resource conflicts and multitasking.¹⁵ Although this classification has merit from a strategic point of view, it is not necessarily easy to model a functional relationship among the different variables.

PROJECT COSTS OR BUDGETS

According to Meredith and Mantel, estimating project costs can be, at one extreme, a well-codified activity, or at the other end of the spectrum, an art where accuracy is rarely achieved.¹⁶ For example, estimating the number of bricks to be used in constructing a wall of known dimensions is essentially an exercise in mathematics, while estimating the number of programming hours to create a software application can be fraught with risk and danger. Meredith and Mantel noted that estimating the cost of complex projects may be relatively straightforward under certain circumstances because some formulas provide a good first approximation.¹⁷ However, cost estimates must consider inflation and technological risk with projects with life cycles that span several years.¹⁸

One of the issues that bears discussion is the actual use of resources, rather than the accounting assumptions used.¹⁹ For example, suppose that \$6,000 of a specific resource will be used for three weeks. None could be employed in the first week, \$5,000 is expended in the second week, while \$1,000 is spent in the third week. If the spending pattern does not appear in the project plan, the accounting department may average the expense over the three-week period, expecting that \$2,000 is spent every week, thus affecting the project's cash flow.²⁰

Gray and Larson believed cost estimates must be constantly refined for various reasons.²¹ First, interaction costs among activities can be hidden in the estimates. This is because tasks, although they are usually assumed to be independent, are rarely completed in a vacuum.²² Second, although cost estimates are typically assumed to be based on normal conditions, reality is usually different. Resource shortages can occur for various reasons and can seriously affect the outcome of a particular task. Third, things go wrong in projects, and accidents occur, particularly when the weather is a factor.²³ Finally, as a project gets further and further down the line, management obtains a better understanding of what needs to be done. This can lead to

¹⁴CLIFFORD F. GRAY, & ERIK W. LARSON, PROJECT MANAGEMENT: THE MANAGERIAL PROCESS (McGraw-Hill, Inc. 3rd ed. 2005).

¹⁵*Id.*

¹⁶Jack R. Meredith, & Samuel J. Mantel Jr., *supra*, note 2.

¹⁷*Id.*

¹⁸*Id.*

¹⁹*Id.*

²⁰*Id.*

²¹Clifford F. Gray, & Erik W. Larson, *supra*, note 14.

²²*Id.*

²³*Id.*

changes in project plans and costs, specifically when customers demand the change due to shifting economic conditions.²⁴

There are several ways to deal with these problems. Gray and Larson discussed three standard methods to meet these challenges, including:²⁵

- Adjusting estimates for specific tasks;
- Employing contingency funds and time buffers; and
- Changing the baseline schedule and budget.

Effective organizations will adjust estimates once they have a better grip on a situation's risks, resources, and particulars.²⁶ Contingency funds and time buffers are specified to deal with the onslaught of uncertainty, thereby reducing the likelihood of cost overruns and their negative effects.²⁷ Because of technological barriers, labor strikes, legal entanglements, political upheaval, and increasing wage and material costs, these circumstances sometimes dictate changing original estimates, where new baseline budgets and schedules must be generated.²⁸ Thus, arriving at accurate estimates can be challenging, particularly when the best attempts to create honest estimates are difficult. Even so, it should never be forgotten that accurate estimates reduce uncertainty and promote effective project management.²⁹

Top-Down Budgeting

Top-down budgeting is predicated on employing senior and middle management's collective judgment and experience.³⁰ This process is similar to a hierarchical planning process, where a project is broken down into finer and finer detail. However, in a top-down method, low-level managers may feel that they have been given insufficient funds to achieve the objectives imposed by top management.³¹ According to Meredith and Mantel, low-level management may believe that the budgeting process is a zero-sum game, where the top managers are the winners, and the low-level managers and the workers are the losers.³²

The advantage of top-down budgeting is that a total budget for a project can be generated in short order, while not sacrificing accuracy.³³ Another advantage is that small but costly tasks need not be identified, because the experience and judgment of senior management may take these kinds of activities into account. However, Meredith and Mantel observed that responses from middle managers seem to indicate senior management may be guilty of underestimating costs in a predictable way.³⁴

Bottom-Up Budgeting

In bottom-up budgeting, tasks, schedules, and specific budgets are created using work breakdown structures. According to the Project Management Institute, a work breakdown structure is a deliverable grouping of the elements of a project with an ever-increasing level of detail, where a deliverable is a measurable and tangible result or

outcome.³⁵ The lowest level of a deliverable in a work breakdown structure is known as a *work package*. Estimates are conducted at the work package level, and then flow upward until a complete estimate for a project is achieved.³⁶

Although bottom-up budgets accurately estimate the costs of specific tasks, the overall estimate can suffer if some of the work packages are ignored. According to Meredith and Mantel, the problem is that it is difficult to obtain a complete list of tasks before undertaking a project.³⁷ Even so, the advantages of bottom-up budgeting tend to promote participative management, where individual contributors work closely with their supervisors to ensure that the resource requirements are accurate.³⁸ Another advantage of bottom-up budgeting is the decreased likelihood that low-level managers and their workers will create unrest within the organization.

According to Meredith and Mantel, bottom-up budgeting is rare because senior managers feel that the process is too risky.³⁹ Senior managers may find that their subordinates are padding budgets to ensure success and build mini empires.⁴⁰ Because budgets are critical in controlling organizations, senior managers may feel that giving up this tool dilutes their power within the firm, potentially shortening their tenure.

Work Element Costing

Building a budget, either from the top down or the bottom up, is a tedious process at best. A work element or work package must be evaluated in terms of its resource requirements and associated costs. Such costs include the direct costs of labor and resources, as well as overhead and general and administrative charges.⁴¹ According to Meredith and Mantel, a project manager should prepare two budgets, one with only direct costs and the other with direct costs, overhead, and general and administrative costs for the accounting department. This ensures that the project manager is never confronted with costs for which they have no control.⁴²

Iterative Budgeting

In a perfect world, there would be no need to negotiate budgets. The project manager and senior management would possess complete information, making any negotiations moot.⁴³ However, project managers currently employ work breakdown structures to model a project accurately. In contrast, senior managers are involved in inspecting the work plans of their subordinates in an attempt to find a more efficient way to accomplish the tasks at hand.⁴⁴ Essentially, senior managers are employing the principles of total quality management.

According to Meredith and Mantel, if the senior management and project management estimates are not very far apart, then the project life cycle curve is concave.⁴⁵ In this case, the senior manager's estimate should be chosen. Figure 3 depicts this situation.

²⁴*Id.*

²⁵*Id.*

²⁶*Id.*

²⁷*Id.*

²⁸*Id.*

²⁹ *Id.*

³⁰ Jack R. Meredith, & Samuel J. Mantel Jr., *supra*, note 2.

³¹*Id.*

³²*Id.*

³³*Id.*

³⁴*Id.*

³⁵PMI STAFF, PRACTICE STANDARD FOR WORK BREAKDOWN STRUCTURES, PROJECT MANAGEMENT INSTITUTE (Project Management Institute 2001).

³⁶Jack R. Meredith, & Samuel J. Mantel Jr., *supra*, note 2.

³⁷*Id.*

³⁸*Id.*

³⁹*Id.*

⁴⁰*Id.*

⁴¹*Id.*

⁴²*Id.*

⁴³*Id.*

⁴⁴*Id.*

⁴⁵*Id.*

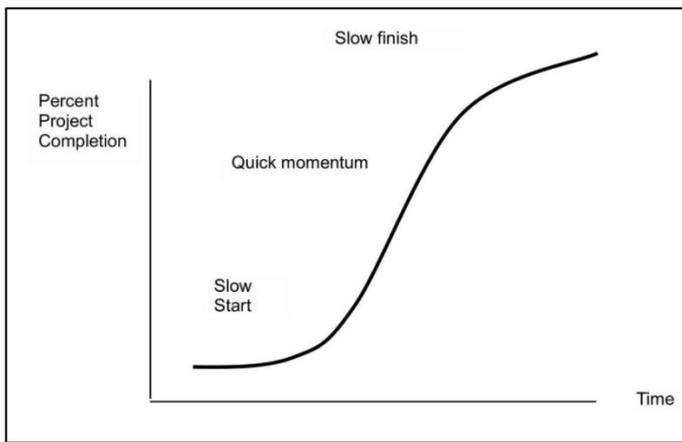


Figure 3. Project Life Cycle Curve as an S-Curve

SELECT SENIOR MANAGEMENT’S ESTIMATES

If there are significant differences between the two estimates, the project life cycle curve is convex, and the project manager’s estimate is probably the better.⁴⁶ In this case, the project manager’s estimate should be chosen. Figure 4 depicts this situation.

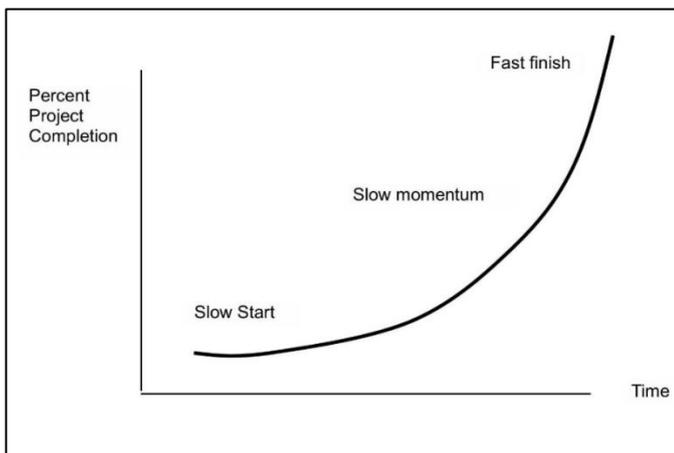


Figure 4. Project Life Cycle Curve as a Parabolic Curve

Rules of Resource Allocation

One of the more serious problems with resource scheduling is achieving proper resource allocation. According to Meredith and Mantel, there are various heuristic methods for attacking the nonlinear complex problems faced by a project manager.⁴⁷ While remembering that technological necessities always take precedence, some of the more common rules include:⁴⁸

- As soon as possible;
- As late as possible;
- Shortest task first;
- Most resources first;
- Minimum slack first;
- Most critical followers;
- Most successors; or
- Arbitrary.

⁴⁶*Id.*

⁴⁷*Id.*

⁴⁸*Id.*

The first rule is usually the default, while the purpose of the second rule is to delay cash outlays as long as possible.⁴⁹ The number of tasks that can be completed is maximized by dealing with the shortest task first. Ordering tasks by the amount of resources employed ensures that the more essential tasks with a high demand on scarce resources are done initially.⁵⁰ Leveling slack time ensures that tasks on the critical path are dealt with first, while prioritizing tasks by criticality also focuses on tasks on the critical path. The seventh rule is similar to the sixth rule, but in this case, all followers are counted instead of just the critical one.⁵¹ For the last rule, priorities are assigned according to a rule not associated with task length, slack time, or resource requirements.⁵² Such rules could be based on the relative value of a project to its parent organization.

SELECT PROJECT MANAGEMENT’S ESTIMATES

According to Meredith and Mantel, senior and project management must be honest with each other.⁵³ Honesty is critical because both parties work closely with each other in the present and the future, and it is ethically necessary to ensure that trust relationships are developed and maintained.

Project Time or Schedules

A schedule is the transformation of a project plan into an operational timetable. It is the basis for monitoring and controlling the activities of a project, and acts as a major tool for managing a project.⁵⁴ In a project environment, a schedule is critical because projects are not ongoing operations and often involve solving complex problems. Not all project activities need to be scheduled with the same level of detail, since there is some justification for listing only those work packages that must be monitored to maintain adequate control.⁵⁵ The fundamental scheduling approach is creating a network of activities, graphically portraying the relationships among the various tasks.

Program Evaluation Review Technique/Critical Path Method

The most common network techniques are PERT and CPM. The PERT technique was developed by the United States Navy in conjunction with Booz-Allen Hamilton and Lockheed Corporation for the Polaris submarine and missile project in 1958. Meanwhile, DuPont created CPM during the same time period.⁵⁶ PERT initially employed probabilistic time activity estimates, whereas CPM used deterministic techniques designed to control both time and budgets.⁵⁷ Although both techniques contained a path of critical activities, CPM permitted schedules to be crashed, where a project would be sped up at increased costs.⁵⁸ The advantage of using PERT/CPM was that the likelihood of cost and schedule overruns significantly declined, despite no significant difference in technological performance.⁵⁹

Although it is beyond the scope of this paper to discuss PERT/CPM in great detail, some mention should be made regarding the two different types of activity network diagrams. Essentially, there are two distinct types of diagrams, Activity on Node (AON) diagrams and Activity on Arrow (AOA) diagrams. These diagramming techniques

⁴⁹*Id.*

⁵⁰*Id.*

⁵¹*Id.*

⁵²*Id.*

⁵³*Id.*

⁵⁴*Id.*

⁵⁵*Id.*

⁵⁶*Id.*

⁵⁷*Id.*

⁵⁸*Id.*

⁵⁹*Id.*

are equivalent, but some projects lend themselves more to one type of diagram rather than the other. In AON diagrams, the activities are represented by rectangles, and arrows describe the relationships between the activities. Figure 5 depicts one such AON diagram.

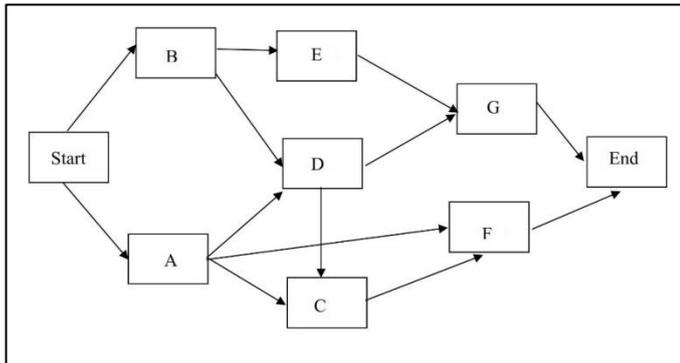


Figure 5. Sample Activity on Node Diagram

In contrast, in an AOA diagram, the activities are on the arrows, and Figure 6 shows how a project would appear as an AOA diagram.

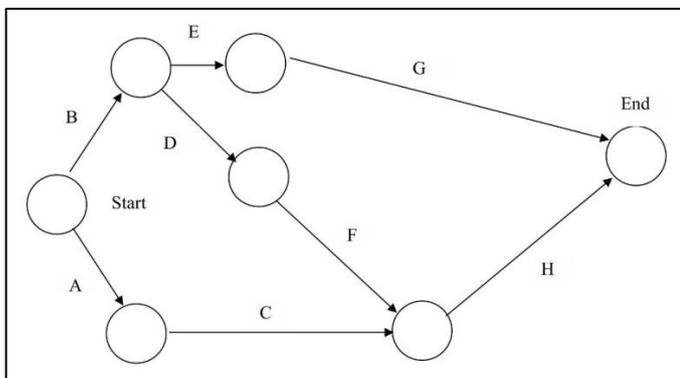


Figure 6. Sample Activity on Arrow Diagram

One of the chief features of PERT/CPM diagrams is that they permit a project manager to calculate activity times. For any given activity, there are essentially four times that need to be computed, and they include:⁶⁰

- Early start time;
- Late start time;
- Early finish time; and
- Late finish time.

Now, *slack time* or *float time* is defined as the late start time minus the early start time. The critical path then becomes that path in a PERT/CPM diagram where each activity has no slack time.⁶¹

Crashing Projects

One of the more interesting features of project management is the ability to crash activity times during crisis periods to ensure that a project is completed promptly. When activities are crashed, a change in technology or the production function occurs, typically producing discontinuities in outcomes and times.⁶² Such crashes can also result in resource reallocations, where additional resources can be added to a project at little or no extra cost.⁶³ With that said, the usual tradeoff is

⁶⁰/d.
⁶¹/d.
⁶²/d.
⁶³/d.

between time limitations, resource limitations, and cost, where a project manager can only effectively manage two out of the three.⁶⁴ Sometimes, when one of these three issues is fixed, the project manager must vary the remaining two to ensure that the fixed issue remains fixed. For example, if the time for a given task is fixed by senior management, a project manager may be obligated to vary the resources and costs to satisfy the time constraint.⁶⁵

Resource loading may be done to achieve this result, where specific resources are focused on a given task for a specified period. Furthermore, resource leveling may need to occur to minimize the period-by-period variations of resource loading, thereby shifting the allowed slack times.⁶⁶ An advantage of resource leveling is that much less hands-on management may be required. Another advantage is that a project manager may employ a just-in-time resource inventory policy without worrying that the quantity of resources delivered is incorrect.⁶⁷

PROJECT MANAGEMENT PROBLEMS

According to Meredith and Mantel, there are at least seven reasons project schedules go sour.⁶⁸ Although not an exhaustive list, they include:⁶⁹

- The scope is changed by senior management without consultation or warning;
- The project due dates are set without giving availability to resources;
- The project cannot be accomplished without exceeding the budget;
- The project due dates are set by the sales group, not by the nature of the projects; and
- The project due dates are set to incentivize people to work harder and faster.

These issues seem to be generic and independent of the technology employed. Some of the reasons for such strong optimism include:⁷⁰

- Thoughtless optimism;
- Capacity is not set equal to demand;
- Student syndrome;
- Multitasking to reduce idle time;
- Complexity of networks;
- People need a reason to work hard; and
- Game playing.

Some people are unwilling to acknowledge that lateness is their fault. According to Meredith and Mantel, such people believe that every problem in a project is an exception, and not symptomatic of a lack of planning.⁷¹ Some senior managers are convinced that projects are like assembly lines and are not subject to management balancing methods. Sometimes projects are not completed on time because project managers are like students, always needing more time.⁷² Furthermore, switching back and forth from project to project or task to task is neither efficient nor effective, particularly when the complexity and uncertainty of merging projects is a recipe for trouble. Some senior managers are of the opinion that project managers and

⁶⁴/d.
⁶⁵/d.
⁶⁶/d.
⁶⁷/d.
⁶⁸/d.
⁶⁹ /d.
⁷⁰/d.
⁷¹/d.
⁷²/d.

project workers have too much slack time, and therefore, shortening a schedule acts as an incentive.⁷³ Finally, some senior managers cut a schedule with the firm belief that extra time and resources are included in a project to ensure the participants have a safe and peaceful life. On the other hand, project workers assume that senior managers cut schedules for no good reason.⁷⁴ The result is that neither is actively working to develop a relationship of trust, thus assuring a negative outcome.

PROJECT PERFORMANCE AND QUALITY

Quality is something that needs no introduction. McCall was apparently the first to actually discuss the characteristics of quality in software.⁷⁵ These characteristics are included in the quality dimensions that appear in Table 1 below. These quality features tend to promote progress, stability, compliance, and a certain amount of quality effort.⁷⁶ These dimensions have practical implications, particularly when attempting to measure the effectiveness of a project while it is in existence. Typically, the quality of an individual activity equals the number of faults in an activity divided by the total number of faults in every activity.⁷⁷ This metric is quite useful while a project is in process, and when detailed data is readily available, but may not be forthcoming at the end of a project, or after a project is completed. From a customer's standpoint, the quality of a project appears to be an assessment of the whole product, not merely the sum of the quality of the final product's component parts.⁷⁸

How Quality Is Measured

For Hayes, the purpose of finding critical incidents is to define the quality of the project.⁷⁹ Some of the expected quality issues that may manifest themselves are contained in Table 1.

Table 1. Project Quality Dimensions and Definitions

Correctness	The Degree to Which the Project Methods Meet the Customer's Specifications
Reliability	The extent to which project methods perform their intended functions.
Usability	The effort required to understand the project's results.
Maintainability	The effort required to find and correct errors.
Testability	The effort required to ensure that a project performs its intended functions.
Portability	The effort required to transfer the project methods from one project to another.
Inter-operability	The effort required to coordinate multiple projects using similar or different methods.
Intra-operability	The effort required for the project components to communicate with one another.
Flexibility	The effort required to use the project methods in other projects.

Since quality can be perceived as a process of identifying customer requirements, it is crucial to understand its dimensions. Correctness

⁷³*Id.*

⁷⁴*Id.*

⁷⁵J. A. McCall, An Introduction to Software Quality Metrics. In John D. Cooper, J. MacMillan, & J. R. Vosburgh, Software Quality Indicators, *Scientific Systems, Inc.* (1986).

⁷⁶*Id.*

⁷⁷G. Gordon Schulmeyer, Software Quality Assurance Metrics. By G. GORDON SCHULMEYER, & JAMES I. McMANUS (EDS.), HANDBOOK OF SOFTWARE QUALITY ASSURANCE (Prentice-Hall 3rd ed. 1999).

⁷⁸BOB E. HAYES, MEASURING CUSTOMER SATISFACTION: SURVEY DESIGN, USE, AND STATISTICAL ANALYSIS METHODS (American Society of Quality 2nd ed. 1998).

⁷⁹*Id.*

can be considered as measuring the degree to which the result of a project meets or even exceeds a customer's specifications.⁸⁰ Reliability gauges the extent to which the project output performs its intended function with precision. Usability is a word that describes the effort required to understand the output from a project. If a user can learn about the output in a short amount of time, and the output is easy to understand, then the project produced high-quality output and is usable.⁸¹

Maintainability is the effort required to find and correct errors, where finding an error is usually easy, while fixing the error can be difficult. According to Meredith and Mantel, testability is the effort needed to test the output to ensure that it performs its intended functions, and that testing occurs in a short amount of time and is easy to conduct.⁸² Portability consists of the ability to move the output of a project from one environment to another, a characteristic that is quite useful in some circumstances. Interoperability and intra-operability are related to each other, where communication of project output both inside and outside its sphere of influence is what is at issue. Finally, flexibility deals with the ability to modify the project output, and is critical in determining quality. Outputs are deemed high quality when they are easy to change with little or minimal effort.⁸³

How Performance Is Measured

According to Gray and Larson, there are two indices of performance efficiency.⁸⁴ The first index is known as the cost performance index (CPI), and measures the cost efficiency of the work performed to date. It is equal to the earned value (EV) divided by the actual cost (AC), where the earned value of a task is the percent completed times its original budget, and the actual cost of the work completed is the sum of the costs incurred in accomplishing the work.⁸⁵ The second index, the scheduling performance index (SPI), measures the current scheduling efficiency. This index equals EV divided by the planned value (PV), where the planned value is the planned time-phased baseline of the value of the work scheduled. It is an approved cost estimate of the resources scheduled in a time-phased cumulative baseline.⁸⁶ Another name for AC is the actual cost of the work performed (ACWP), and an alias for PV is the budgeted cost of the work scheduled (BCWS).

These two indices measure the percent completion of a project, depending on which one is more accurate according to the project manager's judgment. The first index assumes that the actual work that has been completed is quite reliable, while the second index assumes that the actual costs to date and the expected cost after the project are the most reliable in estimating the project completion percentage.⁸⁷ The underlying assumption behind both indices is that the project conditions do not change over time, no improvement or external action is taken, and the information about the project is accurate.⁸⁸ The first index examines the percent completion in terms of budget amounts, while the second index views percent completion in terms of the actual dollars spent in accomplishing the work to date, and the actual expected dollars for the finished project.⁸⁹

⁸⁰*Id.*

⁸¹Jack R. Meredith, & Samuel J. Mantel Jr., *supra*, note 2.

⁸²*Id.*

⁸³Bob E. Hayes, *supra*, note 78.

⁸⁴Clifford F. Gray, & Erik W. Larson, *supra*, note 14.

⁸⁵*Id.*

⁸⁶*Id.*

⁸⁷*Id.*

⁸⁸*Id.*

⁸⁹*Id.*

Influence on Management

Thus, the key is understanding what factors affect CPI, SPI, or both indices. As discussed above, both costs and schedules can positively or negatively affect CPI and/or SPI. The question comes down to when the value for a project is earned. According to Meredith and Mantel, the following four rules exist in determining the earned value for a given task:⁹⁰

- 50-50 estimate rule;
- 0-100 percent rule;
- Critical input use rule; and
- Proportionality rule.

The 50 percent completion rule allows the first 50 percent of the work performed to be earned when a task is started, and the remaining 50 percent to be earned when the task is completed.⁹¹ Although this is a popular rule that requires a minimum effort in estimating the progress of a project, its weakness lies in the fact that it tends to be reasonably optimistic. The zero-hundred percent rule gives no credit until a task is complete.⁹² The advantage of using this rule is that it works well for tasks of short duration, but poorly estimates the progress of a project when a task is pretty complex or takes a relatively long time to complete. The critical input use rule measures the progress of a project based on the amount of critical input expended.⁹³ The advantage of employing this rule comes when the use of the critical input measures the actual progress of a project, but it is a poor estimator when the accomplishment of the task does not contribute to project completion. For example, Meredith and Mantel cited the example of a machine being purchased up-front without any actual work being done.⁹⁴ The proportionality rule divides the planned or actual time to date expended by the total scheduled time or the total budgeted time in calculating the percent completion.⁹⁵

According to Fleming and Koppelman, CPI is the more sensitive index of the two indices.⁹⁶ The reason is that a CPI less than 1.00, or a negative CPI position, can typically never be recovered. In contrast, an SPI value less than 1.00 will eventually drift back up to 1.00 as the project tasks are completed.⁹⁷ CPI will usually remain less than 1.00 once it achieves a value less than unity due to cost overruns. According to Fleming and Koppelman, projects that demonstrate a CPI less than 1.00 tend to remain so, or even deteriorate, for all remaining tasks.⁹⁸ Furthermore, the evidence suggests that while cost overruns can be improved during a project, they cannot be completely recovered.

The fact is that no one involved in a project likes to be behind schedule. Thus, in attempting to make up lost ground, project managers often add resources to accomplish the budgeted amount of work. These additional resources cost money, sometimes in the form of overtime, exacerbating the problem. The result is that the state of the project gets financially worse, which in turn increases the temptation to add extra resources, making them even more attractive.

CONCLUSION

⁹⁰*Id.*
⁹¹*Id.*
⁹² Clifford F. Gray, & Erik W. Larson, *supra*, note 14.
⁹³ Jack R. Meredith, & Samuel J. Mantel Jr., *supra*, note 2.
⁹⁴ *Id.*
⁹⁵ *Id.*
⁹⁶ QUENTIN W. FLEMING, & JOEL M. KOPPELMAN, EARNED VALUE PROJECT MANAGEMENT (Project Management Institute 2nd ed. 2000).
⁹⁷ *Id.*
⁹⁸ *Id.*

To come back to the original question of what is the driving factor in a project is that both cost and time can have a positive and negative effect on performance or quality. Does one dominate the other, or is that not the relevant question? The answer lies in what is produced and how it is produced. In other words, there are no easy answers to this question, but fortunately for project managers, there are ways to measure the problem, as well as several heuristic solutions that possess both advantages and disadvantages. This is the reality of the situation.

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Donald L. Buresh earned his Ph.D. in engineering and technology management from Northcentral University. His dissertation assessed customer satisfaction for both agile-driven and plan-driven software development projects. Dr. Buresh earned a J.D. from The John Marshall Law School in Chicago, Illinois, focusing on cyber law and intellectual property. He also earned an LL.M. in intellectual property from the University of Illinois Chicago Law School (formerly, The John Marshall Law School) and an LL.M. in cybersecurity and privacy and an LL.M. in financial compliance and risk management both from Albany Law School, graduating summa cum laude twice. Dr. Buresh received an M.P.S. in cybersecurity policy and an M.S. in cybersecurity, concentrating in cyber intelligence, both from Utica College. He has an M.B.A. from the University of Massachusetts Lowell, focusing on operations management, an M.A. in economics from Boston College, and a B.S. from the University of Illinois-Chicago, majoring in mathematics and philosophy. Dr. Buresh is a member of Delta Mu Delta, Sigma Iota Epsilon, Epsilon Pi Tau, Phi Delta Phi, Phi Alpha Delta, and Phi Theta Kappa. He has over 25 years of paid professional experience in Information Technology and has taught economics, project management, quality management, management of non-profits, negotiation skills, managerial ethics, and cybersecurity at several universities. Dr. Buresh is an avid Chicago White Sox fan and is active in fencing épée and foil at a local fencing club. Dr. Buresh is a member of the Florida Bar.

LIST OF ABBREVIATIONS

Abbreviation	Description
AC	Actual Cost
ACWP	Actual Cost of the Work Performed
AOA	Activity on Arrow
AON	Activity on Node
BCWS	Budgeted Cost of the Work Scheduled
CPI	Cost Performance Index
CPM	Critical Path Method
EV	Earned Value
PERT	Program Evaluation Review Technique
PV	Planned Value
SPI	Scheduling Performance Index

MISCELLANEOUS CONSIDERATIONS

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