Project Risk and CPI

Why Should CPI = 1?

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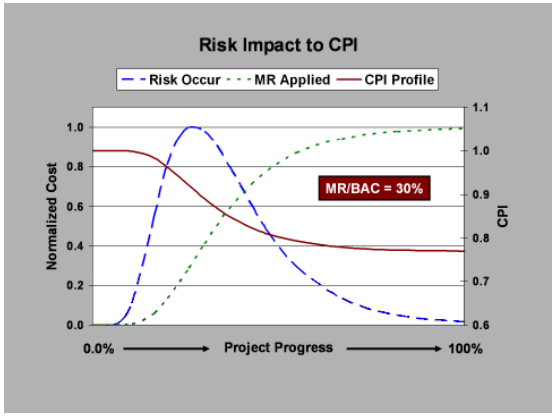

Abstract

The expectation when applying Earned Value Management is to control performance such that CPI = 1.00. This presentation examines that premise. Two influences are identified: schedule and risk. Each is shown to have negative impact on CPI. Recognizing how the influence is exhibited, an alternative management approach is proposed.

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Overview

- Introduction
- CPI and Schedule
- CPI and Risk
- Risk Impact on CPI
- Management Application
- Forecast and Schedule Application
- Summary
- Final Comment

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Introduction

- **Should we rightfully expect CPI = 1.00?**
- To refresh, CPI is the cost performance efficiency, CPI = EV / AC
- Project managers desire to guide the cost performance such that CPI = 1.00
- Those who receive and analyze project status reports examine with reference to CPI = 1.00
- When the CPI value is less than a threshold (CPI_T = 0.85) an explanation and a planned action for performance improvement is expected

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Introduction

- That's today's practice of EVM
- Nevertheless …

  Is CPI = 1.00 a reasonable expectation?
- Commonly, when CPI $<$ CPI_T for an extended time, the PM requests approval to re-baseline
- By establishing a revised baseline, the pressure to improve is relieved …and, momentarily, status reports become acceptable

Introduction

- This practice diminishes the management effectiveness of EVM – for the current project and for future planning and evaluation of process improvement initiatives
- If EVM practitioners could view CPI with an expectation of something other than the value of 1.00 – it may be possible to minimize revising project baselines and preserve project history

CPI and Schedule

- For small projects that may require different skills there may be gaps for certain skills
- For example, the project requires 12 engineers, but for a two week period only 10 have planned work.

Shouldn't this affect CPI?

- Unless the engineers are pooled with another project, they will accrue cost and not have PV available to be earned

CPI and Schedule

- From the outset, we know the resource cost for the project (AC_R) is greater than the budgeted cost, BAC. Thus the expectation for cost efficiency is

  $$CPI_S = BAC / AC_R \quad < 1.00$$

- In turn, this affects management reserve

  $$MR_S = AC_R - BAC$$

- During planning, CPI_S could be used as a measure of scheduling effectiveness. Skills having time gaps could be evaluated and minimized so as to bring CPI_S closer to 1.00

CPI and Risk

- Over the years there have been several initiatives and efforts to couple EVM and Risk Management (RM)
  - In 2005, NDIA survey results indicated a strong desire within the EVM community to integrate the two methodologies
  - At the 2006 IPMC, Patti Tisone presented the Northrop Grumman process
  - In a 2004 paper, David Hilson developed a method connecting EVM performance to risk management reactions
  - Lauren Bone, at the 2007 IPMC, described an approach of interfacing EVM and RM

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CPI and Risk

- The risk evaluation for the project should directly relate to the creation of the EVM Management Reserve (MR).
  - MR is intended to fund the effort needed to address the impact of a risk, should it occur
- Although the other references cited imply this connection, only the presentation by Bone explicitly makes the relationship
  - The Bone method is a probabilistic approach which produces the PMB, MR, and schedule reserve

CPI and Risk

- From the Bone presentation, potential risks are categorized into – *known* & *unknown*
- For the known risks, plans are created and put into action upon risk occurrence
  - The risk plan is integrated into the PMB, as needed, removing funding from MR
  - BAC and the project duration is increased
  - The risk action can then be tracked and managed using EVM methods …*integration of EVM & RM is achieved*

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CPI and Risk

- The handling of the unknown risks is not so well defined – the presumption is the same method is used …with the exception that the planning needed for the mitigation action is included as part of the action
- The Bone method is very good …*however*, there may be circumstances for which management may not choose to integrate the risk action into the PMB …*it may be seen as not worth the effort*

CPI and Risk

- When the risk action is not integrated into the PMB, costs are accrued for the project but no EV is accrued
  - Risk cost must appear in the project …somewhere
  - MR is used to fund the risk mitigation action …where did it go? …consumed by inefficiency
- CPI should be expected to decrease when the risk action plan is not integrated into PMB
- In this instance, the practice of using the CPI threshold may cause unnecessary management actions and project re-baselines

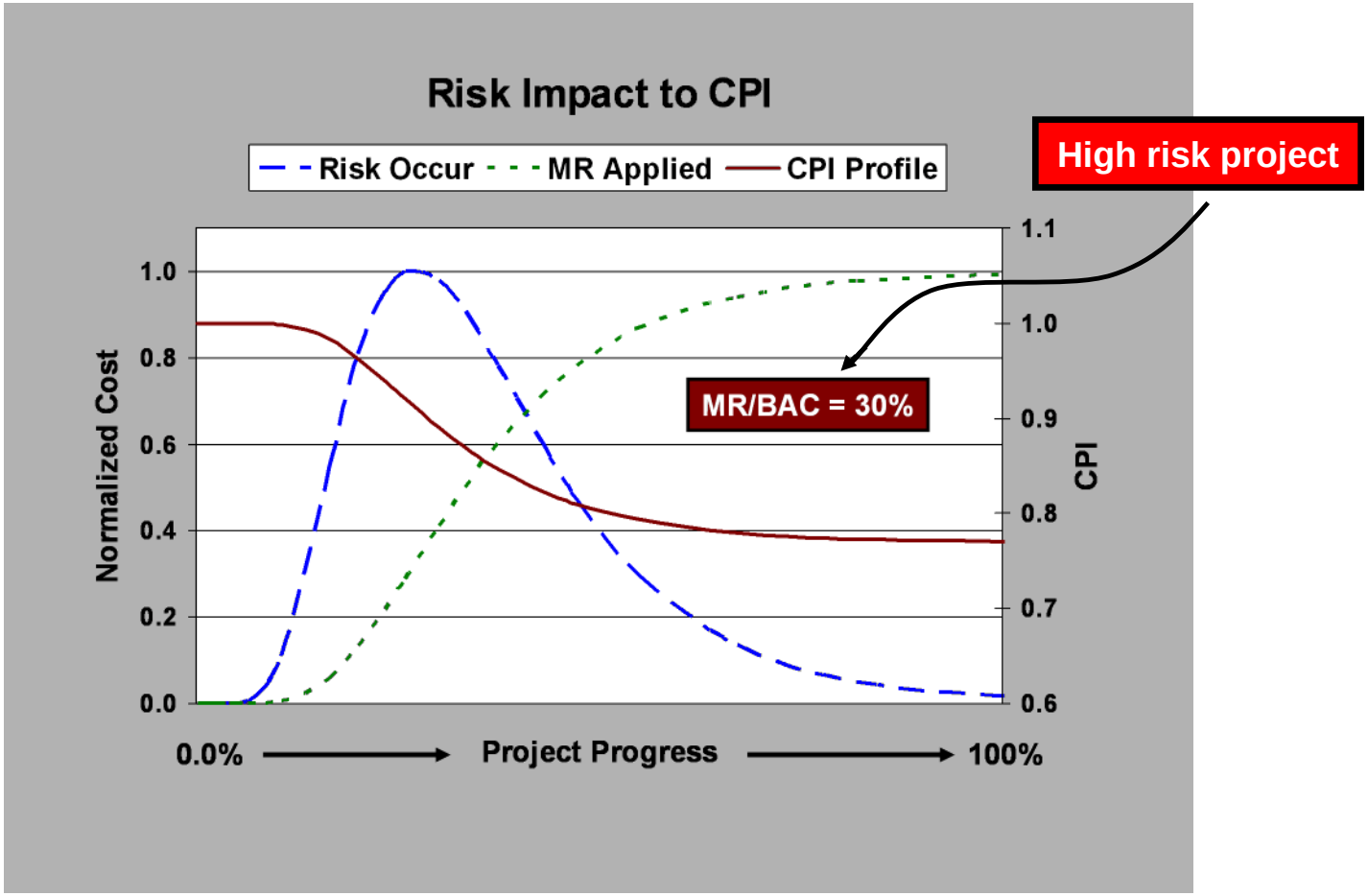
Risk Impact on CPI

- The Bone presentation indicated the distribution of possible project outcomes as right-skewed
  - The distribution is caused by the uncertainty of the occurrence of the risks …and is consistent with my previous research
  - My hypothesis is the risk impact distribution is right-skewed, as well – and has relationship with the concentration of dependent activities (the number of dependent activities is, itself, right-skewed with respect to percent complete)

Risk Impact on CPI

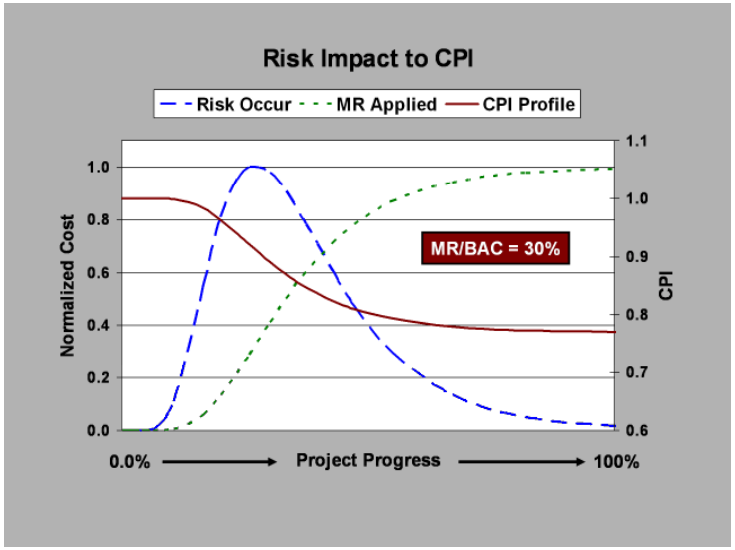
- We have established
  - As risks occur, MR is consumed
  - When the mitigation action is not integrated with the PMB, CPI suffers
- The pieces are all connected
  - Risk planning ⇒ MR
  - MR ⇒ Risk mitigation
  - Percent complete ⇒ Risk occurrence
  - Risk occurrence ⇒ Cost performance

Risk Impact on CPI



Risk Impact on CPI

- Risk Occur and MR Applied are normalized representations
- Risk Occur increases for the first third and then decreases
- If well-planned, MR will be equal to the expected impact of risk
- Then, MR becomes the integration of the risk occurrence impact



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Risk Impact on CPI

- On the figure, CPI is shown decreasing with project progress – beginning at 1.00 and ending at 0.77
- Risk mitigation is not integrated into the PMB …and, thus, there is no PV to earn
- For this situation

$$CPI = EV / (AC_P + AC_R)$$

  - AC_P = actual cost associated with tasks in the PMB
  - AC_R = cost to mitigate risk not integrated into PMB

Risk Impact on CPI

- If MR is utilized as expected, AC_R will follow the graph of MR Applied
- For perfect cost efficiency, CPI is equal to

$$CPI = EV / (EV + MR_A)$$

  - MR_A = MR Applied (function of project progress)
- Thus, for perfect cost efficiency, it is obvious that CPI must decrease as risks occur

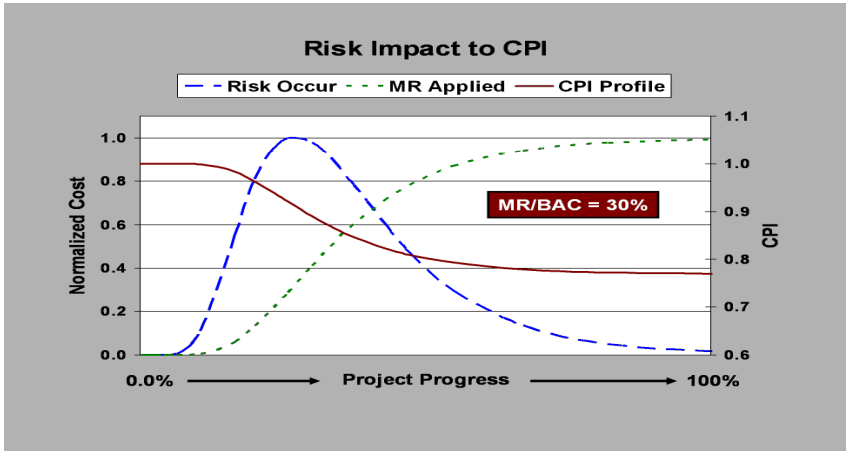
Risk Impact on CPI

- The equation yields the value 0.77 shown on the graph

$$CPI = EV / (EV + MR_A)$$
$$= BAC / (BAC + 0.3 \bullet BAC)$$
$$= 1 / 1.30 = 0.77$$

- The example demonstrates that as project risk becomes high the CPI can be expected to have a final value much lower than 1.00

Management Application



- In today's practice of EVM, the CPI threshold does not consider project risk
  - Whether high or low risk, $CPI_T = 0.90$
  - PMs are compelled to react to breach of threshold
- For the graph, CPI falls below 0.90 early …and not understanding …PM reacts unnecessarily

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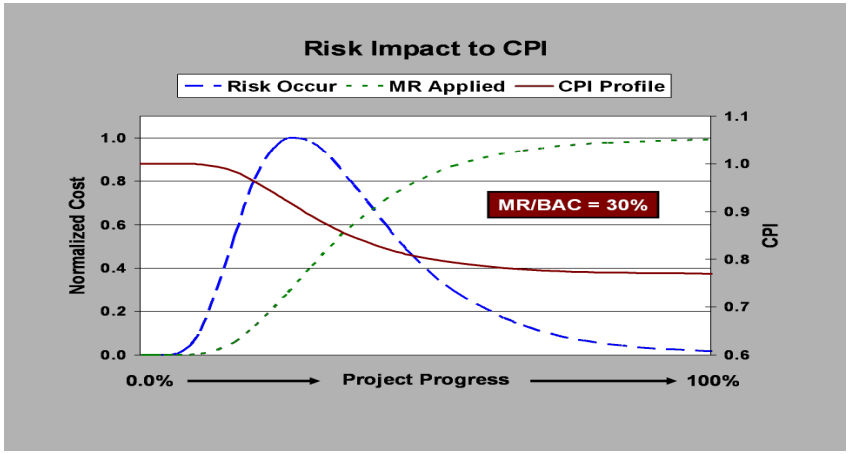
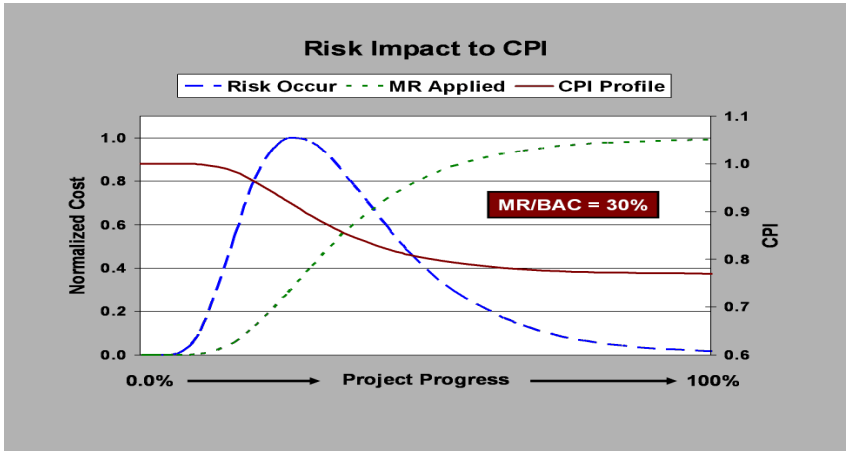
Management Application



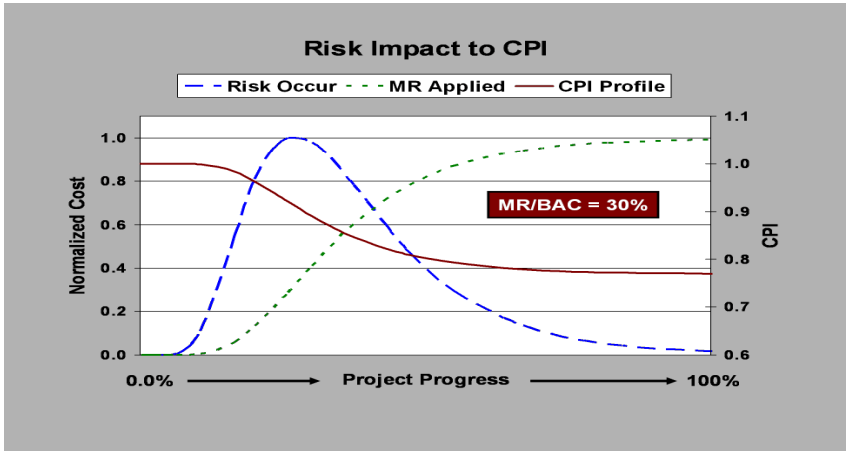
- Because risk events continue to occur, the mitigation actions taken don't halt the decline of CPI
- As conditions worsen, to avert criticism …a revised baseline is created …consuming time and diverting effort from the project

Management Application



- The graph is the outcome of the project planning considering the anticipation of risk
- The CPI as a function of project progress could be used for comparison to actual value …rather than the threshold comparison presently used

Management Application



- The alternative method proposed should
  - Improve management information and decision making
  - Prevent pointless effort to improve cost efficiency
  - Avoid cost and time expended for project re-baselining
  - Improve project histories

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Forecast and Schedule Application

- An interesting point – cost forecasting is not dependent upon integrating risk actions into the PMB
- To illustrate – MR = 0.3 BAC and CPI_{final} = 0.77
- When risk is integrated, the budget = 1.3 BAC
  - Forecast = Project Budget / CPI
    = 1.3 BAC / 1.00 = 1.3 BAC
- When risk not integrated, budget = BAC
  - Forecast = BAC / CPI
    = BAC / 0.77 = 1.3 BAC

Forecast and Schedule Application

- Presentation has been focused on cost performance
- It is reasonable to think that schedule performance using SPI(t) from Earned Schedule will behave analogously to the description for CPI
- Thus, the method presented for cost may be applied to schedule, as well

Summary

- The idea of CPI = 1.00 being a constant point of reference is questioned
- It was shown …when resources are not fully utilized in the plan, there is cost without EV
- Relationship was described between risk occurrence, MR consumed, and CPI as a function of project progress
- A method of managing cost performance utilizing the expectation of worsening CPI is proposed

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Final Comment

- The idea that CPI is expected to worsen during project execution is unsettling
- It is contrary to the application concept of EVM
- The underlying thinking is when inefficient performance is reacted to early in the execution, the possibility of a successful project is enhanced

Final Comment

- However, studies have shown that decreasing CPI is very “normal”
- Dr. Christensen & S. Heise noted in a study that, “*…the cumulative CPI …usually declined as the contract proceeded to completion*”
- A recent study by USAF Major Jack tested for improvement in CPI after a project re-baseline. His finding was that CPI tended not to improve: “*…we find there is no statistically significant change in cumulative CPI slope (negative) after an OTB intervention*”

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Final Comment

- The two studies give credence to the idea: *Risk negatively impacts CPI throughout the project*
- With acceptance of the connection between risk and CPI, the application of the CPI comparison method proposed can be seriously considered
- Research is needed to explore, prototype, and validate the idea presented
- Those having good EVM data are challenged to pursue this research topic

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