Case Study

Forecasting Capital Project Cost Using Monte Carlo Simulation with @Risk for Project

Client: Port of Seattle
Project: Shilshole Bay Marina Replacement & Renewal Project

WHO ARE WE

P&M is a project delivery services firm providing:

- Project, Program and Portfolio Management
- Procurement Strategy and Alternative Delivery Processes
- Project Delivery Solutions Development
- Project Controls Solutions
- Scheduling Management
- Cost Management
- Risk Management
- Claims Analysis and Dispute Resolutions

We have developed a project delivery system **"Myriad"** that provides

- qualitative risk analysis and
- quantitative risk analysis with Monte Carlo simulations.

We are located in Federal Way, Washington.

My name is Hreinn Thormar, president and owner of P&M**.**

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THE CASE STUDY

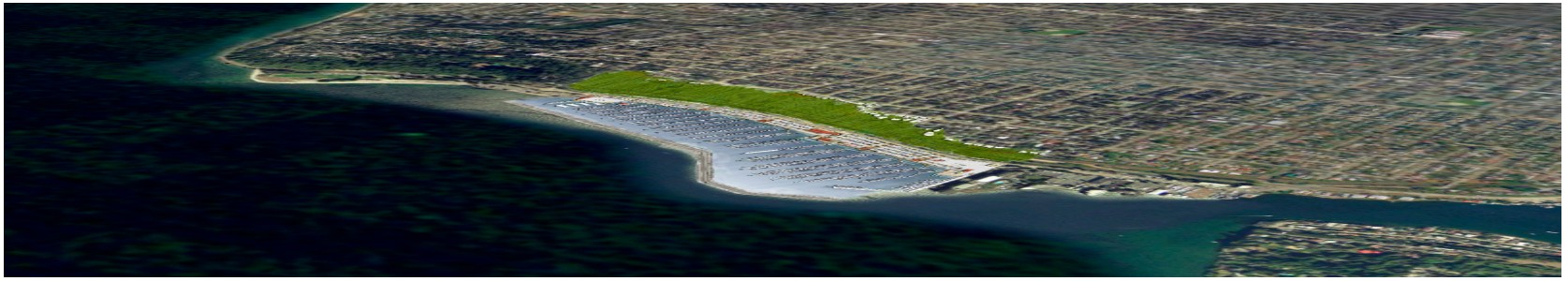
Our case study focuses on **forecasting capital costs** on capital projects and the additional benefits with Monte Carlo simulations and Probabilistic Outcomes for projected costs compared to traditional deterministic project controls and cost forecasting.

Our case study is based on a project with the Port of Seattle – Shilshole Bay Marina - Renewal and Replacement Project “SBM”. The funding authorization is $80M.

This project is a complex construction with

- **tight budget constraints**
- **execution of several simultaneous construction contracts**
- **compounded with operational site with on-going operations and use of the Marina**

This invites several **unforeseen** constraints and **inefficiency impacts** that can not be incorporated into contract documents.



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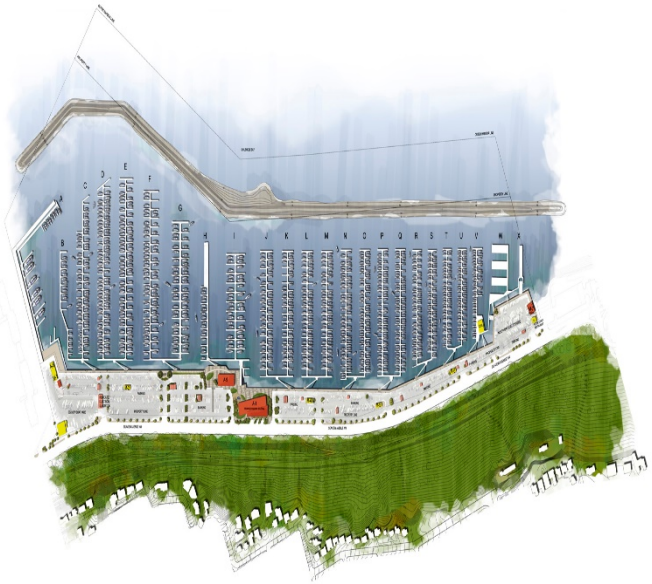
Project Highlights

- **Design/Permitting 2001 - 2005**
- **Construction: 2005 – 2008**
- **Replaces all docks and piers**
- **New mix of slip sizes**
- **Adds 4,000 lineal feet of moorage**
- **Enhanced small boat/sailing center**
- **New public areas and children's play fountain**
- **New administration building and offices**
- **New Anthony's Restaurant**
- **New utilities**
- **Expands dry boat moorage**
- **Replaces creosote wood pilings with steel**
- **Hoffman Construction Co. selected as general contractor**
- **Budget: $80 million**



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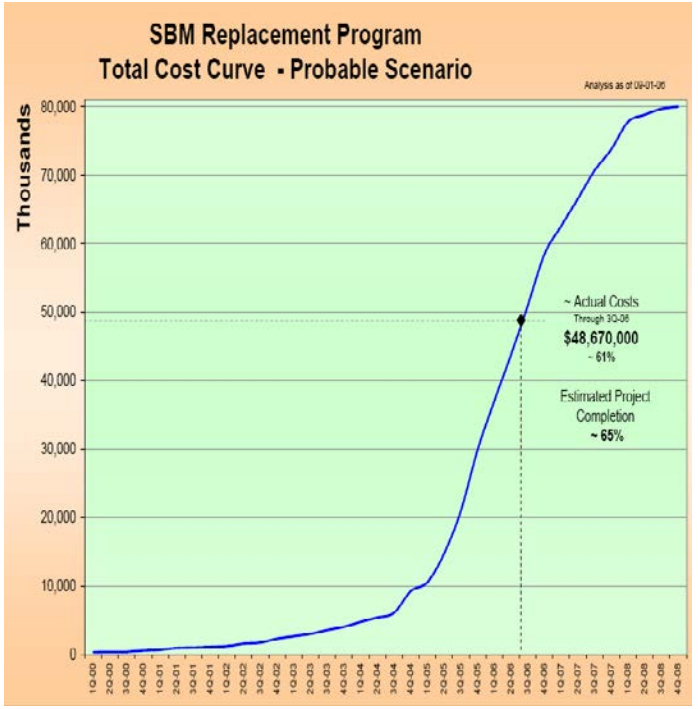
PROJECT RISK

Construction projects are a **complex entity to manage** and each construction project has its own significant changes and challenges like:

- unforeseen conditions
- errors in documents and plans
- scope creep
- schedule delays, etc.

Most owners who manage capital projects have processes in place to manage:

- changes
- contingencies and
- forecasting of cost



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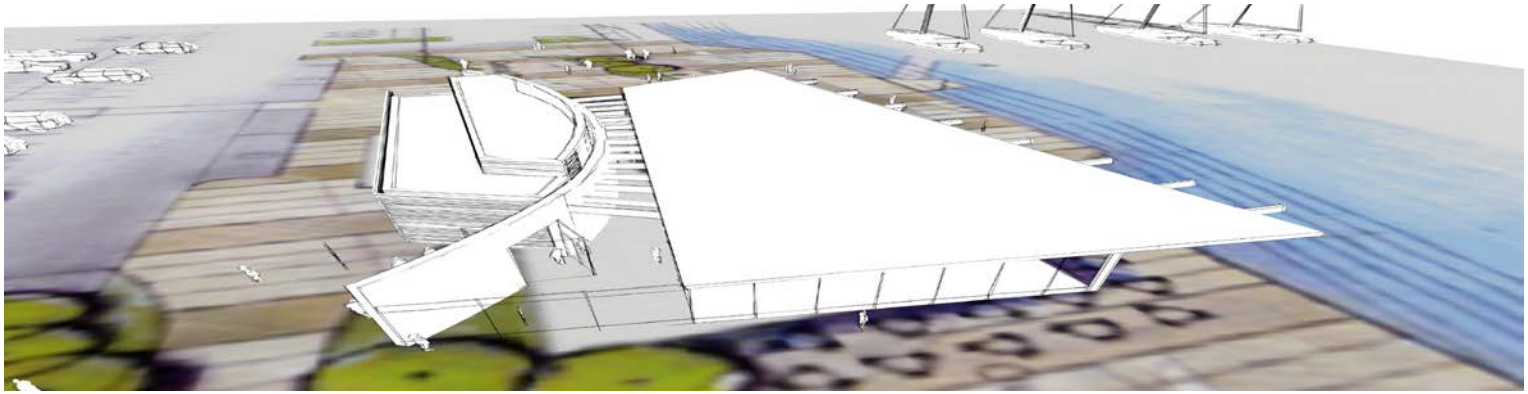
THE CHALLANGE

When project budgets are **tight** it is not unusual that project stakeholders begin asking questions like:

- will we run out of money
- have you considered ….
- what assumptions have you made with your numbers
- are your numbers conservative; optimistic or even most likely

The discussions and explanations become **Complex** and the **Credibility** can become questionable – which is every Project Manager's worst nightmare!



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THE SOLUTION

At the Port of Seattle we introduced the Monte Carlo simulation as the **Solution to the Problem** and we began reporting costs (forecast) with probabilistic outcomes.

The modified approach has shown **SIGNIFICANT** results in the **Visibility** and **Credibility** of the Project Controls.

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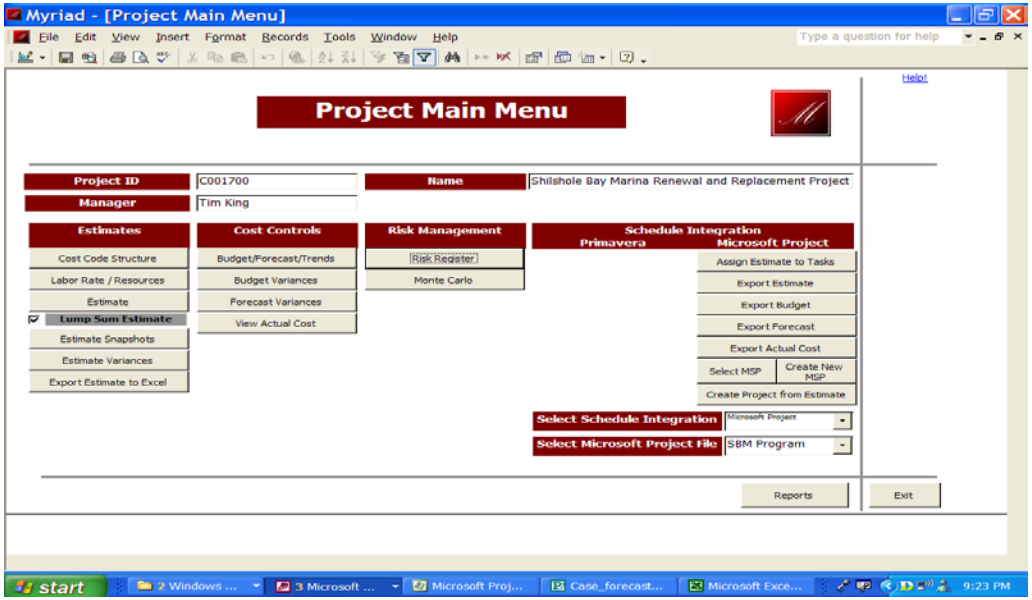
THE TOOL - MYRIAD

The **project controls** is managed in a “light” version of “Myriad” where

- Estimates
- Cost Controls and
- Master Schedules

are prepared, updated and project reporting occurs. Cost information can be loaded into an Excel Spreadsheet or Microsoft Project for risk analysis and Monte Carlo simulations.



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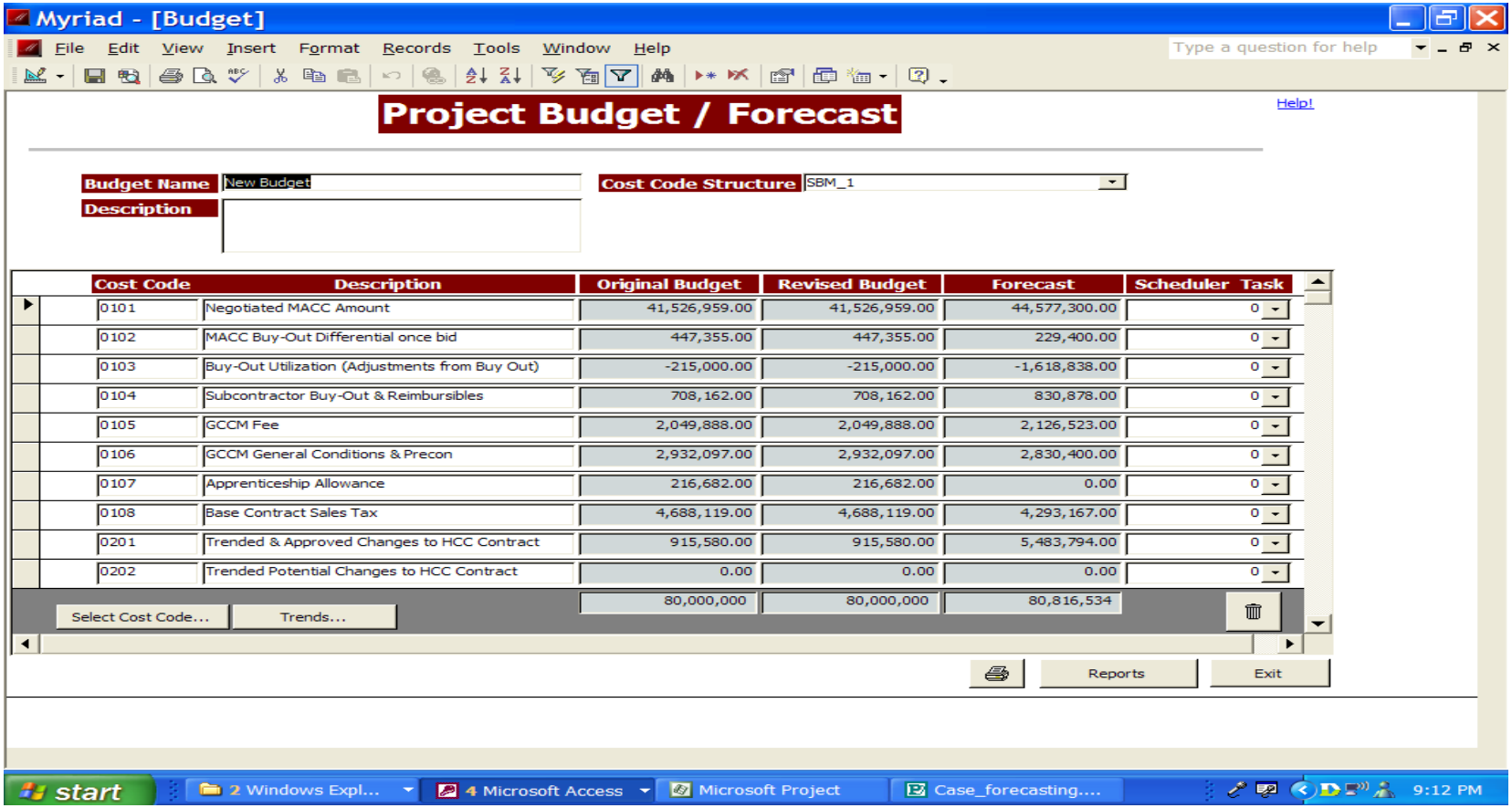
Project Budgets and **Cost Forecasting** are managed via **Variance Control module** and input for **forecasting** is derived from **project spending** and a **cost trend module**.



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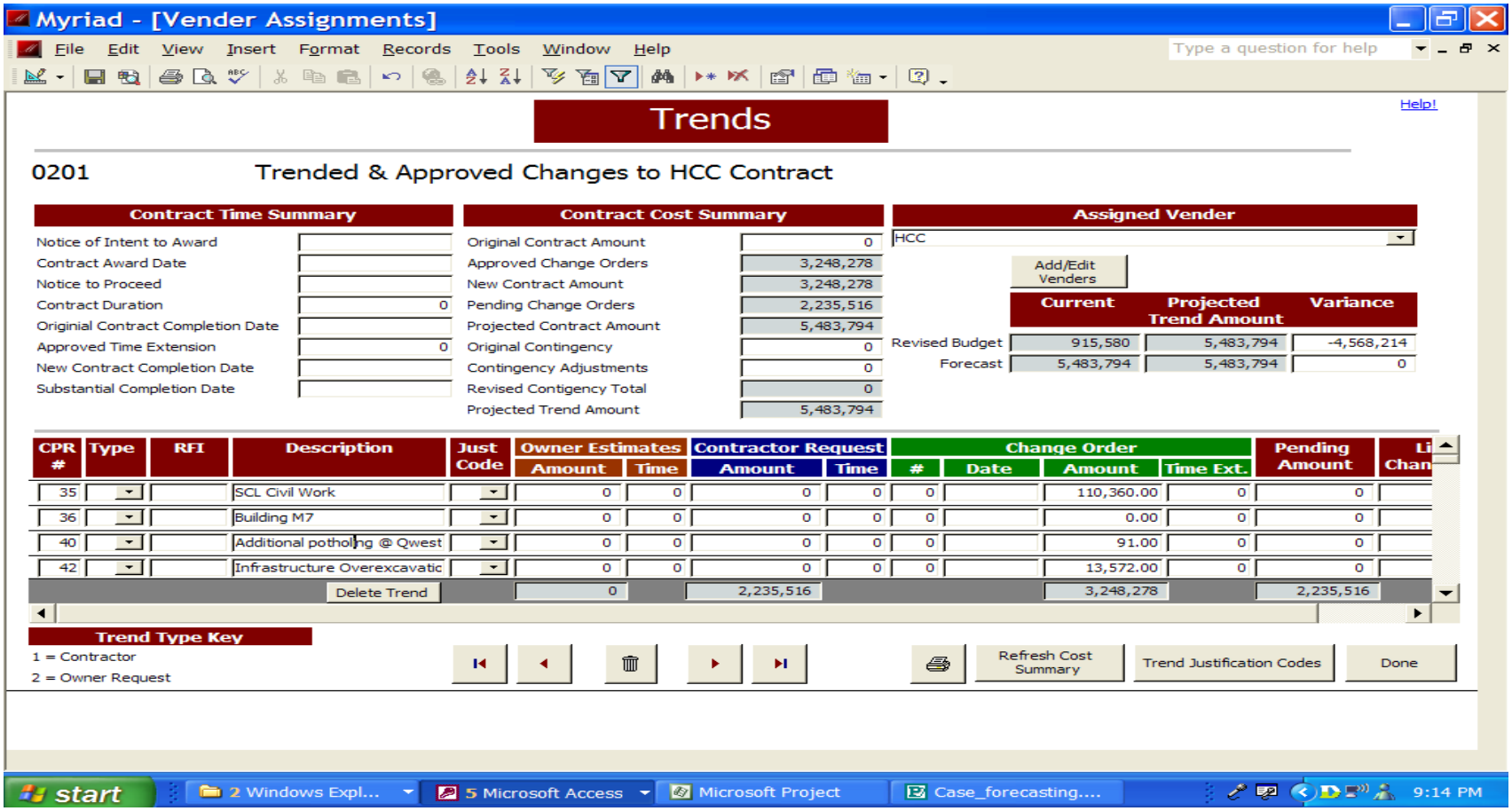
Cost trends are maintained on a daily basis for **actual**, as well as, **potential events** that can drive project forecasting.



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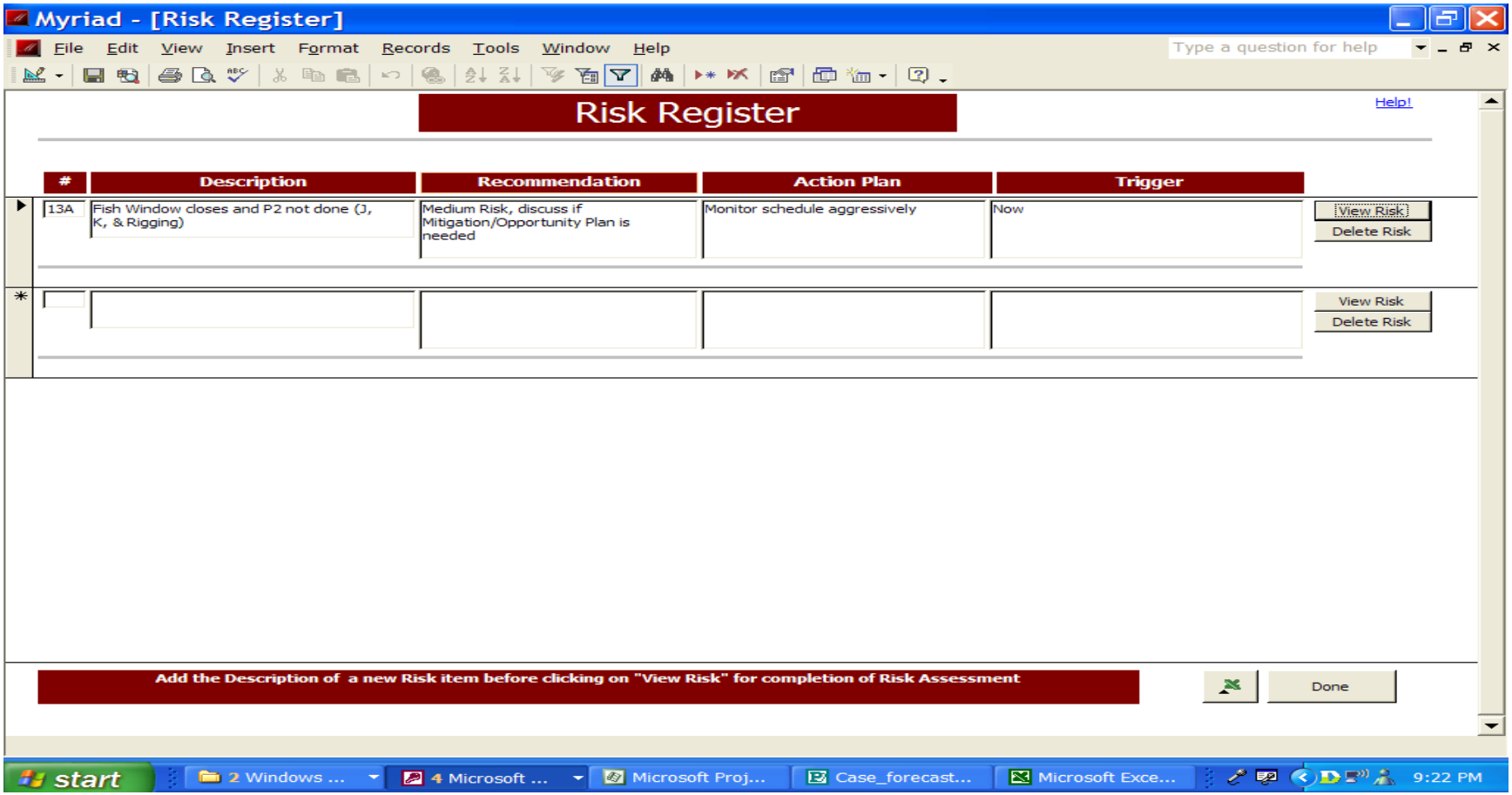
A **risk register** is maintained for the project to identify **qualitative risk and opportunity** issues with mitigation plans and alarm functions.



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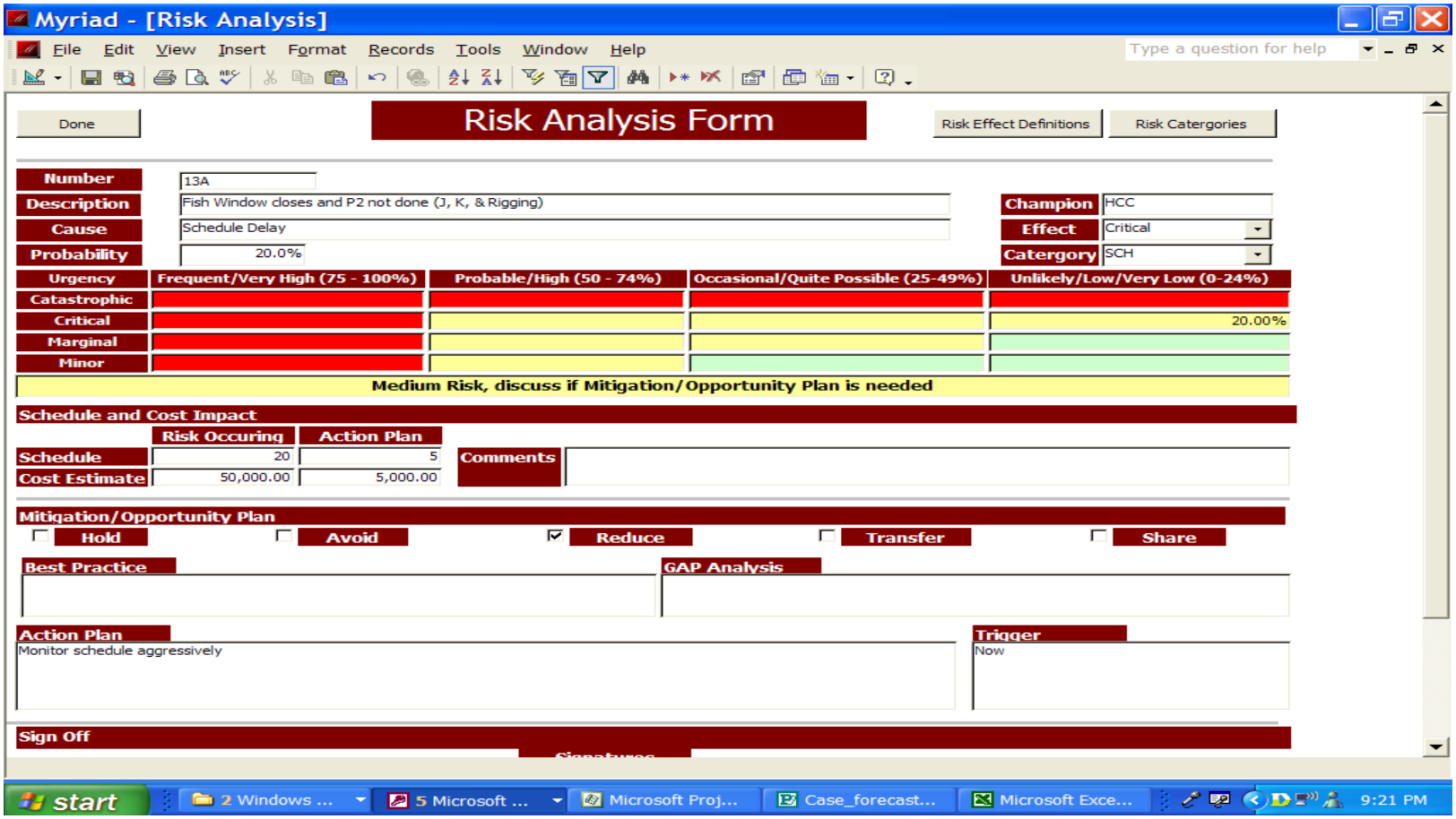
Each line item in the risk register can be analyzed using a **decision model**. Each risk has an estimate of cost and schedule impacts and a Mitigation/Opportunity plan.



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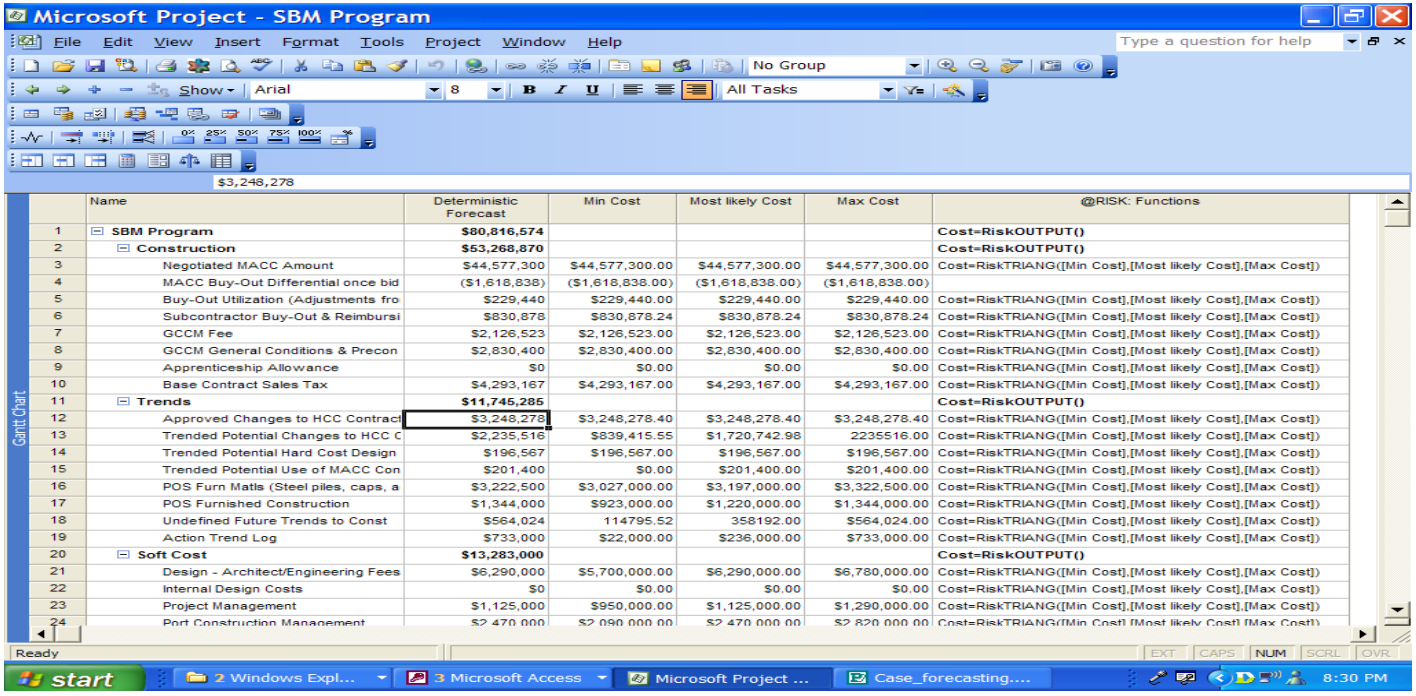
MONTE CARLO

When schedules are loaded with resource and/or cost information, a Monte Carlo simulation can be performed with **@Risk for Project** for Probabilistic outcomes and Sensitivity analysis.

The report below shows a deterministic cost forecast of $80.8M calculated for the project which exceeds the authorized funding of $80M.



	Name	Deterministic Forecast	Min Cost	Most likely Cost	Max Cost	@RISK: Functions
1	SBM Program	$80,816,574				Cost=RiskOUTPUT()
2	Construction	$53,268,870				Cost=RiskOUTPUT()
3	Negotiated MACC Amount	$44,577,300	$44,577,300.00	$44,577,300.00	$44,577,300.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
4	MACC Buy-Out Differential once bid	($1,618,838)	($1,618,838.00)	($1,618,838.00)	($1,618,838.00)	
5	Buy-Out Utilization (Adjustments fro	$229,440	$229,440.00	$229,440.00	$229,440.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
6	Subcontractor Buy-Out & Reimbursi	$830,878	$830,878.24	$830,878.24	$830,878.24	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
7	GCCM Fee	$2,126,523	$2,126,523.00	$2,126,523.00	$2,126,523.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
8	GCCM General Conditions & Precon	$2,830,400	$2,830,400.00	$2,830,400.00	$2,830,400.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
9	Apprenticeship Allowance	$0	$0.00	$0.00	$0.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
10	Base Contract Sales Tax	$4,293,167	$4,293,167.00	$4,293,167.00	$4,293,167.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
11	Trends	$11,745,285				Cost=RiskOUTPUT()
12	Approved Changes to HCC Contract	$3,248,278	$3,248,278.40	$3,248,278.40	$3,248,278.40	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
13	Trended Potential Changes to HCC C	$2,235,516	$839,415.55	$1,720,742.98	2235516.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
14	Trended Potential Hard Cost Design	$196,567	$196,567.00	$196,567.00	$196,567.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
15	Trended Potential Use of MACC Con	$201,400	$0.00	$201,400.00	$201,400.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
16	POS Furn Matls (Steel piles, caps, a	$3,222,500	$3,027,000.00	$3,197,000.00	$3,322,500.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
17	POS Furnished Construction	$1,344,000	$923,000.00	$1,220,000.00	$1,344,000.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
18	Undefined Future Trends to Const	$564,024	114795.52	358192.00	$564,024.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
19	Action Trend Log	$733,000	$22,000.00	$236,000.00	$733,000.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
20	Soft Cost	$13,283,000				Cost=RiskOUTPUT()
21	Design - Architect/Engineering Fees	$6,290,000	$5,700,000.00	$6,290,000.00	$6,780,000.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
22	Internal Design Costs	$0	$0.00	$0.00	$0.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
23	Project Management	$1,125,000	$950,000.00	$1,125,000.00	$1,290,000.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])
24	Port Construction Management	$2,470,000	$2,090,000.00	$2,470,000.00	$2,820,000.00	Cost=RiskTRIANG([Min Cost],[Most likely Cost],[Max Cost])

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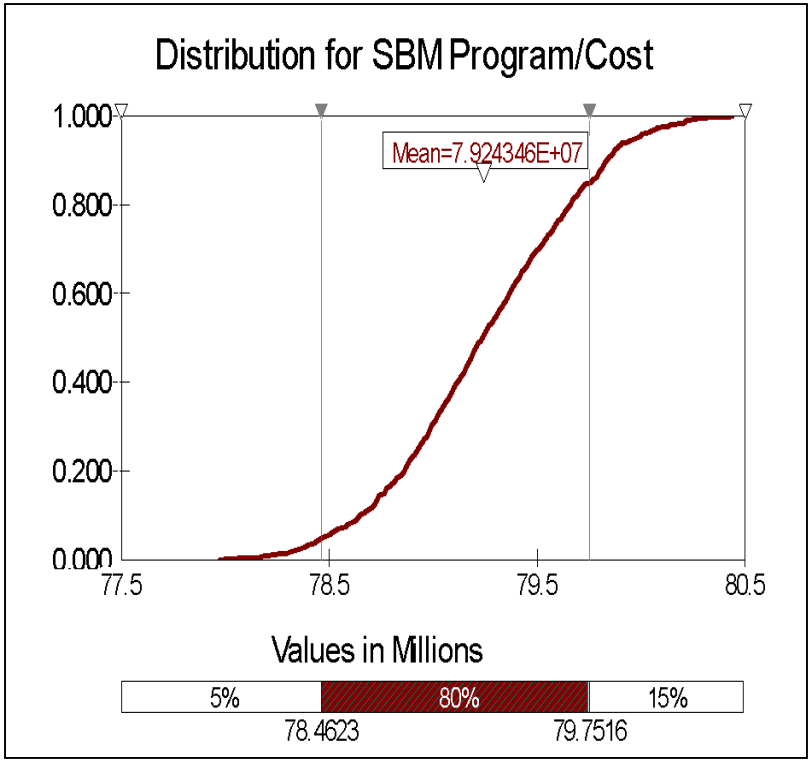
Following the Monte Carlo simulation a report with **probabilistic outcomes** shows an forecast of $79.7M using the 85% percentile which we determined to use at the Port.

Note that the 85% percentile value is lower than the deterministic value of $80.8M.

Result: Visibility - Credibility



Summary Statistics			
Statistic	**Value**	**%tile**	**Value**
Minimum	77973760	5%	78462320
Maximum	80438880	10%	78646208
Mean	79243457.66	15%	78762760
Std Dev	454029.9113	20%	78859144
Variance	2.06143E+11	25%	78926912
Skewness	-0.046812337	30%	78994192
Kurtosis	2.570689613	35%	79052160
Median	79235800	40%	79115576
Mode	78996728	45%	79175696
Left X	78462320	50%	79235800
Left P	5%	55%	79304432
Right X	79751616	60%	79366024
Right P	85%	65%	79427768
Diff X	1289296	70%	79500368
Diff P	80%	75%	79579680
#Errors	0	80%	79659528
Filter Min		85%	79751616
Filter Max		90%	79832016
#Filtered	0	95%	79974560

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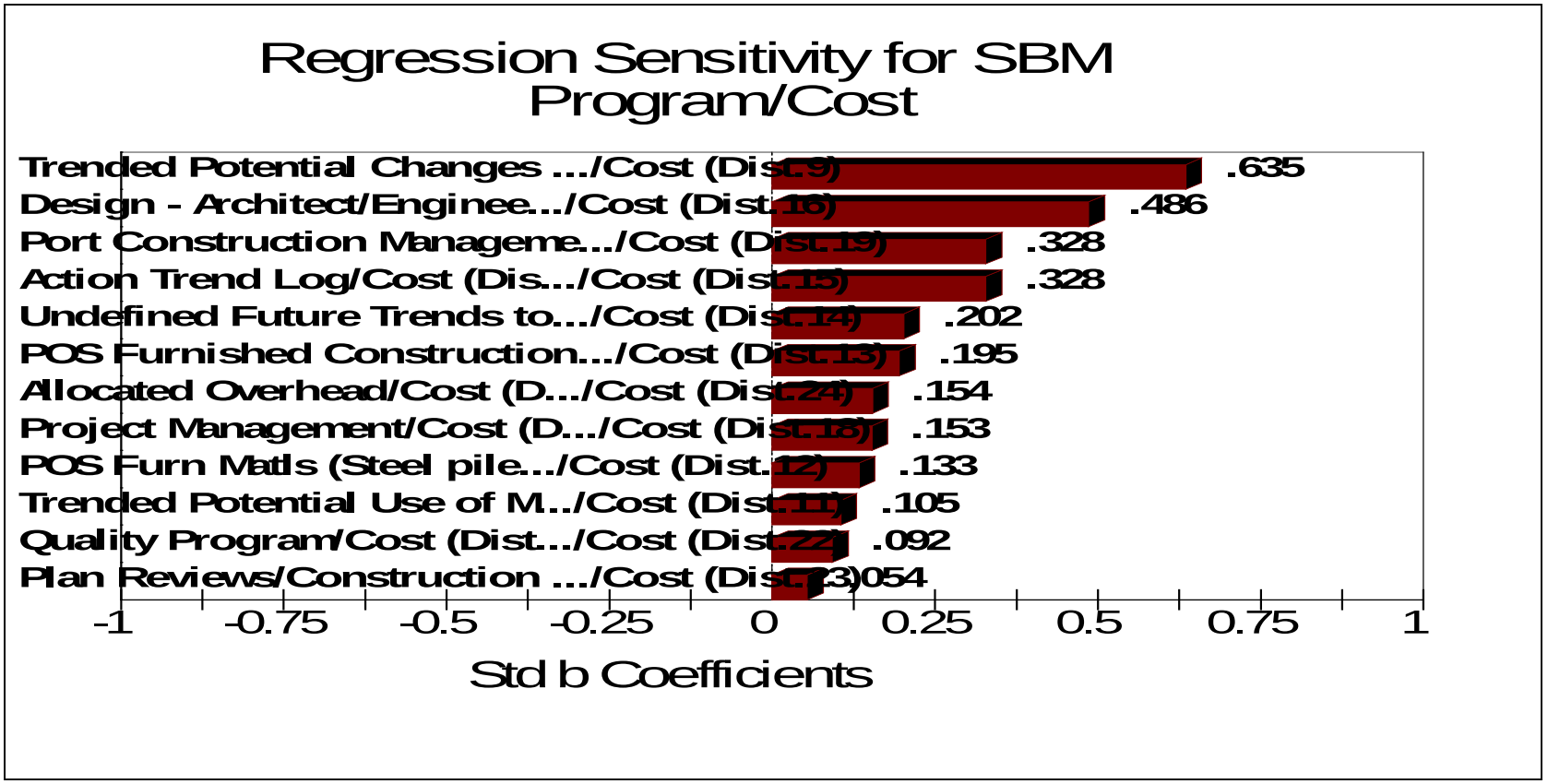
The result of the Monte Carlo simulation provides **sensitivity outcomes** of how each input impacts the outcome. This can be a very helpful tool to focus your resources on the largest risk areas in the project.



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At the Port of Seattle we determined to use the 85% percentile number for the project forecast.

TOTAL FORECASTED COSTS ON ACTIVE PROJECTS	85% Probability Forecast @ Completion
Subtotal Base Construction Contract (Incl. Sales Tax)	*$53,070,000*
Construction Changes (Including Sales Tax)	*$5,564,000*
POS Furnished Mat'ls & Construction	*$4,446,000*
Subtotal Project "Hard" Costs	**$63,080,000**
Design, Administration	*$11,784,000*
Allocated Overhead	*$2,339,000*
Subtotal Project "Soft" Costs	**$14,123,000**
TOTAL ACTIVE PROJECT COSTS	$77,203,000
Completed Projects Carry Forward Cost	*$2,519,000*
TOTAL ALL PROJECT COSTS	**$79,722,000**

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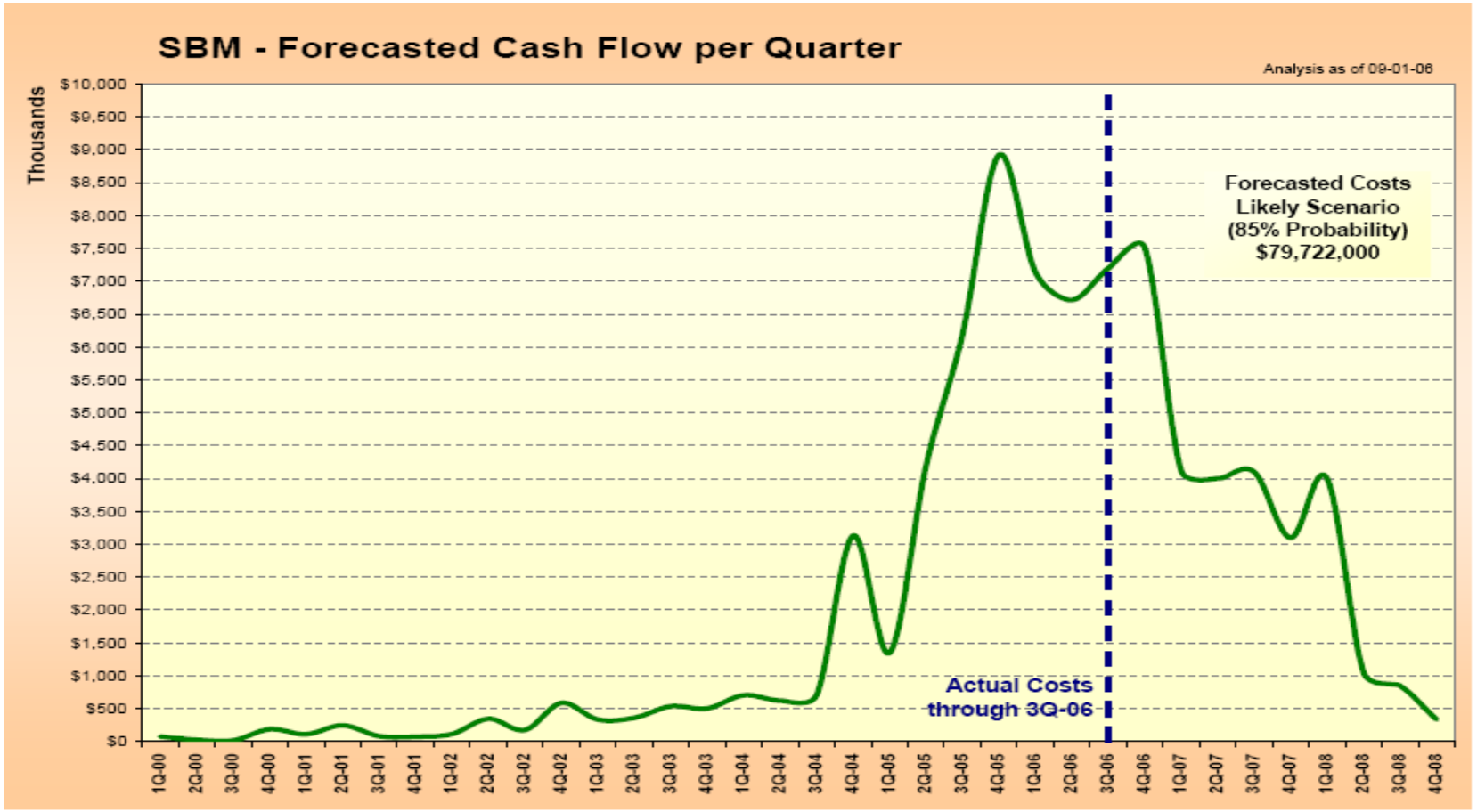

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Get more information from following sources:

- our web site at www.pmsvs.com
- get a brochure
- contact us directly at (253) 248 0038
- email us at main@pmsvs.com

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Project Delivery Services

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- Cash-flows
- Risk Management
- Stochastic / Monte Carlo Simulation
- Earned Value Management
- Integration of Scope - Cost - Schedule and Resources
- Progress Reporting

Myriad
Your Project Controls Solution Center

Check out our web site @ www.pmsvs.com

RISK MANAGEMENT

If you are a project manager and fail to adequately consider the impact of risk and uncertainty on your project, you could be loosing large sums of money!

With each project, there are many uncertain values that must be considered when you are in the planning stage.

Risk Management is an essential element that you must control in order to bring your project in on time and within budget.

Values such as costs; resources; dates and durations can all affect the outcomes of timelines and final budget expenditures.

So, it makes sense to analyze the risk; identify any potential threats to the project; and then assign adequate resources to manage the risks.

With **pmsi** on your team, you can proactively become aware of possible risks ... and receive recommendations to control those risks.

There are several important tools that are frequently used to quantify the risks. One such program is "**Monte Carlo**" simulation which provides information about the project and the likelihood that it will be completed on budget and in a certain time frame. The power of Monte Carlo simulation is the picture of the possible outcome it will create.

With management reports, charts and graphs — management can easily see the possibilities and can then allocate manpower or other resources toward minimizing the impact of the risk on the project.

pmsi has developed a Risk Management database (see **Myriad**) that facilitates complete risk analysis by outlining the following steps:

- Identifying risk and opportunities
- Assessing threats (probability of risk)
- Determining effect from risk
- Determining urgency
- Determining schedule and cost impacts
- Preparing mitigation/ opportunity plans
- Conducting reviews and approvals.

Myriad comes with a full-featured Monte Carlo Simulation Engine for Microsoft Excel®. You can add Risk Analysis to your spreadsheet models quickly and easily to evaluate probabilistic outcomes for:

- Estimated Cost
- Budgets and projected cost (forecasting)
- Determining Contingencies and Management Reserves

pmsi does retail "**@Risk for Project**" from Palisade Corporation. @Risk for Project is a powerful cost and schedule risk analysis tool that works in conjunction with the Myriad application or as a stand alone application. It allows you to run Monte Carlo simulation on project schedules; estimates and resources that are automatically loaded from **Myriad**, so you can assess the probable outcomes of completing projects on time and within budget.

Projects always seem to be in a constant state of change.

And, those changes each impact the project differently.

"He's shown the Port the value of doing Monte Carlo simulations for anticipating overall costs, a very advanced topic. He's been able to expand the port's vision on what they would like to do"
Mark Spaur K/J Consultants

With **pmsi** on your team, you will be able to determine the critical path needed for project completion and be able to identify the most critical tasks that need to be finished.

Every year, many projects get cancelled, run late, or run over budget because risk management has not been adequately addressed.

It makes sense to use **pmsi** to help you assess risks and to provide recommendations that can help you meet your

Questions?
Please contact us today at:

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