Recommended Solutions for Three Problems Commonly Experienced During Portfolio Optimization:

Too Much Mandatory, Reliability Goals Not Achieved, and High Risk Investments Not Funded

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- Do you have too many mandatory projects, such that the remaining discretionary budget is too limited to be able to funnel it towards investments that will help you achieve your goals?
- Are there enough reliability-focused projects selected for funding to allow you to meet your targets? Or, for that matter, even enough proposed for funding?
- Do you have so many high-risk investments that you can't fund them all within the budget constraints?

INTRODUCTION

For most gas, water, and electric utilities, difficult investment planning decisions are made each budgeting cycle. Following asset management best practices, company strategies and objectives should be aligned to the investment decision-making process and a rigorous process for investment analysis and optimization of the proposed portfolio of investments should take place. With the large capital and O&M budgets and the numerous investments that are proposed each budget year, an investment analysis and spend optimization tool is usually required to best analyze the complex trade-offs that occur when deciding to fund or not fund each proposed investment.

This article serves to examine and recommend solutions to three common problems faced by utility investment planners when analyzing and interpreting project portfolio results using an optimization tool. Specifically, we will explore in greater detail the issues of too many mandatory investments in the portfolio, reliability goals not achieved, and high risk investments not funded given budgetary constraints.

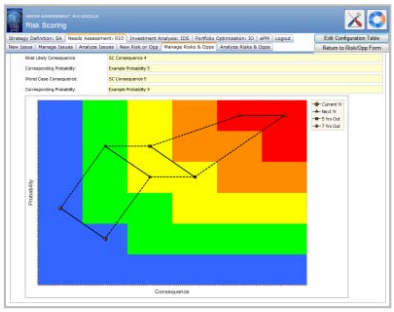
CONTEXT SETTING

Before tackling these issues, it is worthwhile to provide some context setting on our viewpoints. The analysis and recommended solutions within this article follow UMS Group's investment planning and optimization methodology as utilized by our Spend Optimization Suite (SOS) application. It is critical that we understand the risk and investment planning process in its entirety, as all four stages of the process contribute to the achievement of effective investment decision making results and how we specifically address these three identified optimization problems.

The first stage is setting company strategy. We use the Strategic Alignment (SA) module of the SOS to set the company strategy and relative priorities of strategy at two hierarchical levels: the Strategic Objective level, or top level of strategy, and the Success Criteria level, or sub level of criteria which comprise each overall Strategic Objective.

The strategy defined in this module filters through to all risk prioritization and investment optimization decisions made in subsequent steps of the process.

A detailed needs assessment phase, aligned with company strategy, should take place via a Risk Register and Analysis tool. Our Spend Optimization Suite uses the Risk Identification and Opportunities (RIO) module to capture, score, and prioritize business level risks and opportunities that can be mitigated or addressed via proposed investment solutions.



This concept is critical to understanding potential gaps in the proposed investment portfolio and how the gaps should be filled going forward, ensuring a linkage between risks and opportunities and planned solutions.

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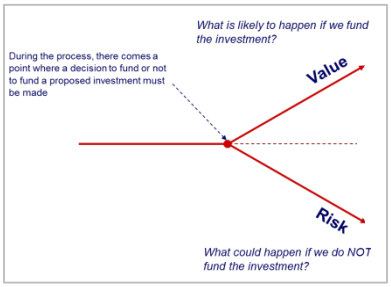
After the risk management/ needs assessment phase, proposed investment solutions and comprehensive investment scoring of each solution need to be captured. The Investment Definition and Scoring (IDS) module of the SOS application captures proposed investment information and scores investments across all success criteria elements of company strategy.

Our methodology scores investments across two different dimensions, value and risk of deferral. As each investment is analyzed during the investment planning process, there is a key decision to be made: fund the investment or defer the investment for one (or more) budget cycles.



By scoring each success criteria measure from the perspective of what will happen if the investment is funded, in other words the value generated by the investment, and what will happen if the investment is not funded, or rather, the risk of deferral of the investment, comprehensive 'what-if' scenario analysis of the investment portfolio can occur.

Investment Optimization, the fourth stage of process, is critical to analyzing the trade-offs of investment funding decisions.

UMS Group's SOS application utilizes the Investment Optimizer (IO) Module to perform these optimization functions.

A critical distinction between basic prioritization and optimization needs to be understood. Investment optimization focuses on selecting the optimum bundle of projects or programs that maximizes the strategic value or minimizes the risk exposure within one or more identified constraints. The most commonly applied constraints are budgetary ones, such as total budget, capital budget, O&M budget, etc., but may also include specific reliability and resource constraints, all of which could be applied at a system, regional or business unit level. Essentially, funded investments are fitted together like a puzzle within these set constraints to collectively maximize the total value of the portfolio. Traditional prioritization techniques simply rank investments based on value score or similar derivative, such as value per dollar. Following these ranking methodologies the selected projects are those with the highest value score above a particular budget cutoff line. This one-dimensional approach has built-in error and may not produce an optimal portfolio of investments when dealing with multiple constraints. This concept of optimization using multiple constraints becomes particularly important when trying to achieve both budget and reliability targets, as discussed later.

Optimization v. Prioritization

Project	Capital Cost	O&M Cost	Value	Total Spend Perspective		Individual Budget Perspective	
				Prioritized	Optimized	Prioritized	Optimized
1	$ 0.97	$ 0.03	3	Y	Y	Y	Y
2	$ 2.05	$ 5.95	3	Y	Y	Y	Y
3	$ 1.68	$ 1.32	1	Y	Y	Y	Y
4	$ 19.92	$ 8.08	9	Y	Y	Y	Y
5	$ 1.04	$ 37.96	7	Y	Y	Y	N
6	$ 7.69	$ 10.31	3	Y	Y	Y	Y
7	$ 9.48	$ 39.52	8	Y	Y	Y	Y
8	$ 27.22	$ 18.78	7	Y	Y	Y	Y
9	$ 24.20	$ 25.80	7	Y	Y	N	Y
10	$ 5.27	$ 44.73	7	Y	Y	N	N
11	$ 38.10	$ 0.90	5	Y	Y	N	Y
12	$ 34.03	$ 14.97	5	Y	Y	N	N
13	$ 54.77	$ 6.23	6	Y	N	N	Y
14	$ 5.94	$ 56.06	6	N	N	N	N
15	$ 22.83	$ 19.17	4	N	Y	N	N
16	$ 16.96	$ 57.04	7	N	Y	N	N
17	$ 17.43	$ 20.57	1	N	N	N	N
18	$ 13.61	$ 28.39	1	N	N	N	N
19	$ 4.02	$ 52.98	1	N	N	N	N
20	$ 6.77	$ 39.23	0	N	N	N	N
Totals:	$313.98	$488.02	91	71	76	41	52

THREE COMMON PROBLEMS

Now that the key methodologies of the underlying process have been explained, we can explore three commonly experienced problems that may occur during portfolio optimization.

Over the past fourteen years of working with our utility clients to optimize their investment portfolios, we have heard many of the same issues being raised. Namely:

1. We have so many mandatory investments that it is nearly impossible to focus on discretionary spend. How do we ensure that we are also funneling funds toward discretionary

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(continued) investments that help us to achieve our yearly goals?

2. We have to meet reliability targets, but each year we are falling short. How can we ensure that the portfolio of selected investments will help to achieve these targets?

3. We have so many high risk investments that many are not funded given our budgetary constraints. How do we ensure that we are not missing critical high risk investments?

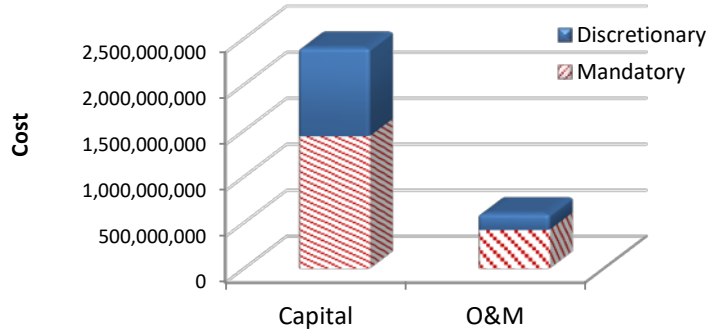
Whether you have these problems, or don't currently have enough information to know if these are problems, the information collected, manipulated, and outputted within an optimization tool, like our SOS application, should help to identify and solve these types of issues. Let's examine each one in more detail.

PROBLEM #1: TOO MUCH MANDATORY

The Need: To better understand the level and composition of 'true' mandatory investments within the total proposed portfolio and how they impact decision making.

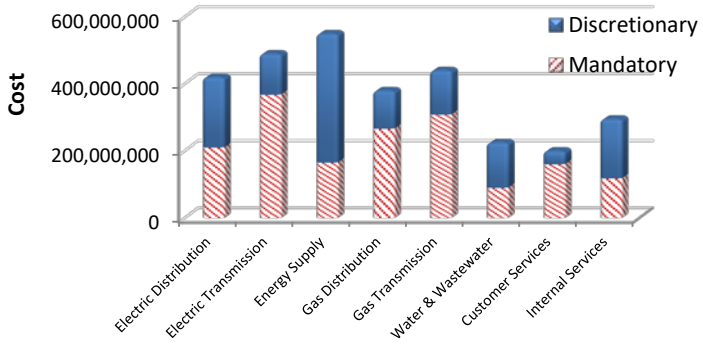
Recommended Analysis: 1. Analyze the percentage of your portfolio that has been designated mandatory. This will provide a better understanding of the "leftover" discretionary percentage, while also providing opportunities to reclassify mandatory investments, where necessary, and allocate the remaining discretionary funding to achieve improvements and meet company goals and objectives.

Fig. 1: Pre-optimization Charting Displaying Mandatory Amounts (Currency and Percentage) by (configurable) Cost Category



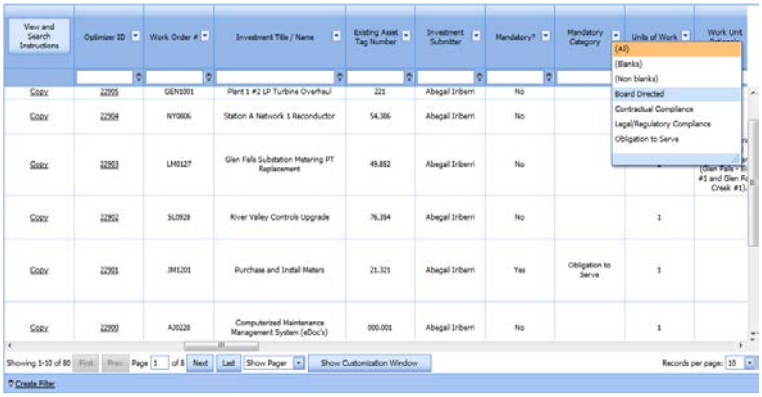
^ SOS Note: View (all web charts) in terms of cost (shown) or percentage, all years vs. individual years, and export charts to various formats.

Fig. 2: Pre-optimization Charting Displaying Mandatory Amounts (Count, Cost and Percentage) by each (configurable) Demographic Category



^ SOS Note: Select demographic category to show on chart from drop down, and view by count or cost (shown).

Fig. 3: Pre-optimization Reporting Displaying Some of the Filter Options for Analyzing Mandatory Amounts and Categorizations



^ SOS Note: Filter by drop down, type in, custom combination, grouping, and more.

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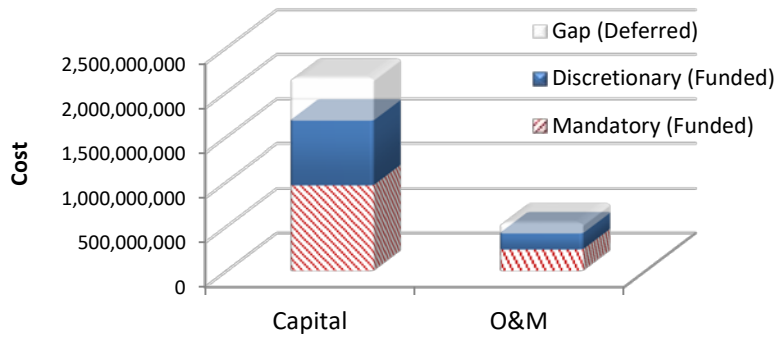
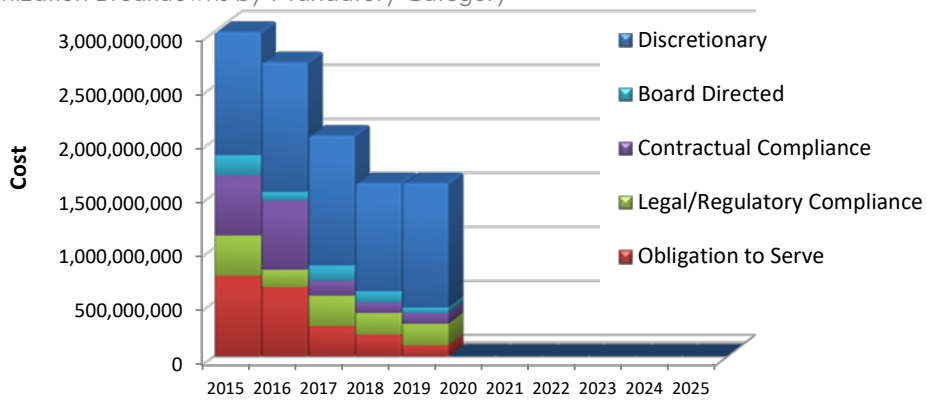
2. Compare optimization scenarios with varying levels of mandatory forced. For example, run and compare a scenario with all mandatory projects forced for funding vs. only certain mandatory categories forced vs. no mandatory categories forced, providing a view of comparative impacts on value achieved and risk mitigated. For example, if the politically driven category of mandatory projects is turned off (not forced), what additional value can be achieved? What additional risk can be mitigated?

Fig. 4: Post-optimization Breakdowns by Cost Category



^ SOS Note: View the breakdown by cost type in terms of what was funded and what was deferred, showing a quick view of the portion of funded investments that were mandatory.

Fig. 5: Post-optimization Breakdowns by Mandatory Category



^ SOS Note: View breakdown by mandatory category for each year included in the analysis, up to 10 years (5 year analysis shown here)

Fig. 6: Single Year Results Comparison: With and Without Mandatory Forced

					Scenario 1: **All** Mandatory Forced	Scenario 1: **No** Mandatory Forced
Project	Mandatory?	Cost (000)	Value	Risk of Deferral	Selected?	Selected?
Project 1	Yes	579,268	1.3	25	✓	✓
Project 2	Yes	1,073,721	2.1	25	✓	✓
Project 3	No	2,478,950	0.6	15	✗	✗
Project 4	Yes	2,186,751	0.5	25	✓	✗
Project 5	No	428,835	0.3	2	✗	✓
Project 6	No	312,660	4.8	4	✓	✓
Project 7	No	72,285	3.5	12	✓	✓
Project 8	Yes	1,950,000	1.4	8	✓	✗
Project 9	No	1,084,914	1.6	15	✗	✓
Project 10	Yes	601,271	2.5	20	✓	✓
Project 11	Yes	1,750,151	5.0	5	✓	✓
Project 12	No	613,530	3.1	12	✓	✓
Project 13	No	1,002,201	1.6	20	✗	✓
Project 14	No	547,000	2.7	20	✗	✓
Project 15	No	646,750	4.1	15	✓	✓
Project 16	No	229,469	3.6	0	✓	✓
Project 17	No	161,906	2.2	12	✓	✓
Project 18	No	183,290	1.9	5	✓	✓
Project 19	Yes	1,108,574	4.6	9	✓	✓
Project 20	No	282,000	1.4	0	✓	✓
			Total Value Achieved		**42.0**	**46.3**
			Total Risk Mitigated		**177**	**201**

< For a very simple, illustrative scenario (single year, 20 projects, no unitization), we see a value maximization run delivers higher value (as well as more risk mitigated) when analyzing the portfolio of scored investments without forcing mandatory. This can be also be a particularly interesting comparison when turning off individual mandatory categories, as opposed to all of them.

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Common Problem Found During Analysis: There is too much mandatory, leaving very little discretionary budget to make decisions, or even exceeding the budget constraints with the just the mandatory investments.

What You Can Do:

• Set stricter guidelines for mandatory projects by tightening definitions or limiting the mandatory designations. For example, 'Contractual Obligations', if left as an undefined mandatory category, could be broadly interpreted by many project planners. Applying strict definitions, such as 'a non-modifiable agreement has been entered with a supplier for the equipment / materials associated with the proposed investment for the upcoming budget cycle' could help to reduce the tagging of investments as mandatory, when in truth they are not.

• Ensure that anything marked as mandatory is truly mandatory in the selected budget year, as opposed to at some point in time in the future. What should be avoided is proposing and tagging an investment as mandatory in an upcoming budget year, when in reality the project is not mandatory for some years to come. This happens frequently with load type investments. In many cases, the increased capacity is not actually required for several years, but because it is both a capacity investment and it makes good business sense, from a financial perspective, to do the investment now, the investment is marked as mandatory. This type of investment should be justified, and potentially funded, based on its financial and operational merits, not via a 'forced' mechanism. This guideline should be enforced through training and/or review processes.

• Ensure that discretionary elements are not being lumped in with the mandatory component. We have seen many cases of 'mandatory investment bloating', where an entire investment is tagged as mandatory, but only a portion of that investment qualifies as mandatory. An example of this could be substation beautification around a new substation that is deemed mandatory due to obligation to serve requirements. The 'beautification' piece should be entered and scored as a separate discretionary investment.

• Require mandatory projects to be scored, allowing for these types of analyses and trade-off decisions when necessary. A large majority of mandatory investments still bring value to the company if funded and/or exhibit risks of deferral outside of regulatory or contractual mandates. In order to see the complete picture of value and risk of deferral associated with a portfolio of investments, it is key that mandatory investments are scored. In our experience, we have found that too many companies bypass the step of scoring mandatory investments. This limits the ability to fully examine trade-offs between discretionary and mandatory investments, prevents investment optimizers from overriding faulty mandatory designations, and prohibits the calculation of a total value achieved (or total risk of deferral) impact of the entire portfolio.

Expected Outcomes:

• Reduced mandatory amounts free up budget to achieve higher value and/or mitigate more risk within the same budget constraints.

• Investment Optimizers gain more control over the analysis process. They will be able to override any investments 'erroneously' designated as mandatory, demonstrate mandatory/ discretionary trade-offs to the board and regulators, often justifying the need for additional funding, and calculate total company value achieved/ risk of deferral impacts of the entire portfolio, not just the discretionary portion.

• "Pork" can be avoided, where pet projects are attached to work that is truly mandatory. Although related, non-mandatory work may be done with the mandatory work in the end, when it makes sense to do so to save on resources, cost, etc. However, this allows for a trade-off decision rather than automatic funding.

PROBLEM #2: RELIABILITY GOALS NOT ACHIEVED

The Need: To achieve yearly reliability goals (maintain and/or improve current system reliability) via selective investment funding.

Recommended Analysis: 1. Capture the expected improvement (if funded) and the probabilistic degradation (if

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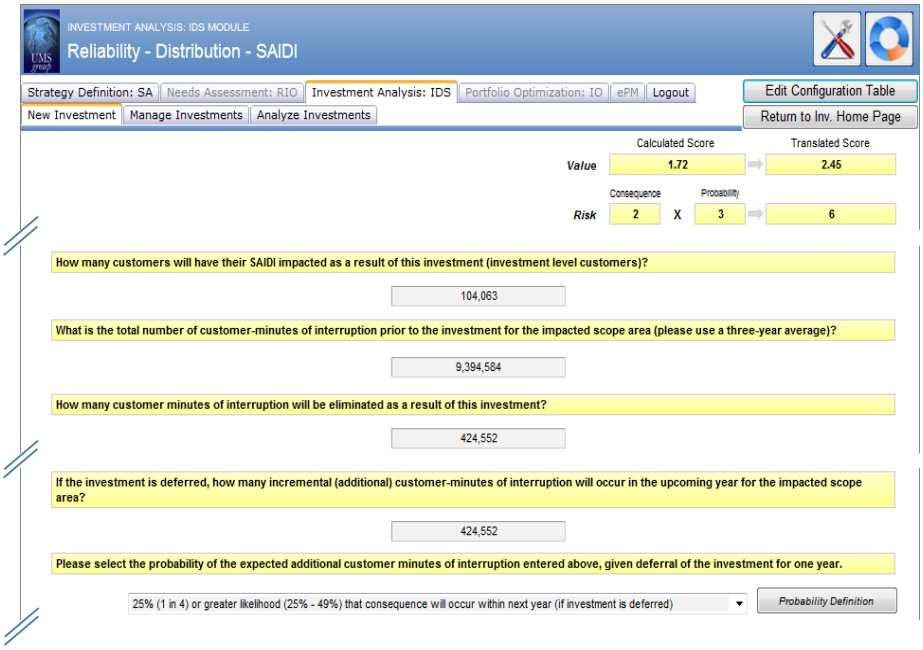
deferred) for each investment. This requires input of quantitative responses, often calculated based on historical performance. A key to quality inputs is the ability to track and access this historical reliability data, as well as model future performance degradation in the absence of any repair/replace funding.

Fig. 7: Calculation of Value and Risk of Deferral Reliability Impacts

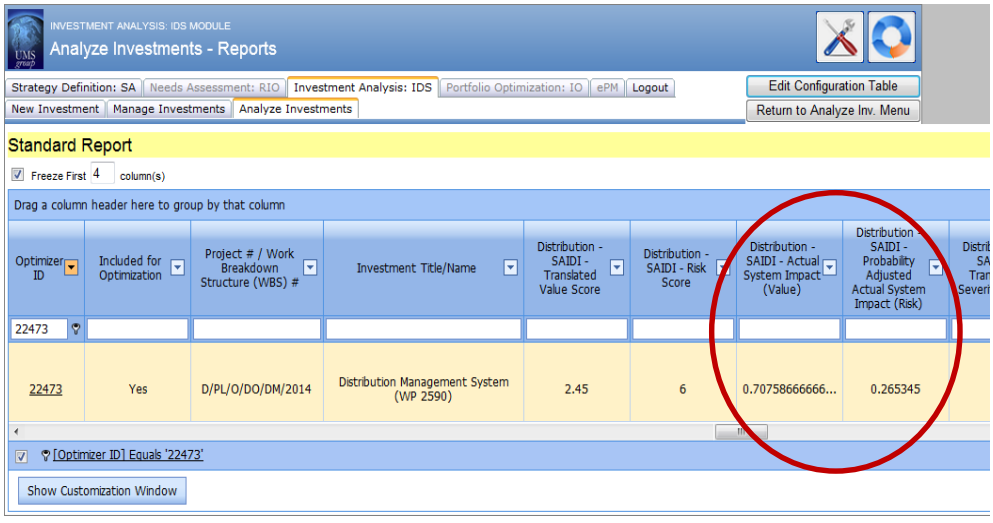


^ Core questions for calculating reliability scores (in this case, SAIDI), which can be further augmented with factors around worst performing circuits, regional gaps, etc.

< Success Criteria Scores:

- Calculated Value Score, compiling all scoring factors, any scale
- Translated Value Score, putting the calculated score on a common scale
- Consequence Score, calculated similarly to value and translated to a common integer scale
- Probability Score, based on a selection corresponding to a common integer scale
- Risk Score = Consequence x Probability

Fig. 8: Actual System Reliability Improvement Impacts (if investment is funded) and Actual Probability-Adjusted System Reliability Degradation Impacts (if investment is deferred)



< Actual system impacts displayed in reporting, based on scoring impacts and behind-the-scenes system values.

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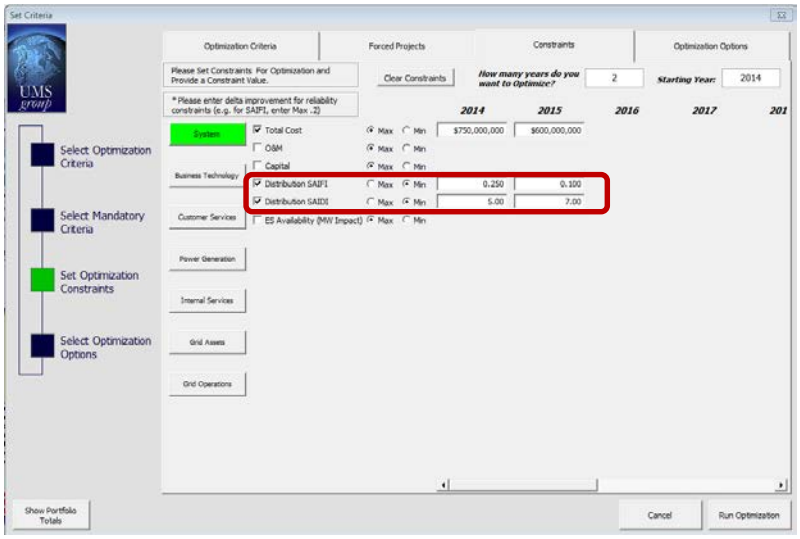
2. Run optimization scenarios with reliability constraints applied (often in addition to the standard budgetary constraints). We recommend using the calculated actual system impact values (per investment) to constrain a scenario based on total reliability impact. For any reliability measure where this data is collected, a constraint can be set as minimum target, whereby a minimum reliability improvement needs to be achieved via the investments selected. Conversely, if reliability is already at target, a maximum improvement can be set as a constraint, after which no more money will be spent on reliability improvements. By running these analyses, it quickly becomes evident if the desired improvement levels can be achieved via the selected mix of investments.

3. Analyze expected reliability performance over time, taking into the account the current reliability, degradation factor, and impacts of both funded and deferred reliability investments.

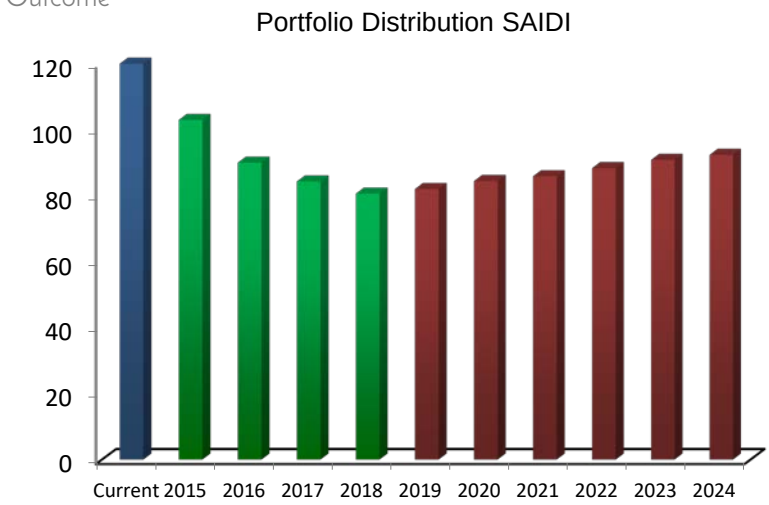
Common Problem Found During Analysis: The portfolio of proposed investments cannot meet the minimum improvement constraint, as not enough reliability projects have been submitted. This may happen after "lean" years, where there is not enough budget to fund reliability projects, or they get beat out by work designated as mandatory, and assumptions are made that the projects won't be funded if they're submitted. Likewise, by analyzing the portfolio results over time, a more troubling picture might arise. Overall System Reliability (e.g. SAIFI, SAIDI, etc.) might be degrading substantially over the next several years, given current system degradation factors and the lack of reliability-focused repair/replace investments included in the portfolio.

Fig. 9: Optimization Scenario Constraint Parameters (Configurable)



^ SOS Note: This picture shows an example of setting minimum reliability constraints across each year included in the scenario.

Fig. 10: Portfolio View of Reliability Index, Given 10-Year Scenario Outcome



^ SOS Note: The example chart shows an improvement for the first four years (green), and then degradation for the next six years (red). The current value and "do nothing" degradation value are entered/edited by the user.

What You Can Do:

- Go back to the engineers/planners and request

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• (continued) more reliability project submissions – the potential projects are "out there" and this type of request is typically happily obliged.

• Communicate to the investment planners / engineers that reliability performance is, in fact, a priority and that reliability improvement investments, even small ones, will no longer be pushed to the wayside.

• Reconsider the relative priority of the 'Reliability' or 'Operational' strategic objective. It may be that additional emphasis needs to be placed on the reliability objective to close performance gaps. By temporarily shifting weighting priority from other objectives to this objective, optimization results will provide more reliability-focused outcomes.

Expected Outcomes:

• Reliability targets should be more attainable. With both greater priority placed on the operational/reliability objective and planners focusing their efforts on creating and entering projects specifically geared toward system reliability improvements, there should no longer be an absence of reliability-focused investments.

• All the reliability information is now available to the human experts to make final investments decisions and clearly communicate the trade-offs. Despite the importance of system reliability in the utility world, we must caution shifting all focus to reliability ad infinitum. Be sure performance gaps are re-evaluated each year and alter and communicate priorities accordingly, based on that gap analysis.

PROBLEM #3: HIGH RISK INVESTMENTS NOT FUNDED

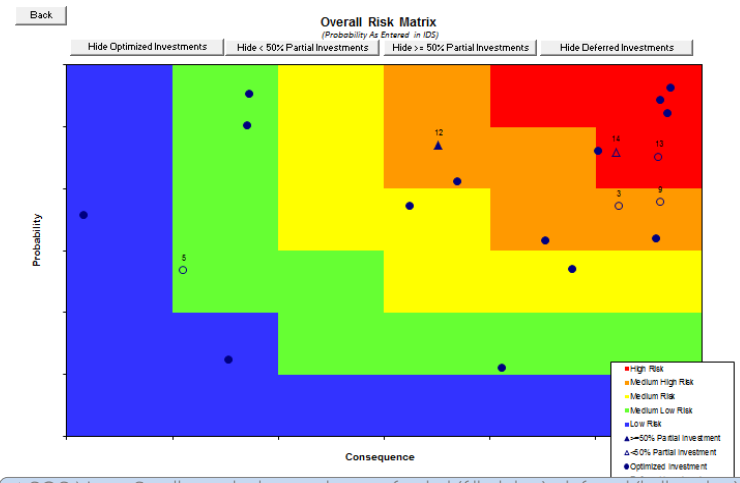
The Need: To see your profile of risk exposure and make sure it is maintained at an acceptable level.

Recommended Analysis: 1. Analyze the overall portfolio risk distribution on a scatter plot to understand the impact of funded and deferred investments.

Be sure to consider the risk profiles from an overall risk score perspective, generally the maximum risk score across all objectives, as well as from an individual objective perspective (e.g. 'Financial' risk matrix).

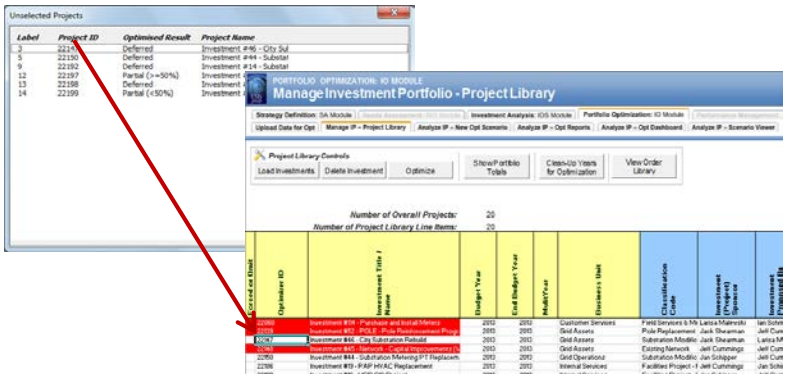
2. Trace back individual high risk deferred investments to investigate their risk evaluations and/or force them to be automatically selected in the next optimization scenario. In

Fig. 11: Optimization Results Distributed on the Risk of Deferral Matrix



^ SOS Note: Small sample dataset showing funded (filled dots), deferred (hollow dots) and partially funded (triangles) projects, according to each project's overall risk of deferral (consequence and probability).

Fig. 12: Easy tracing and manipulation of deferred investments in the IO (Investment Optimizer) Module



^ SOS Note: Clicking on a deferred project on the chart shows a list of all deferrals, allowing easy click-through back to the Project Library for analysis / modification.

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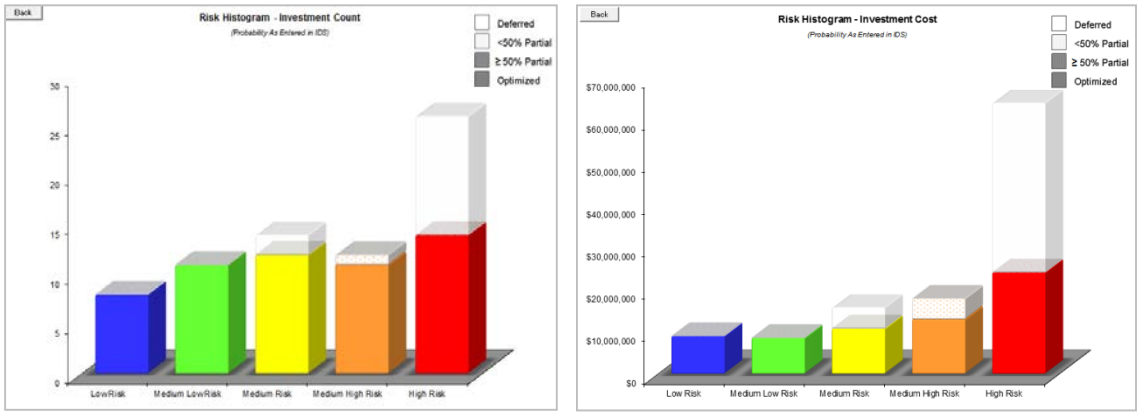
2. (continued) some cases, investments maybe have been erroneously categorized as 'high' risk and may require adjustment.

3. Analyze risk distribution histograms based on investment cost and count. Higher cost investments are often correlated with a higher risk of deferral due to the size and nature of the investment, so cost alone may not provide the full picture. If risk histograms for both investment count and investment cost skew toward high risk of deferral, this could indicate an aging asset infrastructure with the company up against an asset replacement wall. If this logic check does not ring true, then scoring may need to be adjusted and/or risk definitions tightened (e.g. what truly equates to a catastrophic risk event), as too many projects may be receiving a higher risk score than is warranted.

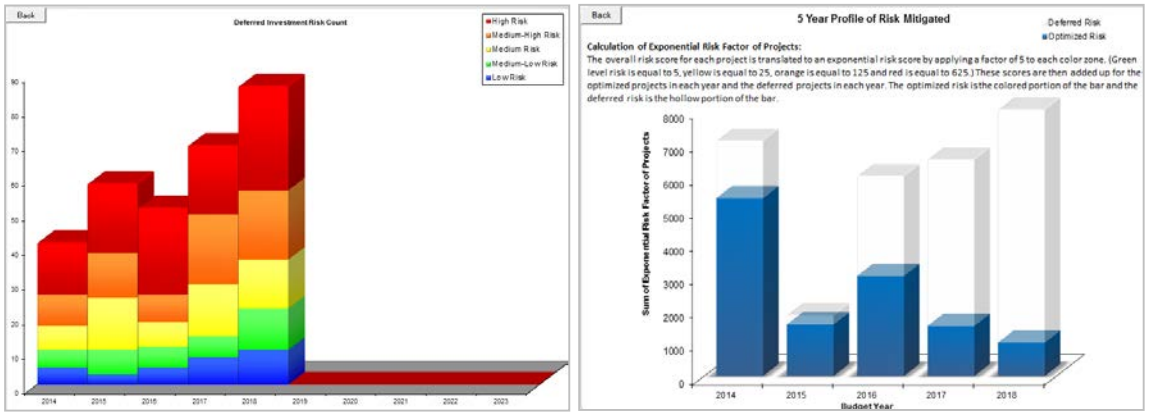
4. Analyze the risk profile from a multi-year perspective. It is helpful to understand the direction that risk is trending in future years. Are high risk projects continually being deferred? Is the total amount of

Fig. 13: Investment Cost and Count Risk Histograms



^ SOS Note: Each color represents a different risk level, with blue at the low risk of deferral end and red at the high risk of deferral end. The color portions indicate optimized (or funded) investments, whereas the clear or dotted portions indicate deferred or partially funded investments.

Fig. 14: Multi-Year Risk Analysis: Multi-Year Deferred Investment Count by Risk Level and Multi-Year Risk Mitigated (from a summed exponential risk score perspective)



^ SOS Note: The first chart indicates the amount and level of portfolio risk for deferred investments only over a 5-year optimization timeframe. The second chart indicates the total combined amount of risk mitigated (blue) and risk deferred (clear) over a 5-year period. This chart sums the exponential risk of deferral factors associated with each investment to determine the total summed risk profile.

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risk mitigated (from a summed exponential risk impact view) improving or degrading over time? These analyses will help to shed light on the total portfolio deferral risk horizon and help you determine if additional emphasis needs to be placed on investment risk of deferral mitigation, as opposed to just value creation.

Common Problem Found During Analysis: There were too many high risk investments deferred, and the remaining level of risk exposure is not acceptable.

What You Can Do:

• Review high risk projects to ensure scoring is consistent and accurately reflecting risk of deferral. In some cases this might require discussing the risk scoring of a particular investment with the project planner and potentially having them rescore those evaluation sections. At other times, this may be as simple as performing minor tweaks to the risk scoring weightings, scoring algorithms, and/or score translation/ distribution scales to create a more normal distribution of risk scores across the investments.

• Evaluate the trade-offs of optimization results based on both a value scenario (overall value score optimized) and a risk of deferral scenario (overall risk of deferral score optimized). In most cases, the answer falls somewhere in the middle of these two extremes, and discussions can be better focused on the truly difficult decisions, such as a high risk investment being funded in the risk optimization scenario, but not in the value optimization scenario. In this case, it is often beneficial to run a value optimization scenario with all high risk investments 'forced' through the analysis as mandatory. This ensures that the company is not knowingly exposed to potentially catastrophic situations.

• Increase or institute scoring training sessions, with particular focus on risk of deferral scoring. In general, the scoring should be designed to ensure that nothing catastrophic with a high probability of occurrence happens in the next budget cycle (or until the investment can be proposed and evaluated again). Often too wide of a view is taken during analysis where the scoring aligns with a severity and likelihood of occurrence at some point in the distant future. Training can help to build consistency in scoring and will most likely reduce the number of investments identified at as high risk.

• Similar to the recommended analysis of mandatory investment spend, you might want to investigate to see if any of the high risk investments have been 'padded' with additional non-high risk work. By stripping out these non-high risk tasks and evaluating them as separate investments, you might well have enough funds to cover all of the remaining, valid high risk investments.

• Investigate ways to mitigate high risk investments via lower cost solutions. Start by asking investment planners to present an alternative, lower cost investment option. For example, high financial risks might be able to be mitigated via much lower cost insurance options (where insurance companies are able to spread the risk across a much larger pool of companies/individuals). In some cases, investment planners may present a new option that only temporarily mitigates the risk. Although companies often shy away from this approach, it may be a 'necessary evil' during a heavily constrained budget year, and it will at least protect the company, employees, and public from any immediate harm.

• If you have determined that the investment risk scoring evaluations are accurate and investment alternatives have been exhausted, perform the recommended analyses and make your case for acquiring additional funding to cover the high risk investments and/or for (temporarily) deferring high value projects, that may have been selected first in other budget years.

Expected Outcomes:

• An investment funding plan is achieved with all unacceptable risks addressed. In doing so, changes to investment risk of deferral scoring, creation of alternative investment options, and/or identification of additional funding may be necessary to achieve the acceptable risk level. The graphical outputs created during investment optimization can be used to easily and clearly communicate the final portfolio risk profile results to company stakeholders.

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CONCLUSION

If you haven't run into these issues of too much mandatory, not being able to achieve reliability goals, or having too much risk exposure after setting the budget, looking into these areas and analyzing supporting data could be very valuable. If you struggle with acquiring/ accessing this data or do not have the necessary decision support tools in place to support this type of analysis, a portfolio evaluation and optimization tool might be a worthwhile investment. Such a tool could help collect this information on a common platform and provide the related analytics to really understand, as well communicate, what proposed investments provide at a portfolio level and any corresponding trade-offs. Ultimately, solving these types of problems propels you toward achieving your company strategy, making informed decisions efficiently, and communicating the supporting reasoning and impacts of those decisions effectively across your organization.

For more information on our viewpoints, case studies, etc. regarding investment portfolio optimization please contact us at: info@umsgroup.com

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