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Prime Value Method to Prioritize Risk Handing Strategies

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ABSTRACT

Funding for implementing risk handling strategies typically is allocated according to either the *risk-averse* approach *(*the worst risk first) or the *cost-effective* approach (the greatest risk reduction per implementation dollar first). This paper introduces a *prime value* approach in which risk handling strategies are prioritized according to how nearly they meet the goals of the organization that disburses funds for risk handling. The *prime value* approach factors in the importance of the project in which the risk has been identified, elements of both risk-averse and cost-effective approaches, and the time period in which the risk could happen. This paper also presents a *prioritizer* spreadsheet, which employs weighted criteria to calculate a relative rank for the handling strategy of each risk evaluated.

1.0 INTRODUCTION

Risk is an outcome of an event that might happen to the detriment of a program, project, or activity. It is described by the probability (P) that it will occur and the consequence or impact (C) of the occurrence (Risk = P X C). An essential contributor to a successful project is management of risk. Risk management is a process that enables one to look to the future, see what it may hold, and then return to take action in the present – when it can do the most good.

The most important outcome of risk management is the lessening of risk through successful implementation of risk handling strategies. Implementing risk handling strategies requires the expenditure of funds. As competition for funding is often fierce and seldom is there enough funds to go around, a disciplined method for allocating funds to handle risk is needed.

This paper introduces a *prime value* approach in which risk handling strategies are prioritized according how nearly they meet the goals of the organization that disburses the funds for risk handling. It presents a *prioritizer*, which calculates a relative rank for each risk handling strategy so that the organization that disburses funds for risk handling can identify which handling strategies to fund first.

Input for the prioritizer is derived from risk assessments, which identify and evaluate risks to a project or activity. The elements of risk management are described in Section 2.0.

2.0 RISK MANAGEMENT

Risk management comprises seven elements illustrated in Figure 1.

Figure 1 – Risk Management Process

2.1 Risk Assessment

Before the *prime value* approach to risk handling strategy prioritization can be applied, risks must be assessed. The risk assessment part of the risk management process includes the four elements bracketed in Figure 1.

2.1.1 Risk Identification

Risk Identification is an organized approach to foresee events that could affect the activity, and to identify the risks (and consequences) of those events.

2.1.2 Risk Evaluation

After the risks have been identified, they are evaluated based on the seriousness of their consequences (how bad) and the probability of occurrence (how likely), if they do occur. The degrees of seriousness of the consequences, described in Table 1, are defined in terms of the percentage of project's or activity's baseline budget represented by the consequence. The probabilities of the risks' occurring are described in Table 2.

Table 1 – Consequence Definitions

Consequence	Definition
Small	COST impact is less than 0.5% of baseline. For example: • < $500K in a $100MM baseline cost
Moderate	COST impact is between 0.5% and 2.0% of baseline. For example: • between $500K and $2MM in a $100MM baseline cost
Significant	COST impact is between 2.0% and 5.0% of baseline. For example: • between $2MM and $5MM in a $100MM baseline cost
Severe	COST impact is between 5.0% and 10.0% of baseline. For example: • between $5MM and $10MM in a $100MM baseline cost
Grave	COST impact is more than 10.0% of baseline.

Table 2 – Probability Definitions

Probability	Definition
Non-Credible	Estimated to have a probability of occurrence of ≤ 10^{-6} (or other non-credible probability defined for the activity)
Very Unlikely	Risk expected to happen only once during the life of the project, program, or activity Probability of single event occurrence < 15%.
Unlikely	Risk expected to happen once or twice during the life of the project, program, or activity Probability of single event occurrence 15% to 45%.
Likely	Risk expected to recur from 2 to 4 times during the life of the project, program, or activity Probability of single event occurrence 45% to 75%.
Very Likely	Risk expected to recur more than 4 times during the life of the project, program, or activity Probability of single event occurrence >75%.

When probabilities and consequences from Tables 1 and 2 are arrayed in the 4X5 matrix shown in Figure 2, the qualitative initial risk level can be determined. Note that the risk levels in Figure 2 are simply lettered from *A* (highest) to *G* (lowest). This offers seven qualitative risk levels instead of three. If only three risk levels are preferred levels A-C = *high*; D-E = *moderate*; and F-G = *low*. The consequence and probability of each risk place it in a particular level in the matrix.

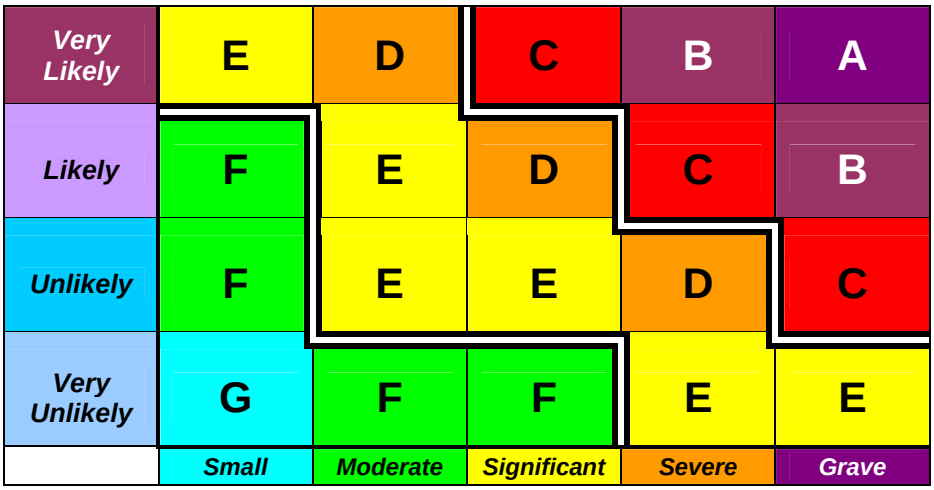

Figure 2 – Risk Level Matrix

2.1.3 Risk Handling

Risk handling strategies fall into one of the four groups shown in Figure 3.

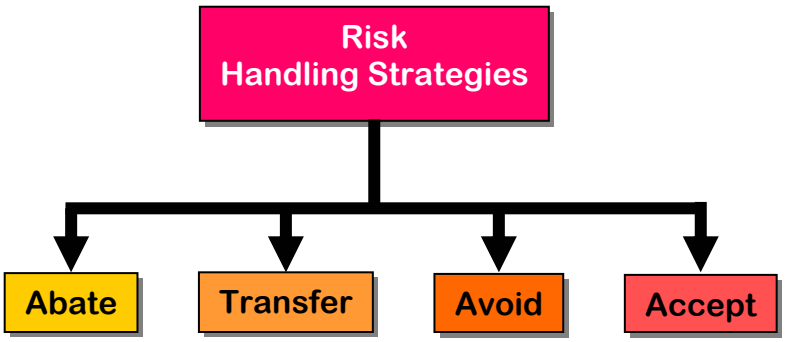

Figure 3 – Risk Handling Strategies

To **abate** a risk is to take action to *mitigate* (lessen the severity of) the risk's consequence, *reduce* the probability of the risk's happening, or both. After a risk is successfully abated, some risk remains, but at a lower risk level. The risk handling strategy to abate a risk usually has a cost. The risk that remains after the handling strategy is implemented is called the *residual risk*.

To **transfer** a risk is to shift the consequence of a risk and ownership of the response to another party. For example, a risk could be transferred to an outside group by purchasing insurance. Transferring risk usually has a cost (e.g. the cost of insurance). The

party to which a risk is transferred must accept the risk transfer. After a risk is successfully transferred, the risk level drops to zero. No residual risk remains.

To **avoid** a risk is to select an approach in which the risk cannot happen. This can be done by redesign, or selection of an alternative approach, which does not include the particular risk. Taking a new course of action to avoid a risk may carry with it additional cost. (The new course of action may have risks of its own, however.) After successfully avoiding a risk, the risk level drops to zero. No residual risk remains.

To **accept** a risk is to decide to take no action to deal with it. Either the risk is not worth addressing, or there is no suitable handling strategy. This strategy is selected when it is more cost effective to continue the activity as planned than to commit resources to handle the risk. The cost and duration to implement this handling strategy is zero.

2.1.4 Risk Impact Determination

Risk impact determination postulates the effect of residual risks (i.e. after successful implementation of the risk handling strategies) on cost and schedule. The outcome is a residual consequence and a residual probability, which determine the residual risk level.

2.1.5 Risk Handling Implementation

When the risk handling strategy is to abate or avoid the risk, the cost of implementing the risk handling strategy must be estimated -- even if the cost is "included in the baseline budget", the amount must be identified.

3.0 RISK HANDLING GOALS AND CRITERIA

After the risk handling strategies, their costs, and their effects have been determined as described in Section 2.0, this information is used as input to the risk handling strategy prioritizer.

The first step in applying the *prime value* approach to prioritize risk handling strategies is to determine the goals of the risk management process. Four goals quickly become apparent:

1. The most important projects should have preferential handling of their risks
2. Risks that could happen soon should be handled first
3. The risks with greater impact should be addressed before less consequential risks
4. The strategies that produce the greatest risk reduction per dollar should have priority

The above goals suggest these criteria:

- **Project importance** -- *More important projects receive funding for risk handling strategies in preference to projects of lesser importance.*

  The application of this criterion depends on the perceptions of the organization that disburses funds for risk handling. Just as "beauty in things exists merely in the mind

which contemplates them"[1], the organization that disburses funds for risk handling must decide on the importance of each program, based on national priorities, Department objectives, perceptions, interfaces with other programs, and the *realpolitik* of the situation.

The perceived importance of projects is categorized as

√ typically important
√ highly important
√ extremely important

Extremely important programs would be those with *visibility*. For example, projects in the Department of Energy with *visibility* are defined as those within the awareness of DOE or department executive management, site executive management, Federal or state regulators, or certain stakeholder groups.

- **Timing --** *Risks that could happen in the near-term are handled before risks that could happen later*.

  The timing of the risks' happening is characterized as:

  √ Near-term (could happen in less than a year)
  √ Intermediate-term (could happen in 1 to 3 years)
  √ Far-term (could happen later than 3 years)

- **Initial risk level --** *Risks with higher initial risk levels are handled before risks with less impact.*

  Initial risk level determined as described in Section 2.1.2. As indicated in Table 1, the dollar value assigned to the consequence alone does not indicate the full effect of a risk. The *prime value* initial worst case consequence is regarded in the context of the baseline budget for the project (e.g. the effect of a $1 million risk on a $10 million project is proportionately greater than the effect of $1 million risk on a $50 million project). This criterion captures the *risk-averse* approach to risk management.

- **Risk level reduction per dollar --** *Strategies that achieve the greatest reduction of risk per dollar of funding for handling strategy implementation are preferred.*

  This criterion captures the *cost-effective* approach to risk management.

[1] David Hume's Essays, Moral and Political, 1742.

4.0 PRIORITIZER INPUTS

Because the criteria in Section 3.0 cover four different facets of risk management, the organization that disburses funds for risk handling must weight the criteria. The *prioritizer*, which accompanies this paper, employs the Kepner-Tregoe method for weighting. The *prioritizer's* data input fields for weighting criteria appear in Figure 4.

The organization that disburses funds for risk handling enters a number from 1 (least important) to 5 (most important), which reflects the importance of the criterion, in the *Raw weight* column. The *prioritizer* normalizes the raw weights to establish the criteria weights, which appear in the output column, *Normalized weight*. If the organization doing the rating chooses not to use one or more criteria, the raw weight input cell can be left blank.

Criteria weighting		
Criterion	Raw weight (1-5)	Normalized weight
Project importance		
Timing		
Initial risk level		
Risk level decrease/$		

Figure 4 -- Data Input Fields for Weighting Criteria

Each project owner (usually the Project Manager) will have completed a risk assessment, as described earlier. The results of the assessment supply information about the particular project's risks as shown in Figure 5. The project owner will provide:

- Risk name and number
- Project initial risk level (high, moderate, low)
- Risk timing (near-term, intermediate term, far-term)
- Baseline project budget (K$)
- Initial worst case consequence (K$)
- Initial probability (very unlikely, unlikely, likely, very likely)
- Risk handling strategy implementation cost (K$)
- Residual worst case consequence (K$)
- Residual probability (very unlikely, unlikely, likely, very likely)

The organization that disburses funds for risk handling arranges all the risks on a single *prioritizer* spreadsheet, weights the criteria, and assesses the importance of each project. The *prioritizer* ranks the inputs, applies the weight for each criterion and combines the results to yield an overall relative rank (the *Prime Value* Rank) for each of the risk handling strategies.

Note that even if the cost of the RHS is "included in the baseline budget", it still is a cost and must be quantified and included.

Risk name and number	Project initial risk level (h,m,l)	Relative *Prime Value* Rank	Relative initial risk level	Project impor-tance (t, h, x)	Risk timing (n, i, f)	Baseline project budget (K$)	Initial worst case conse-quence (K$)	Initial probability (vu, u, l, vl) or a decimal	RHS implementa-tion cost (K$)	Residual worst case conse-quence (K$)	Residual probability (vu, u, l, vl) or a deci-mal

In these input fields, the evaluator can use a letter designator for the probability (vu, u, l, vl) or a decimal between 0 and 1, which repre-sents the probability (e.g. .25)

Input fields: Supplied by project owner (pink)
Added by the organization that disburses funds for risk handling (light green)

Output fields: Calculated by prioritizer (orange and gold)

Key for *project importance*		Key for *probability*			Key for *risk timing*		
t =	typically important	vu =	very unlikely	< 15% chance	n =	near-term	<1 year
h =	highly important	u =	unlikely	15% to 45% chance	l =	intermediate-term	1 to 3 years
x =	extremely important	l =	likely	45% to 75% chance	f =	far-term	> 3 years
		vl =	very likely	> 75% chance			

Figure 5 – *Prioritizer* Input and Output Fields

5.0 HOW THE PRIORITIZER WORKS

The *prioritizer* makes four calculations to synthesize the *Prime Value* Rank. The number returned in the Relative *Prime Value* Rank column is a normalized value for each risk handling strategy, compared to all the other strategies: the larger the number, the better the strategy meets the goals of the organization that disburses funds for risk handling.

The calculations are done in hidden cells of an Excel spreadsheet, which is the *prioritizer's* framework. The spreadsheet illustrated in Figures 5 and 7 has only the input and output cells. Although values may appear in the *Prime Value* Rank column before all the input fields are filled, these numbers do not reflect the rank until all inputs are made.

The *prioritizer* converts the qualitative importance to a value representing the raw project importance:

t = typically important	= 0.25
h = highly important	= 0.50
x = extremely important	= 0.75

The *prioritizer* normalizes the raw importance scores for all the risks. Each normalized score is multiplied by the importance criterion weight. The result is the **importance score*** for the risk.

The *prioritizer* converts the qualitative risk timing to a value representing the raw risk timing:

n = near-term (<1 year)	= 0.25
I = intermediate-term (1 to 3 years)	= 0.50
f = far-term (> 3 years)	= 0.75

The *prioritizer* normalizes the raw risk timing scores for all the risks. Each normalized score is multiplied by the risk timing criterion weight. The result is the **risk timing score*** for the risk.

The *prioritizer* converts the qualitative initial probability to a value representing initial probability:

vu = very unlikely (< 15% chance)		= 0.075
u = unlikely	15% to 45% chance	= 0.3
l = likely	45% to 75% chance	= 0.6
vl = very likely	> 75% chance	= 0.875

The *prioritizer* calculates the initial consequence value by dividing the project baseline budget by the worst case consequence

The *prioritizer* calculates the raw initial risk level by multiplying the initial consequence by the initial probability. The *prioritizer* normalizes the raw initial risk scores for all the risks. Each normalized score is multiplied by the worse-case-risk criterion weight. The result is the **worst case risk score*** for the risk.

Residual risk is the risk that remains after the risk handling strategy has been implemented. The *prioritizer* calculates the residual risk the same way it calculates the initial risk. It multiplies the residual consequence by the residual probability. The *prioritizer* subtracts the residual risk from the initial risk to determine the decrease in risk caused by implementing the risk handling strategy. The *prioritizer* divides the decrease in risk by the cost of the risk handling strategy and normalizes the quotients. Each normalized score is multiplied by the risk-level-decrease-per-dollar criterion weight. The result is the **risk level decrease per dollar score*** for the risk.

The *prioritizer* sums the **importance score, timing score, worst case risk score, risk level decrease per dollar score.** The sum is displayed in the spreadsheet column headed *Prime Value* Rank. To highlight the best values the *prioritizer* colors the rank of top 15% of the risks to handle bright blue, the middle 50% medium blue, and the bottom 35% of the risks to handle light blue.

The *prioritizer* performs one other function: it calculates the overall relative initial risk level for all the risks by comparing the relative consequence and probability among all the risks entered. This output appears in the column headed *Relative initial risk level*. The relative initial risk level enables the organization that disburses funds for risk handling to identify the worst overall risks. The rank of top 33% are colored red, the middle 33% are colored yellow, and the lowest 33% are colored green.

Figures 6 and 7 illustrate an example of the prioritizer at work. In the example weighting table (Figure 6) the organization that disburses funds for risk handling assigned a weight to each criterion (column headed *Raw weight*). The prioritizer normalized the weights and recorded them in the column headed *Normalized weight*. The organization that disburses funds for risk handling assigned an importance to each project (column headed "project importance" in Figure 7).

Input from the project owners was added to the other input columns in Figure 7. The prioritizer calculated the relative rank of the handling strategies in the column headed Relative *Prime Value* Rank. In the example according to the weights selected, the handling strategy for Project E risk A has the highest relative rank, so it should be the first one funded. Conversely, the handling strategy for Project B risk C has the lowest relative rank. It should be the last one funded.

Although the example in Figure 7 shows eleven risks for five projects, the *prioritizer* can accommodate a much larger number of project and risks.

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* These calculations do not appear in the input/output spreadsheet

Criteria weighting		
Criterion	Raw weight (1-5)	Normalized weight
Project importance	2	0.167
Timing	3	0.250
Initial risk level	2	0.167
Risk level decrease/$	5	0.417

Figure 6 – Example Criteria Weighting

Worst value risk handling strategy

Risk name and number	Project initial risk level (h,m,l)	Relative *Prime Value* Rank	Relative initial risk level	Project impor-tance (t, h, x)	Risk timing (n, i, f)	Baseline project budget (K$)	Initial worst case conse-quence (K$)	Initial probabil-ity (vu, u, l, vl) or a decimal	RHS imple-mentation cost (K$)	Residual worst case conse-quence (K$)	Residual probabil-ity (vu, u, l, vl) or a decimal
Project A risk A	h	0.066	0.018	x	n	2000	0.5	vl	3	1	u
Project A risk B	h	0.078	0.012	x	n	2000	0.5	l	0.25	0.75	u
Project A risk C	h	0.070	0.012	t	i	3000	0.5	l	0.25	0.2	u
Project B risk A	h	0.086	0.036	x	i	5000	1	vl	0.5	0.3	u
Project B risk B	h	0.100	0.025	h	f	1000	2	u	1	0.5	u
Project B risk C	h	0.047	0.012	t	f	2000	0.5	l	0.6	0.1	l
Project C risk A	h	0.059	0.012	t	f	2000	1	u	0.3	0.2	l
Project C risk B	h	0.115	0.073	t	i	3000	2	vl	1	0.3	u
Project D risk A	h	0.075	0.025	x	n	3000	1	l	1.5	0.3	u
Project E risk A	h	**0.172**	0.250	x	f	4000	10	l	2	0.5	u
Project E risk B	h	**0.129**	0.125	x	n	5000	5	l	1.2	1	u

Figure 7 – Example Risk Handling Strategy Ranking

Best value risk handling strategy

6.0 BENEFITS OF THE *PRIME VALUE* METHOD TO PRIORITIZE RISK HANDLING STRATEGIES

The *prime value* method, as applied by the *prioritizer*, has three advantages:

1. Risks and their handling strategies from many projects can be considered together according to a common basis. When risk consequences are determined by the percentage impact on the baseline of the projects or activities and the same ranges of probabilities are used, the subsequent risk levels become comparable across the enterprise.

2. Prioritization is multi-dimensional; the four most important elements (project importance, risk timing, initial risk level, and risk reduction per dollar) are taken into account at the same time.

3. The criteria for evaluating the risk handling strategies are weighted. The weights can be adjusted according the inclinations of the organization that disburses funds for risk handling.

The disciplined *prime value* process employs credible evaluation methods to provide:
- Structure to approach complex risk handling programs
- Rationale for decisions
- Consistency in the prioritization process
- Objectivity
- Documented criteria, and values used to prioritize risk handling strategies
- Decisions that are repeatable, reviewable, and revisable

BIOGRAPHY

David Noller has over 40 years experience in industry. He has worked as a Systems Engineer for 12 of his 17 years at the Savannah River Site. Before joining Washington Savannah River Company (the maintenance and operations [M&O] contractor at the Savannah River Site), he held various positions in the chemical process industry.

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