P3-Value: Risk Assessment Tool User Manual

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Innovative Program Delivery

U.S. Department of Transportation
Federal Highway Administration

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1 Overview

The Federal Highway Administration's (FHWA) Office of Innovative Program Delivery (OIPD) is producing a P3 Toolkit comprising tools and guidance documents to assist in educating public sector policymakers, legislative and executive staff and transportation professionals. The P3 Toolkit forms the base of a broader P3 capacity-building program which includes a curriculum of P3 courses and webinars. The P3 Toolkit will address Federal requirements related to P3s and four key phases in P3 implementation: (1) Legislation and Policy; (2) Planning and Evaluation; (3) Procurement; and (4) Monitoring and Oversight.

The target audiences for the P3 Toolkit resources are decisionmakers and technical staff in public sector agencies such as:

- State Executive and Legislative Offices;
- State Departments of Transportation (DOT);
- Metropolitan Planning Organizations (MPOs);
- Regional Planning Agencies;
- Tolling Authorities;
- Local jurisdictions; and
- FHWA Division Offices.

Purpose of P3-VALUE

P3-VALUE (Public-Private Partnership Value-for-Money Analysis for Learning and Understanding Evaluation) is a key component of FHWA's P3 Toolkit. It is a suite of educational tools that introduces users to public-private partnerships (P3s) and the methods used in P3 evaluation, discusses limitations, and explains how public agencies may evaluate different procurement options for a particular project. P3-VALUE can help users understand the processes and considerations that go into a rigorous quantitative analysis of P3 procurement options for transportation projects. P3-VALUE is based on the experience of the U.S. P3 market and therefore reflects the terminology and methodology practiced in the United States. The focus of FHWA's Office of Innovative Program Delivery and its P3-VALUE tools is on long-term P3 contracts that involve designing, operating, constructing, operating and maintaining new highway facilities, also known as greenfield projects.

P3-VALUE is based in Microsoft Excel, and is supported by primers, user guides and other guidebooks, some of which are under development. Practitioners can use P3-VALUE to better understand the concepts, inputs, assumptions and outputs from evaluations of risk, financial feasibility and "value for money" analyses, which are used to evaluate the potential of P3s to

generate value in comparison with conventional methods of project delivery. Users are cautioned that P3-VALUE has been designed for educational purposes only and is not intended to guide decisions on actual projects. The complexity of the analyses for specific projects requires that they be performed by experts using more detailed modeling; however, P3-VALUE provides hands-on instruction in how such detailed modeling analyses are conducted and can help government officials understand the importance of the inputs and assumptions used by modeling experts and the extent to which key assumptions can affect the analysis results.

Structure of P3-VALUE

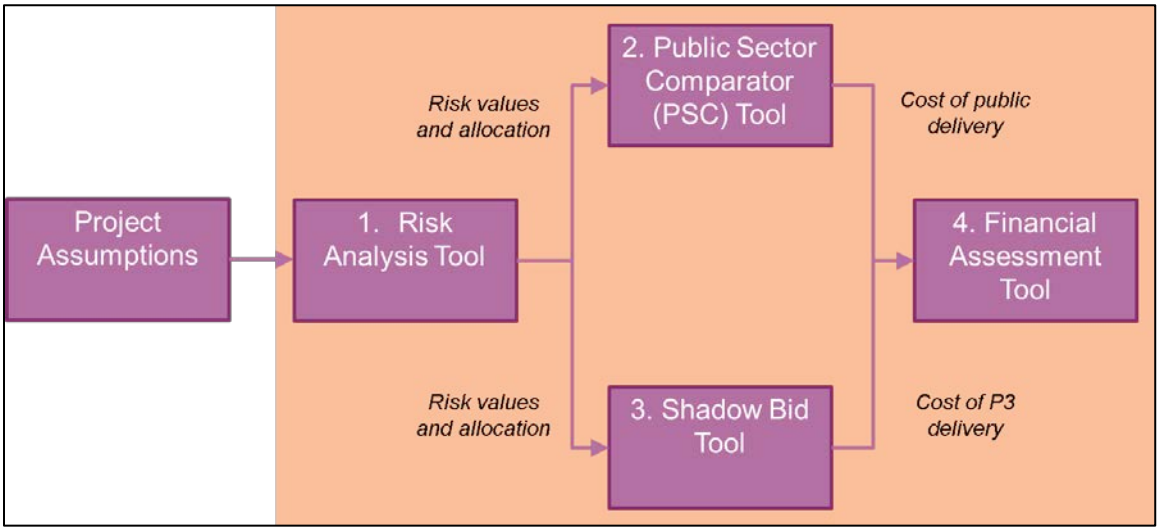
Under a public-private partnership (P3) for a highway project, a private partner may participate in some combination of design, construction, financing, operations and maintenance, including collection of toll revenues. Value for Money (VfM) analysis is a process used to compare the financial impacts of a P3 project against those for the traditional public delivery alternative. The methodology for carrying out a VfM analysis that is incorporated in P3-VALUE involves:

- Creating a Public Sector Comparator which estimates the risk-adjusted whole-life cost of carrying out the project through a traditional approach;
- Estimating the risk-adjusted whole-life cost of the P3 alternative (either as proposed by a private bidder, or a hypothetical "shadow bid" at the pre-procurement stage); and
- Completing an "apples-to-apples" comparison of the present values of costs under the two approaches.

As depicted in Figure 1, P3-VALUE is comprised of four interactive, integrated spreadsheet-based analytical tools that allow users to explore different components of Value for Money Analysis (VfM) including:

- ***Risk Assessment Tool*** – This tool allows users to document project risks and risk management strategies and to estimate the costs of risks under different procurement structures.
- ***Public Sector Comparator (PSC) Tool*** – This tool allows users to calculate the risk-adjusted costs for a project that is designed, financed, constructed, maintained and operated under a traditional public sector delivery model.
- ***Shadow Bid Tool*** – This tool allows users to calculate the costs of payments to a private partner for delivering a project as a P3 concession.
- ***Financial Assessment Tool*** – This tool allows users to compare the PSC and Shadow Bid costs for procuring a project and to assess the financial subsidies required using different procurement methods.

Figure 1: P3-VALUE Overview



Accompanying Evaluation Resources

P3-VALUE is supported by several other tools and guides, including:

- An *Orientation Guide* that summarizes the issues and factors that are evaluated when considering a P3 as a financing and procurement mechanism;
- Three Primers, one each on *Risk Assessment* (reference for Risk Assessment Tool), *Value for Money Analysis* (reference for Public Sector Comparator and Shadow Bid tools) and *Financial Structuring and Assessment* (reference for Financial Assessment Tool);
- *User guides* for each analytical tool in the P3-VALUE suite that explain how to use the tools;
- *Frequently Asked Questions* and a *Troubleshooting Guide* that provide technical advice in support of the P3-VALUE tools;
- *Evaluation Guidebooks* (under development) for practitioners seeking a deeper understanding of evaluation processes and data sources as well as the concepts, assumptions, inputs and outputs involved in the above analyses; and
- *P3-SCREEN,* an Excel-based project screening tool along with a supporting user guide to assist practitioners seeking to perform a preliminary screening evaluation of the suitability of a P3 for high-cost highway projects.

P3-VALUE and its accompanying evaluation resources serve as a reference for decisionmakers and practitioners seeking to understand P3s as a financing alternative for major capital projects. Practitioners can use P3-VALUE and its accompanying resources to familiarize themselves with the process of evaluating procurement decisions, the data required to conduct quantitative assessments

of procurement options and the impact that various assumptions can have on the desirability and feasibility of different procurement structures.

Risk Assessment Tool

This User Manual, the *Risk Assessment Tool User Manual* (User Manual) dated April 19, 2013, corresponds to version 1.0 of the FHWA *Risk Assessment Tool* (Risk Tool) and both are part of FHWA's P3-VALUE tool suite. FHWA designed the Risk Tool and User Manual as educational materials to demonstrate how a DOT might identify, assess, allocate, and mitigate project risks when considering a project for P3 procurement. Although the Risk Tool is interactive, FHWA does *not* intend for the users to conduct a risk assessment for a real-world project using the tool. FHWA expects that appropriate experts will perform such analyses for a project sponsor. Actual requirements will vary for each project and project data assumptions necessary to conduct a risk assessment process must reflect a specific project.

The basic concepts involved in risk assessment are provided in FHWA's *Primer on Risk Assessment for Public-Private Partnerships (Primer)*, which is accessible at www.fhwa.dot.gov/ipd/p3/toolkit/guidance_documents/risk_assessment/toc.htm. The *Risk Assessment & Allocation for Public-Private Partnerships Guidebook*, which is currently under development, will build upon the Primer to provide an advanced understanding of the practical applications and challenges of assessing project life cycle risks associated with P3 projects.

System Requirements

The P3-VALUE tools are Microsoft Excel spreadsheets that are best viewed in Microsoft Excel 2007 or later editions. Users may not be able to access the tools when using an earlier version of Excel or when using a different operating system, such as Macintosh.

2 Quick-Start Guide

While the User Manual provides detailed guidance on the Risk Assessment Tool, users may also refer to the "Quick-Start" version below for step-by-step instructions.

ACCESSING THE RISK ASSESSMENT TOOL

1. OPEN THE RISK TOOL.
   Note: Minimum system requirements for using the tool include Windows and Excel 2007 or newer.
2. CLICK "ENABLE EDITING" AND/OR "ENABLE CONTENT" ON YELLOW BAR ACROSS TOP OF SCREEN.
3. READ THE DISCLAIMER AND INSTRUCTIONS.
4. CLICK "I ACCEPT."

MANAGING THE INPUT FIELDS

1. NAVIGATE TO THE "MODEL ASSUMPTIONS" TAB.
   This sheet contains project data that provides the basis for determining the values in the quantitative risk assessment.
   INPUT ASSUMPTIONS IN THE LIGHT-BLUE CELLS.
   a. Input estimated costs (in dollars) for construction, operation, maintenance and delays.
      Note: Only the assumptions regarding delay costs affect the outputs.
   b. Input estimated length (in months) of each phase.
   c. Input estimated toll rate and revenue losses (in dollars) and traffic volume.

2. NAVIGATE TO THE "RISK REGISTER" TAB.
   The outcomes from each stage of the risk assessment process are captured here.
   INPUT DATA IN THE LIGHT-BLUE CELLS.
   Note: Users should complete the risk register at least once from the public sector perspective and save a version of the tool. To obtain risk values from the private sector perspective, users can either repeat the process from the private sector's perspective, or make a general assumption, such as "all risk values are 15 percent lower from the private perspective."

   a. Complete the "Risk Identification" section.
      i. Enter the risk number.
      ii. Select the risk category from the drop-down menu.
      Note: See the "Definitions" tab for descriptions of the available risk categories.
      iii. Select the impact phase from the drop-down menu.
      Note: If a risk event has the potential to impact multiple project phases, users must enter that risk for each phase separately.
      iv. Select the risk type (opportunity or threat) from the drop-down menu.

v. Input a description of the risk.
vi. Input a description of potential consequences of the risk occurring.

b. Complete the "Qualitative Risk Assessment" section.
Note: See the "Risk Assessment Matrix" tab for guidance in determining probabilities and consequences for this section.
i. Select the probability rating from 1 (very low) to 5 (very high) from the drop-down menu.
ii. Select the cost consequence of the risk occurring from 1 (not severe) to 5 (severe) from the drop-down menu.
iii. Select the schedule consequence of the risk occurring from 1 (not severe) to 5 (severe) from the drop-down menu.

c. Complete the "Quantitative Risk Assessment" section.
Note: Risk quantification is only necessary for those risks with "medium," "high," or "very high" risk ratings from step b) above.
i. Input the probability of the risk occurring as a percentage (0% - 100%).
ii. Select the appropriate probability distribution (triangular or uniform) for the risk's schedule impact from the drop-down menu.
Note: See the "Definitions" tab for an explanation of the distributions.
iii. Input minimum and maximum schedule impacts (in days) for uniform distribution, or minimum, most likely, and maximum schedule impacts for triangular distribution.
iv. Select the appropriate probability distribution (triangular or uniform) for the risk's cost impact from the drop-down menu.
Note: See the "Definitions" tab for an explanation of the distributions.
v. Input minimum and maximum cost impacts (in real dollars) for uniform distribution, or minimum, most likely, and maximum cost impacts for triangular distribution.

d. Complete the "Allocation & Mitigation" section.
i. Input the allocation of risk between the public and private sectors as a percentage (0% - 100%). The sum of those two cells must equal 100 percent for each risk.
ii. Input potential mitigation strategies for addressing each risk.
Note: The proposed mitigation strategies do not factor into the outputs.

OUTPUTS

1. NAVIGATE TO THE "COST IMPACT OUTPUTS" TAB.
2. ENTER A VALUE FROM 300 – 1,000 FOR THE NUMBER OF ITERATIONS, CLICK "RUN SIMULATION."
3. REVIEW THE COST IMPACTS.

This sheet displays the total cost impacts generated from the risk assessment process. Note the risk impacts at various percentiles, across project phases, and the cumulative allocation between public and private.

4. NAVIGATE TO THE "COST RISK SENSITIVITY" TAB.
   This sheet displays the 10 most significant risks, ranked from greatest to least cost impacts.
5. NAVIGATE TO THE "SCHEDULE IMPACT OUTPUT" TAB.
   This sheet displays the total schedule impacts generated from the risk assessment process. Note the risk impacts at various percentiles, across project phases, and the cumulative allocation between public and private.
6. NAVIGATE TO THE "SCHEDULE RISK SENSITIVITY" TAB.
   This sheet displays the 10 most significant risks, ranked from greatest to least schedule impacts.

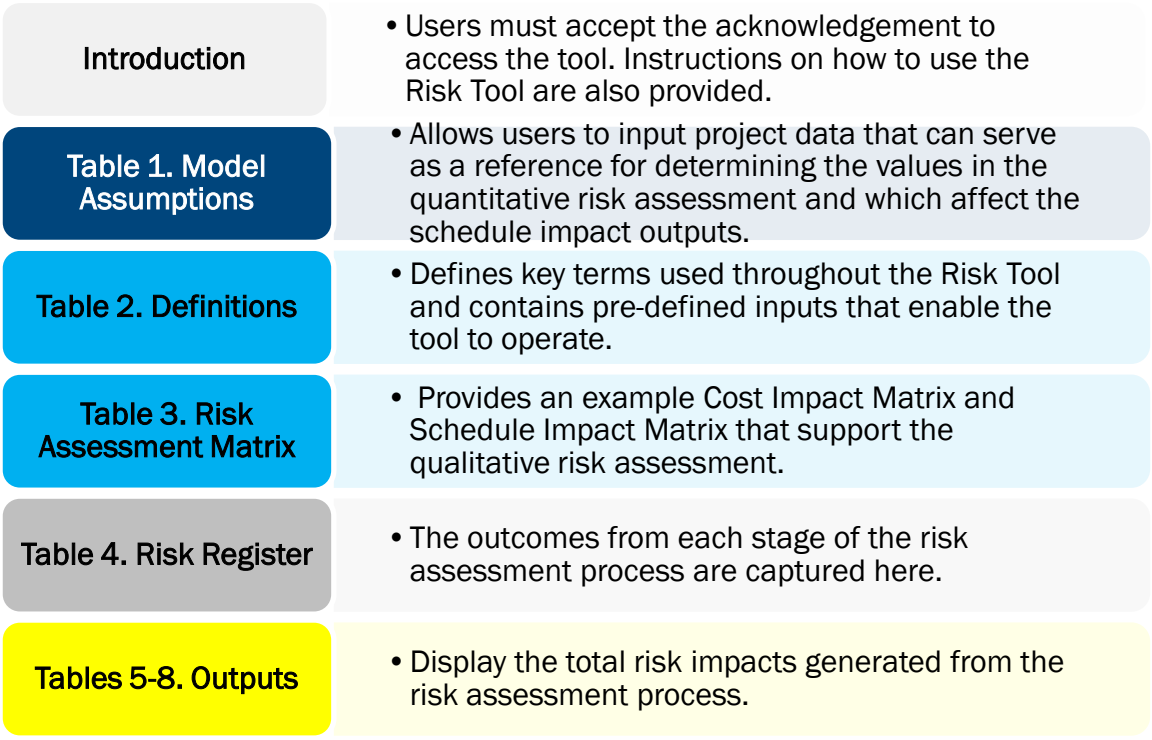
3 Risk Tool Overview

The four major steps in a risk assessment generally include:

1. **Identify** the project risks.
2. **Assess** the risks for cost and schedule impacts through a qualitative and quantitative assessment process.
3. **Allocate** risks to the party best able to manage them.
4. **Mitigate** the occurrence and/or the impact of a risk.

This User Manual provides an overview of the risk assessment process and includes instructions for utilizing the Risk Tool at each stage. As outlined in Figure 2, the Risk Tool includes an Introduction and eight key tables to simulate the risk assessment process. The 'Definitions' and 'Risk Assessment Matrix' tables provide instructions and reference information for the user. This User Manual focuses on the Risk Tool's inputs and outputs in the 'Model Assumptions,' 'Risk Register,' and 'Outputs' tables, as informed by the 'Risk Assessment Matrix' and as they relate to the four-step risk assessment process. The 'Risk Register' table is divided into four sections to record the inputs of each stage in the risk assessment process. It is important to note that users must accept the disclaimer in the 'Introduction' before accessing the remaining content of the Risk Tool.

Figure 2: Getting Started with the Risk Assessment Tool



Example Scenario

This User Manual and the Risk Tool include example inputs from a hypothetical availability payment-based P3 project to demonstrate the application of the Risk Tool. The example assumptions, risks, and outputs do not reflect either a traditional or P3 structure, but rather include a comprehensive list of considerations for a project sponsor and its evaluation team. In completing the Risk Tool for their own notional project, users should first approach the inputs from the public agency perspective for a traditional procurement and save their outputs before repeating the steps from the private partner's perspective for P3 procurement.

Timing & Prerequisites

A project sponsor should conduct a risk assessment at the early stages of the project development process and revisit the risk assessment throughout project development and delivery as part of sound risk management practices. An initial risk assessment should begin once a project sponsor has completed sufficient preliminary design work to understand a project's scope and alignment and developed an initial estimate of a project's schedule, procurement options, and life cycle costs.

Using the Risk Assessment Tool

The user inputs project data in the 'Model Assumptions' tab. Note that all inputs are entered into cells shaded light-blue. The assumptions listed in the model are examples of the project data needed to conduct the risk assessment process. The actual assumption categories and values will vary by project, but the tool accounts for sample cost, schedule, and revenue assumptions.

- **Cost assumptions** include construction base cost, annual operating cost, average annual maintenance cost and daily delay costs.
- **Schedule assumptions** include the expected duration of various project phases (planning, design, construction, commissioning, turn-over, and operations). The project phases listed under schedule assumptions are used in identifying the impact phase during the risk identification process and in determining values in the quantitative risk assessment process.
- **Revenue assumptions** are applicable for toll projects and may include the estimated toll revenue per day to assist in calculating impacts of project delays or interruptions.
- **Financing assumptions** are applicable if a project utilizes financing and can be included to reflect any penalties that may be incurred if a risk event is realized.

It is important to note that with the exception of the daily delay costs, these user assumptions do not factor into the Risk Assessment Tool's outputs. The assumptions fields are provided as an exercise to help users make realistic cost and schedule impact assumptions in the Risk Register sheet.

4 Risk Identifications

The first step of the risk assessment process is to identify risks.

Risk Identification

Agencies may identify risks through a workshop process that engages key project stakeholders and team members with diverse skill sets, perspectives, and experiences. Workshops should include, but not be limited to, experts in design, engineering, right-of-way, construction, tolling, operations and maintenance, law, finance, environmental and geotechnical review, materials, and project management. Examples of risk identification strategies include:

- **Assumption Analysis:** Risks are identified by considering the assumptions made in the analysis of project delivery options, such as initial cost estimate assumptions. Unreasonable assumptions pose potential risks to a program/project.
- **Experience-Based Risk Assessment:** Risks are identified by the project team and field experts, drawing upon their collective experience.
- **Analysis of Lessons Learned:** Risks are identified from an analysis of issues encountered by similar programs/projects in the past.
- **Checklist:** A checklist of common project delivery risks is reviewed to identify an initial set of risks and then other methods are applied to identify project-specific risks.

Risk Description

Once an agency identifies risks, it should describe those risks to include:

- **Category:** Categories are defined for commonly identified risks. The 'Definitions' tab of the Risk Tool, Appendix B of this User Manual, and Chapter 3 of the *Primer* provide a representative list of risk categories and their descriptions. The list is not exhaustive and does not encompass all risks that project sponsors should consider.
- **Impact Phase:** When managing risks and conducting risk assessments, it is important to understand a project's exposure to different types and degrees of risk throughout a project's life cycle. By allocating risks across a project's various development and operational phases, it is

possible for project teams to view the risk profile of the project over its entire life cycle. For more detailed information about risk timing, see below.

- **Type:** Risks might have a potential positive (opportunity) or a negative (threat) impact on the project. The impact or benefit of the risk can be described in the risk consequence (refer below) or on its own.
- **Description:** Descriptions can include the key causes of the risk, which helps identify what can trigger the risk event and supports the approach to allocating risks and developing mitigation strategies.
- **Consequences:** It is important to include the effect of potential damages / costs / delays or benefits that a project may realize if the risk event were to happen. Risk consequences can assist in determining the quantified values of the risk as well as its allocation and options for mitigation. The value of the consequences is entered in the Risk Register in real dollars.

Using the Risk Assessment Tool

Once an agency identifies a project's risk categories, phases, types, descriptions, and consequences, it should input this information into the 'Risk Register' tab under the section labeled "Risk Identification." Note that all cells shaded light-blue are editable. The user can select the risk category, phase, and type from a drop-down list and manually enter the risk description and consequences. The model includes sample descriptions and consequences for the 19 listed risks, though not every project has the same risks and similar risks may have different consequences in different project contexts.

Impact Phase

The timing of risks and mitigation measures are important. When identifying a risk, it is important to articulate what project phase it may impact (i.e., when during the project schedule the risk would potentially occur). In including information about timing, the user can refine the description of the risk and assess the causes and consequences. Risks can overlap and occur in multiple phases of a project, but the mitigation of that risk may be different across those phases. It is important that the agency assess the risks associated with each project phase. The expected costs of risks may vary as the project moves between phases, as may the appropriate mitigation strategies.

A project's life cycle consists of multiple phases, from inception to contract close-out. Typical phases for a highway project include planning, design, construction, commissioning, turn-over, operations, and handback. The example risks provided in the Risk Tool are assigned to specific phases. While some risks may carry over into multiple phases, the Risk Tool allows each risk to be allocated to only one impact phase. Risks that occur over multiple phases should be broken down into individual components for each phase in which the risk may occur and entered in the Risk Register. This can result in a risk being repeated several times, with each entry in the Risk Register

assessing the risk during one specific impact phase. Table 3-1 of the *Primer* offers a sample breakdown of risks by project phase. The example phases in the Risk Tool are:

- **Planning Phase:** Tasks in this phase can include financial and technical feasibility studies, environmental review, development of budget and schedule estimates, public involvement, and an assessment of existing assets for replacement or renewal.
- **Design Phase:** This phase involves the development of detailed construction documents and project management plans, issuance of permits, and development of detailed cost and schedule estimates.
- **Construction Phase:** This phase involves the construction of the physical asset.
- **Commissioning Phase:** This phase is where the facility is prepared for operations.
- **Turn-Over Phase:** In this phase documents such as warranties, license information, and operations and maintenance (O&M) manuals are turned over to the operations team.
- **Operations Phase:** This may include ramp-up, mature operations, and handback. In the *ramp-up* phase, the facility is complete and operations and maintenance activities are undertaken to meet expected service levels. Revenue generation, in the form of tolls, may also commence. Depending on the type of P3 project (whether the project is a "greenfield" new construction project, a managed lane project, or a "brownfield" asset monetization project), there may be a transition period for the project where uncertainties are higher as new processes are implemented and traffic levels adjust to demand. In the *mature operations* phase, the facility has been open for sufficient time to allow for operations and maintenance processes to become more efficient and traffic levels more certain. The *handback* phase occurs in the final years of a concession when processes are implemented to transition the facility to public control.

5 Risk Assessment

This stage of the risk assessment process involves a qualitative risk assessment followed by a quantitative risk assessment.

The risk assessment process for a transportation project can be very complex. Risks can affect projects directly by raising costs and causing schedule delays and indirectly by forcing additional planning, review, and management oversight activity. Risks are often interrelated and decisionmakers should seek to account for the correlations and dependencies among risks as they assess the probability and consequences of individual risks. While, for the purposes of simplicity, the Risk Tool does not account for correlation among risks, it is important for users to be aware of and to document potential correlations where they may occur.

Qualitative Risk Assessment

At the onset of the risk assessment process a qualitative risk assessment can help decisionmakers determine the amount of detailed consideration that a risk warrants in the quantitative risk assessment. The identification phase may result in hundreds of potential risks being identified with varying degrees of likelihood and consequences. It may not be an efficient use of resources to quantify the values of each risk; thus, many agencies utilize a preliminary or qualitative risk assessment to determine the risks to be quantified.

For a qualitative risk assessment, decisionmakers consider both the likelihood of a risk occurring and the consequences of it occurring at a gross level (e.g., very high, high, medium, low, or very low). These qualitative judgments are entered into a risk impact matrix to determine the risk rating. A separate assessment may be conducted for the cost and schedule impacts of the risk.

Using the Risk Assessment Tool

The 'Risk Assessment Matrix' table supports the qualitative risk assessment process. It contains the Cost Impact Assessment Matrix and the Schedule Impact Assessment Matrix. These matrices provide guidance for assessing the risk severity rating based on the probability of a risk occurring and the impact or consequence of the risk occurring on project cost and schedule. Figure 3 below shows representative matrices.

After analyzing the risk probability and consequences, users should go to the "Qualitative Assessment" section of the 'Risk Register' table, where they may select the probability rating, cost consequence and schedule consequence on a scale of one to five from the drop-down menus (refer to Figure 3 to determine the appropriate rating). Once the risk probability and the cost consequence are selected, these ratings determine the overall cost impact rating based on the Cost Impact Assessment Matrix. Similarly, the risk probability and schedule consequence determines the overall schedule impact rating based on the Schedule Impact Assessment Matrix.

Once a risk has been identified and assessed according to representative assessment matrices, a color rating will be automatically calculated and populated for that particular risk in the 'Risk Rating' column. The following colors are significant:

- Light green indicates a very low risk rating
- Green indicates a low risk rating
- Amber indicates a medium risk rating
- Red indicates a high risk rating
- Light red indicates a very high risk rating

It is important to note that the Risk Assessment Tool only prompts users to quantify those risks that have a medium, high, or very high risk rating and consequently the outputs do not account for lower-rated risks.

Figure 3: Representative Cost and Schedule Impact Assessment Matrices

Representative Cost Impact Assessment Matrix						
		Cost Consequence				
		5	4	3	2	1
Probability	Scale	> 25%	10% - 25%	3% - 10%	1% - 3%	<1%
	5 - > 70%	Very High	High	High	Medium	Low
	4 - 40% - 70%	High	High	Medium	Medium	Low
	3 - 20% - 40%	High	Medium	Medium	Low	Low
	2 - 5% - 20%	Medium	Medium	Low	Low	Low
	1 - 0% - 5%	Low	Low	Low	Low	Very Low

Representative Schedule Impact Assessment Matrix						
		Schedule Consequence				
		5	4	3	2	1
Probability	Scale	> 365 days	120 - 365 days	30 - 120 days	7 - 30 days	< 7 days
	5 - > 70%	Very High	High	High	Medium	Low
	4 - 40% - 70%	High	High	Medium	Medium	Low
	3 - 20% - 40%	High	Medium	Medium	Low	Low
	2 - 5% - 20%	Medium	Medium	Low	Low	Low
	1 - 0% - 5%	Low	Low	Low	Low	Very Low

Quantitative Risk Assessment

The outcomes of the qualitative risk assessment can help in identifying the risks to be quantified. An agency may decide that the qualitative assessment indicates that all risks need to be quantified, or that some risks will not be quantified because their overall impact on the project is negligible or their chance of occurrence is highly unlikely. An example of this may be the risk of a power outage prior to construction. Other risks may be significant, but may be difficult to quantify, such as changes to relevant laws or occurrence of uninsurable natural disasters. It is important for public agencies to track these risks and to establish mitigation plans where possible.

Quantifiable risks are events or conditions that have impacts on either the project's cost or schedule that can be predicted and estimated. Examples of clearly quantifiable risks include potential site issues, logistical constraints, market conditions, and right-of-way (ROW) issues, with these types of risks being quantified through professional knowledge, lessons learned from prior projects, or

various studies. The risks quantified in the Risk Tool provide some examples of the types of risks that are typically quantified.

A risk may be classified as an opportunity rather than a threat, to include the benefit of this potential event to the project's schedule and budget. When entering an opportunity, or upside risk, users select "opportunity" from the risk type drop-down menu and enter the remaining assumptions normally (Note: Do not enter cost impacts as negative dollars, the tool will automatically invert the cost impact value into a cost savings).

Using the Risk Assessment Tool

The 'Definitions' table describes triangular and uniform distributions. Once an agency determines the appropriate distribution, the user may input or select the appropriate information to quantify risks under the "Quantitative Risk Assessment" section of the 'Risk Register' table:

- *Probability Percentage:* The probability percentage can be input on a scale of 0 percent to 100 percent to reflect the probability percentage of a risk occurring. The user should refer to Figure 3 to ensure that the percentage is consistent with the probability rating assumed in the qualitative risk assessment. When the user clicks in the Probability Percentage cell, a message displays the probability rating scale to assist the user in entering a percentage that aligns with the rating. If the Probability Rating and the Probability Percentage are not consistent, the Probability Percentage cell will turn red and an error message will alert the user that the percentage entered does not match the probability rating.
- *Distribution:* A triangular or uniform distribution for the schedule and cost impacts for each risk can be selected from a drop-down menu. The selection of the distribution type determines the schedule impact and cost impact fields to be completed (i.e. two-point or three-point estimate).
- *Schedule Impact:* The schedule impact represents the implications for the project schedule if the risk occurs by inputting the two- or three-point estimates for each risk in terms of days. The 'Schedule Impact' field automatically calculates based on the data inputted into these fields and the selected distribution type.
- *Cost Impact:* The cost impact is completed by inputting the two- or three-point estimates for each risk in terms of dollars. The 'Cost Impact' field automatically calculates based on the data inputted into these fields and the selected distribution type. For any risks identified as an opportunity, users are able to enter their assumptions normally and the tool accounts for the potential benefit of the opportunity by reducing the overall cost and schedule risk impacts.

In the "Quantitative Risk Assessment," users are not able to input counterintuitive numbers in the Minimum, Most Likely, and Maximum fields under Schedule Impact and Cost Impact. In both the Cost and Schedule Impact sections of the Risk Register, a message will be displayed with a restriction if the following conditions are not met and the cell will turn red:

- Minimum value must be greater than or equal to 0 and less than Most Likely and Maximum Values; or
- Most Likely value cannot be less than the Minimum value or greater than the Maximum Value; or
- Maximum Value must be greater than the Minimum Value and the Most Likely Value.

While lower-rated risks may not be quantified, the lower-rated risks may be aggregated into a higher-level, catch-all risk that can be quantified. Aggregated risks may include risks such as miscellaneous design issues, construction productivity issues, or other general concerns. It is important to note that while aggregated risks are general in nature, the assumptions behind the quantitative assessment of the risk need to be well defined and understood.

Using the Risk Assessment Tool

The Risk Assessment Tool only prompts users to quantify risks that have medium, high, or very high risk ratings. Consequently, the outputs only reflect the potential impacts of the quantified risks occurring. To quantify lower-rated risks, users may aggregate the lower-rated risks off sheet (users cannot calculate an aggregated risk within the Risk Tool) and estimate the quantitative impacts of those risks if they cumulatively represent a more significant (medium, high, or very high) risk.

The same project team members responsible for qualitative assessment are usually responsible for the quantitative assessment. The quantitative assessment follows the qualitative assessment by determining actual values based on the scale ranges selected for the qualitative assessment (i.e., if the probability rating is a 3 in the qualitative assessment, this rating is first reviewed in the quantitative assessment and a probability percentage within the scale range of 20 percent to 40 percent is selected). Figure 3 provides example scales and Chapter 4 of the *Primer* explains common risk quantification techniques.

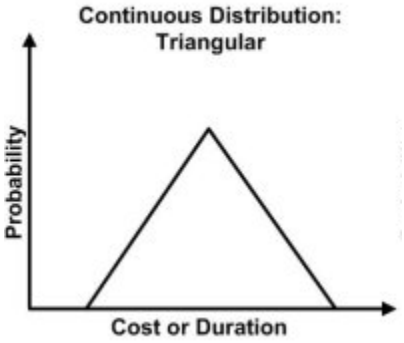
Probability Distribution

The Risk Tool employs the Monte Carlo simulation, which requires the user to estimate the probability distribution of a risk's impact. Two of the simplest and most commonly used distribution estimation techniques used in quantification of risks for P3 projects are triangular distribution and uniform distribution. Other types of distribution methods, such as normal, lognormal and discrete distributions can be used and are described in FHWA's Risk Assessment and Allocation for Highway Construction Management Risk.[1]

[1] FHWA, *Risk Assessment and Allocation for Highway Construction Management*
http://international.fhwa.dot.gov/riskassess/index.cfm

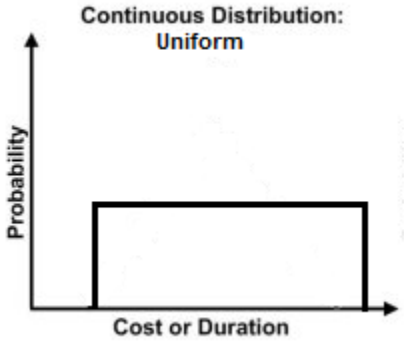
Triangular distribution (see Figure 4) is applied to risks where a three-point estimate of the impact is possible.[2] Here, discrete values for the minimum, most likely, and maximum risk impacts are defined.

Figure 4: Triangular Distribution



Uniform distribution (see Figure 5) is used for two-point estimates. Any value between the low point estimate and the high point estimate will have an equally likely chance of occurring. It implies that the impact of the risk has an equal chance of being any value within the specified range.

Figure 5: Uniform Distribution



Assessing Efficiencies of Private Sector Risk Management

In some instances, the private sector may have a greater capacity to manage certain project risks than the public sector. The public sector may assess those private sector efficiencies through two

[2] Ibid

separate approaches. First, the agency may conduct separate risk assessment processes for the public and private delivery structures, with each process utilizing probabilities, likelihoods, cost and schedule impacts, and allocations that reflect the specific delivery structure. Alternatively, an agency may conduct the risk assessment process once based on either the public or private delivery (though the agency typically bases its assessment on public delivery, as that is more familiar to the project team) and make adjustments for the other delivery method through applying efficiency factors or general percentage reductions.

Assessing Revenue Risks

In conducting a VfM analysis for a revenue-based project, it is important to consider the potential impacts of revenue risks (e.g., due to lower-than-projected traffic volume on a tolled highway). The Risk Assessment Tool does not directly accommodate revenue risks; instead, P3-VALUE users may follow the first or third approach below to address revenue risks:

1. Select a discount rate that reflects the revenue risk premium to discount the PSC and Shadow Bid (Note: This is the most preferred approach; however, since the same discount rate will also be applied to costs, users should verify whether discounting of cost estimates at the same rate is appropriate, given that cost risks may already be accounted for in the cost estimates) ;
2. Apply different discount rates to project revenues and project costs; or
3. Quantify revenue risk in the risk assessment process to measure revenue risk cost impacts (or loss of revenue). This is the preferred approach if the first approach is deemed to underestimate the present value of costs.

Using the Risk Assessment Tool

The P3-VALUE suite accommodates both approaches for assessing the potential efficiencies of private sector risk management as described above. To follow the first approach, users may complete the Risk Assessment Tool twice (once for a public delivery and once for a private delivery) to generate risk values for the PSC and Shadow Bid Tools, respectively. If users follow this approach, it is recommended that they save a separate version of the tool for each delivery structure for easy reference to the results. Alternatively, users may complete the risk register once (for public delivery) and make a general assumption about the percent difference between public and private risk management and adjust the risk value assumptions for the Shadow Bid accordingly. For example, the pre-populated "Example Scenario" in the Shadow Bid Tool is based on risk value assumptions that are 15 percent lower than the risk value assumptions in the pre-populated "Example Scenario" in the PSC Tool.

6 Risk Allocation

Risk Allocation is an approach to optimizing the mitigation of risk, rather than eliminating the risk altogether, and assigning risk to the party (public or private) best able to manage it.

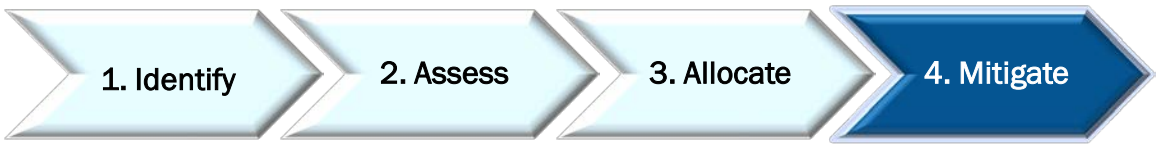
Chapters 2 and 5 of the *Primer* offer guidance on determining the appropriate risk allocation for P3 projects based on project type and procurement structure.

Using the Risk Assessment Tool

The user may document risk allocation of each risk in the "risk allocation" columns of the "Allocation & Mitigation" section of the 'Risk Register' tab. For each risk, the user may input the share of the public and private sector as a percentage. The total allocation must equal 100 percent for each risk. If the total value entered for the risk allocation is greater than 100 percent, the cells will turn red to indicate that the values need to be adjusted. The cells will not turn red if the total value is less than 100 percent, though, so users should be careful when entering their assumptions.

7 Risk Mitigation

Risk mitigation involves developing strategies that may be employed to lower the probability of the risk event occurring or the consequence of the risk if it occurs. Risk mitigation is one of the four risk management strategies discussed below.



During the risk assessment process, the project development team should identify strategies for dealing with each risk. Potential risk strategies include:

- **Avoidance:** The team changes the project plan to eliminate the risk or to protect the project objectives from its impact. The team might achieve this by changing scope, adding time, or adding resources (thus relaxing the so-called "triple constraint").
- **Transference:** The team transfers the financial impact of risk by contracting out some aspect of the work. Transference reduces the risk only if the contractor is more capable of taking steps to reduce the risk and does so.
- **Mitigation:** The team seeks to reduce the probability or consequences of a risk event to an acceptable threshold. It accomplishes this via different means that are project- and risk-specific. Mitigation steps, although costly and time consuming, may still be preferable to going forward with the unmitigated risk.
- **Acceptance:** The project manager and team decide to accept certain risks. They do not change the project plan to deal with a risk or identify any response strategy other than agreeing to address the risk if it occurs.

Using the Risk Assessment Tool

Users may input risk mitigation strategies under the "Allocation & Mitigation" section of the 'Risk Register' tab. The mitigation information does not feed into the risk assessment outputs, but it is important for a project team to systematically think through the broad range of risk mitigation strategies that could apply to a P3 project and to reconsider strategies through the project's life cycle to ensure all risks are mitigated effectively. Appendix C of this User Manual provides additional risk mitigation strategies based on experiences of previous P3 projects in the transportation sector.

8 Risk Assessment Outputs

The outputs of the risk assessment process can be applied to a cash flow model to allow project sponsors to estimate the risk-adjusted, net present cost of a project. In this way, outputs from the Risk Assessment Tool are used in the Public Sector Comparator Tool, the Shadow Bid Tool, and the Financial Assessment Tool to calculate the potential range of risk-adjusted net present costs of different project delivery methods, to determine whether a particular method offers Value for Money (see Figure 6).

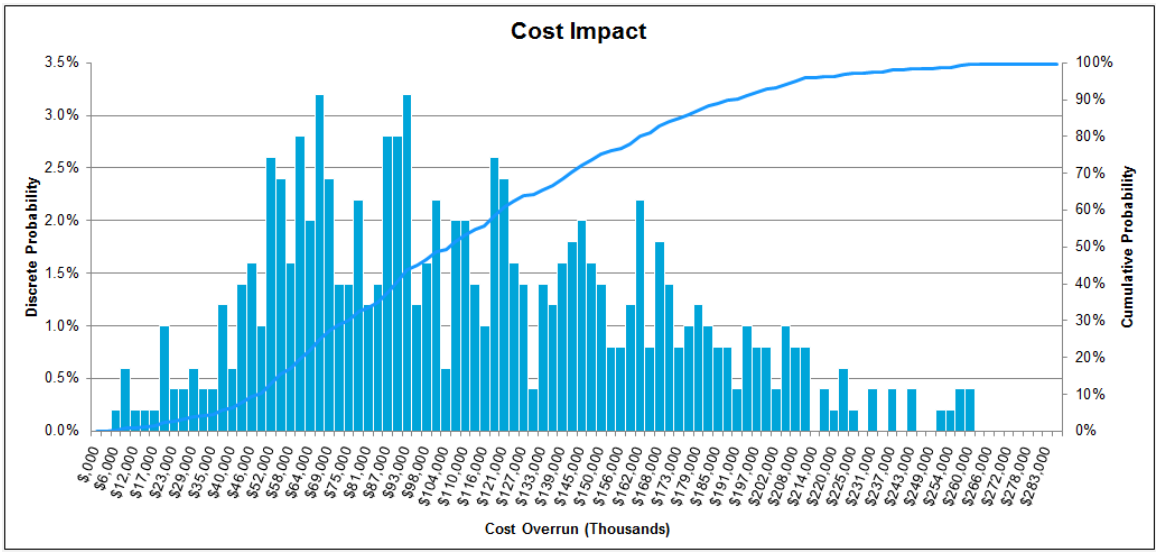
Figure 6: Evaluation Process

Risk Assessment Tool Outputs

In the Risk Tool, the results of the quantitative risk assessment and risk allocation steps feed into a Monte Carlo Simulation, which calculates total risk impacts. The simulation outputs are summarized in the 'Cost Impact Output' table and the 'Schedule Impact Output' table. The cost and schedule risk results are specified at the 10th percentile (P10), 70th percentile (P70), and 90th percentile (P90) to show the range of possible outcomes. The 70th percentile (P70) is the estimate that FHWA uses when conducting Cost Estimate Reviews (CERs) for major highway projects. The results are portrayed graphically in a distribution histogram with a cumulative distribution (or s-curve).

Figure 7 shows a sample distribution histogram and cumulative distribution. These charts are useful for selecting risk values for different confidence levels. In Figure 7, each vertical bar represents the discrete probability that a cost overrun of the amount on the x-axis will occur. The s-curve represents the cumulative probability that the value of risk will be equal to or less than the intercept on the x-axis. For example, according to Figure 7 there is 50 percent likelihood that cost overruns will be less than $110 million.

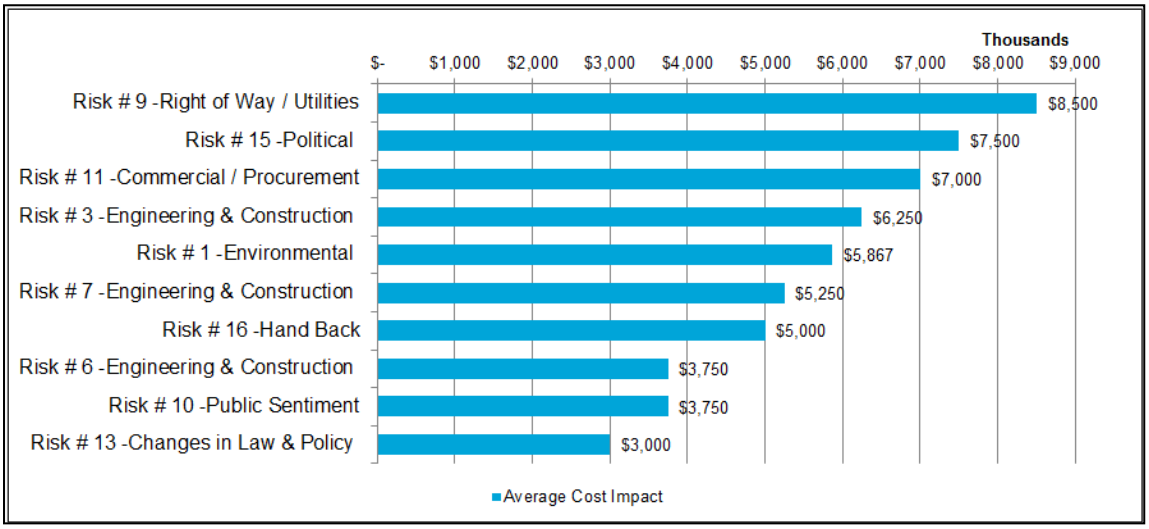
Figure 7: Probable Cost Overrun Chart



Histograms are provided in 'Table 6: Cost Risk Sensitivity' and 'Table 8: Schedule Risk Sensitivity' to indicate which risks present the greatest average impact.[3] Figure 8 shows a sample impact bar graph. The histogram presents the most important risks by average cost impact. The example in Figure 8 indicates that Risk #9 - Right of Way/Utilities, has the greatest average impact on project costs. The Risk Tool generates the charts for both cost and schedule impacts. The dollar values of the schedule impacts are provided in the 'Schedule Impact Output' table.

[3] Office of Transportation Public-Private Partnership (PPTA), *PPTA Risk Analysis Guidance* http://www.vappta.org/resources/PPTA%20Office%20Risk%20Guidance%20Document%20v2.1%2020110930.pdf

Figure 8: Cost Risk Sensitivity Histogram



The 'Cost Impact Output' and 'Schedule Impact Output' tables also display the aggregated allocation of risks between the public and the private sector. It is important to note that the allocation of cost impacts and schedule impacts may vary because they are evaluated independently during the quantitative assessment process and the impact of each risk on cost and schedule (and therefore the percentage of the total impact) may not be the same.

Using the Risk Assessment Tool

The Outputs tables present the results of the risk assessment process as cost impact values and schedule impact values by project phase as well as the percentage of risks allocated to the public and private entities. For each phase, the results include values at the 10th percentile, 70th percentile, and 90th percentile.

The total risk impacts (both cost and schedule) are generated from a Monte Carlo simulation. To run the simulation, users must enter the number of iterations in the "Generate Outputs" section of the 'Cost Impact Output' table. The number of iterations must be between 300 and 1,000. Upon clicking "Run Simulation," the values calculate based on the number of iterations entered and the data entered in the 'Risk Register' table. Note that the accuracy of the simulation depends on the number of iterations and therefore a greater number of iterations will increase the likelihood that a "smooth" output distribution curve will form with risk probability estimates. Generally, a simulation for 300 iterations is completed within 30 seconds, while a simulation for 1,000 iterations is completed in 1-2 minutes.

The outputs are for educational purposes to give users a sense of the outcomes a risk assessment process may produce. The outputs would be used to prepare the project's risk-adjusted cash flows and to conduct a VfM analysis.

Integrating Outputs with other Evaluation Tools

To integrate the cost and schedule consequence outputs of the Risk Assessment Tool into project cash flow models, agencies must consider the timing of the risk impact on the project and evaluate the cost of risks for each project phase. This will allow agencies to appropriately discount the cost consequences of risks that occur in the future. The P10, P70 and P90 values and the percentage risk share displayed in the 'Cost Impact Output' table and the 'Schedule Impact Output' table are key inputs for the other P3-VALUE tools. The table below specifies the outputs that become key inputs for the other P3-VALUE tools. It is important to note that users must complete the risk register from the perspective of both the public and the private sector to obtain the separate outputs that become inputs into the PSC and Shadow Bid Tools respectively. The risk values used in the Financial Assessment Tool's viability evaluation should be from the public perspective.

Inflating Outputs in other Evaluation Tools

The Risk Assessment Tool does not include inflation assumptions like the PSC and Shadow Bid Tools do; therefore, the risk value outputs from the Risk Assessment Tool that feed into the PSC and Shadow Bid Tools are later inflated by those tools based on the user-defined inflation rates in those tools. Specifically, either the Consumer Price Index (CPI) or the Operations Phase Index applies to the operations phase risk values, while the Construction Phase Index applies to the design-build phase risk values.

Table 1: Integrating Risk Assessment Outputs with P3-VALUE Tools

OUTPUTS		INPUTS					
Risk Assessment Tool		Public Sector Comparator Tool		Shadow Bid Tool		Financial Assessment Tool	
Worksheet	*Cell*	*Worksheet*	*Cell*	*Worksheet*	*Cell*	*Worksheet*	*Cell*
Table 5 – Cost Impact Outputs	G16	Assumption	E80	Assumption	E103		
Table 5 – Cost Impact Outputs	H16	Assumption	E81	Assumption	E104		
Table 5 – Cost Impact Outputs	G17	Assumption	E82	Assumption	E105		
Table 5 – Cost Impact Outputs	H17	Assumption	E83	Assumption	E106		
Table 5 – Cost Impact Outputs	F26	Assumption	E86	Assumption	E109	Viability Evaluation – Assumption	E78
Table 5 – Cost Impact Outputs	G26	Assumption	F86	Assumption	F109	Viability Evaluation – Assumption	F78
Table 5 – Cost Impact Outputs	H26	Assumption	G86	Assumption	G109	Viability Evaluation – Assumption	G78
Table 5 – Cost Impact Outputs	F27	Assumption	E87	Assumption	E110	Viability Evaluation – Assumption	E79

OUTPUTS		INPUTS					
Risk Assessment Tool		Public Sector Comparator Tool		Shadow Bid Tool		Financial Assessment Tool	
Worksheet	*Cell*	*Worksheet*	*Cell*	*Worksheet*	*Cell*	*Worksheet*	*Cell*
Table 5 – Cost Impact Outputs	G27	Assumption	F87	Assumption	F110	Viability Evaluation – Assumption	F79
Table 5 – Cost Impact Outputs	H27	Assumption	G87	Assumption	G110	Viability Evaluation - Assumption	G79
Table 7–Schedule Impact Output	G18	Assumption	F80	Assumption	F103		
Table 7–Schedule Impact Output	H18	Assumption	F81	Assumption	F104		
Table 7–Schedule Impact Output	G19	Assumption	F82	Assumption	F105		
Table 7–Schedule Impact Output	H19	Assumption	F83	Assumption	F106		
Table 7–Schedule Impact Output	F38	Assumption	E88	Assumption	E111	Viability Evaluation – Assumption	E80
Table 7–Schedule Impact Output	G38	Assumption	F88	Assumption	F111	Viability Evaluation – Assumption	F80
Table 7–Schedule Impact Output	H38	Assumption	G88	Assumption	G111	Viability Evaluation – Assumption	G80
Table 7–Schedule Impact Output	F39	Assumption	E89	Assumption	E112	Viability Evaluation – Assumption	E81
Table 7–Schedule Impact Output	G39	Assumption	F89	Assumption	F112	Viability Evaluation – Assumption	F81
Table 7–Schedule Impact Output	H39	Assumption	G89	Assumption	G112	Viability Evaluation - Assumption	G81

9 Summary and Tool Limitation

This User Manual is an educational resource part of FHWA's P3-VALUE Toolkit. The User Manual corresponds to the FHWA Risk Assessment Tool, providing a step-by-step overview of the risk assessment process with instructions for utilizing the Risk Tool at each stage. Together, these educational resources provide users with a better understanding of the process for identifying, evaluating, and allocating risks and for developing strategies to mitigate risks in a P3 project.

The information, examples, and process outlined in this User Manual do not encompass all issues and options for conducting a risk assessment for a highway P3 project. The *Risk Assessment and Allocation Guidebook* being developed to supplement FHWA's P3-VALUE Toolkit contains additional information and Appendix D of this User Manual provides references and resources from domestic and international jurisdictions for further guidance.

The Risk Assessment Tool has been designed for use in FHWA-sponsored training. FHWA anticipates that at the conclusion of the risk assessment training, users will have a greater understanding and appreciation of the risk assessment process and of several key considerations when developing and conducting an assessment. FHWA encourages users to engage appropriate experts (either in-house or external) to develop their own risk assessment tools and processes for potential P3 projects. The level of knowledge gained from this training should help in such an effort.

Risk Assessment Tool Limitations

To provide a notional example of a functioning and interactive Risk Assessment Tool, a number of assumptions and formulas are included in the Risk Tool that relate to the pre-populated "Example Scenario" and may not be suitable for all types of potential scenarios. For example, the "Example Scenario" does not include toll collection in its delivery structure and consequently the Monte Carlo simulation does not directly accommodate revenue risks, though P3-VALUE users can address revenue risks through their selection of a discount rate in the PSC and Shadow Bid Tools. Additionally, the Monte Carlo simulation is based on the assumption that all risks are independent, with no correlation between the risks.

Appendix A: Glossary

Term	Description
Commissioning phase	The commissioning phase, often referred to as the 'Start-Up' phase, is where the asset is prepared for operations. This phase often involves the testing and integration of the project's systems and components to ensure that all applicable design criteria are met.
Construction phase	The construction phase involves the actual construction of the physical asset. This phase is often the most sensitive to risks which could result in change orders, schedule delays, and contract disputes. By identifying potential risks before the construction phase, it may be possible for the project team to better anticipate and manage construction risks before they occur.
Contingency	An allowance included in the estimated cost of a project to cover unforeseen circumstances.
Concessionaire	Private entity that assumes ownership and/or operations of a given public asset (e.g., train station, bus operation) under the terms of a contract with the public sector
Cost impact	Cost impact is the additional cost of labor, equipment and materials that are incurred when the risk event occurs and whoever is responsible for that risk has to carry out additional work as a direct result of the event. Indirect costs, such as the cost of site offices, utilities and additional resources for engineers, inspectors, etc. are not included in the cost impact.
Design phase	The design phase, often referred to as a 'pre-construction' phase, involves the development of detailed construction documents and logistics plans, issuance of permits, and development of detailed cost and schedule estimates. During this phase, the public sector can solicit proposals or bids from qualified contractors and vendors to execute the work based on the detailed design and or operations criteria. Depending on the delivery method, the bid solicitations may take place early or late in the design phase. For example, under P3 or Design-Build, solicitations can take place early or possibly even before the design phase while under traditional Design-Bid-Build bid solicitations are unlikely to be issued until a complete set of construction documents is finalized towards the end of the design phase.
Discount rate	The discount rate is a percentage by which a cash flow element in the future (i.e., project costs and revenues) is reduced for each year that cash flow is expected to occur.
Impact phase	A project's life cycle typically consists of multiple phases, from inception to contract close-out. Typical phases for a highway project include planning, design, construction, commissioning, turn-over, and operations. When managing risks and conducting risk assessments, it is important to understand the project's exposure to risk over each project phase. By allocating risks across the project phases, it is possible for project teams to view the risk profile of the project over its entire life cycle. The example risks provided in the Risk Tool are assigned to specific phases, and a breakdown by phase of the total risk exposure is presented in the 'Output' tab. While some risks may carry over into multiple phases, the Risk Tool allows each risk to be allocated to only one specific phase called the 'impact phase' (i.e. the phase in which the exposure to the risk is greatest). If possible, the risk in such situations can be broken down into individual portions and then assigned to a specific impact phase.
Operations phase	During the operations phase, the completed asset is operated and maintained to ensure continuation of beneficial use and/or revenue generation over the life of the asset.
Opportunity risks	A risk may be categorized as an opportunity risk if it has the potential to have a positive impact on the project. Opportunity risks are intrinsic to the project. If an agency quantifies risks differently for different procurement structures, the potential for double-counting efficiencies that are provided through the risk allocation for a procurement structure (as part of the VfM Analysis process) can exist.
Non-technical risk	Risks posed by political, regulatory, economic, and social conditions, or stakeholders.
NPV	Net present value.

Planning phase	Planning is the earliest phase of the project in which the project is purely conceptual with relatively low design definition, and very rough high-level estimates of the cost and schedule. Tasks in this phase typically consist of financial and technical feasibility studies, development of rough budget and schedule estimates, public forums if applicable, and an assessment of existing assets for a replacement or renewal project.
Primer	Within the context of the *Risk Assessment Tool User Manual*, "*Primer*" refers to the FHWA's *Primer on Risk Assessment for Public-Private Partnerships*, which provides of an overview of general/basic concepts of the risk assessment process.
Procurement phase	Stage at which a pool of bidders is down-selected based on specific criteria.
Project brief	The project brief details the government's objectives, service delivery requirements, policy and commercial matters, material background information and the processes for submitting and evaluating submissions. It also sets out government's role and intentions for the infrastructure to be built, and explains how checks and balances are observed in the process to help to ensure impartiality.
PSC	Public Sector Comparator: A PSC represents the most efficient public procurement cost (including all capital and operating costs and share of overheads) after adjustments for competitive neutrality, retained risk and transferable risk to achieve the required service delivery outcomes. This benchmark is used as the baseline for assessing the potential value for money of private party bids in projects.
Retained risk	The value of those risks or parts of a risk that a government proposes to bear under a P3 arrangement.
RFP	Request for Proposals.
Risk allocation	The process of assigning operational and financial responsibility for specific risks to parties involved in the provision of services under a P3. Also see risk transfer.
Risk Allocation Matrix	A table used as a management tool throughout the procurement process to provide an overview of the major risk categories to be considered when developing procurement, to explain why the risks are transferred, shared, or retained under different procurement options. As each deal will have project-specific risk, the Risk Allocation Matrix is only a tool to help understand the principles regarding risk allocation. For each project, the actual risk allocation will need to consider the principles of allocation and the circumstances of the deal.
Risk Register	A document which identifies the bearer of a particular risk and which will also contain quantitative assessments (i.e. costs and likelihoods) of the characteristics of the risks).
Risk transfer	The process of moving the responsibility for the financial consequences of a risk from the public to the private sector.
Schedule impact	Schedule impact is the delay that an event may cause to the project schedule.
Technical risk	Risks arising from deviations from the project's original technical assumptions, specifications, or requirements.
Transferrable risk	The value of any risk that is transferable to the bidder.
Turnover phase	Turn-over is a relatively short phase that occurs after successful commissioning of the project. During this phase, documents such as warranties, license information, and operations and maintenance (O&M) manuals are turned over to the operations team. Additionally, all open financial, legal, regulatory, and technical items are closed to ensure successful commencement of beneficial use and revenue generation.
Value for Money (VfM)	The procurement of a P3 project represents VfM when, relative to a public sector procurement option, it delivers the optimum combination of net life cycle costs and quality that will meet the project objectives.

Appendix B: Risk Categories and Definitions

The risk categories provided below are only representative and do not encompass the full spectrum of risks to be considered when evaluating a project.

Reminder: The following list is not exhaustive and does not encompass all risks that project sponsors should consider.

Risk Category	Description
Design	Major construction projects may have several design risks as a result of deficiencies or complexities in the project's design that may impact project costs or result in delays.
Engineering & construction	This risk category addresses the difficulties encountered during construction that may result in additional costs or delays in delivery and/or service. Generally, the private contractor responsible for construction is allocated many of these risks; however, the project delivery method and the responsibilities of the public agency can impact the risk allocation.
Planning & approvals	The public or private sectors face a significant risk if they do not obtain the necessary approvals required to construct and operate the asset. A non-comprehensive list of necessary approvals may include: environmental approvals, construction approvals, operating licenses, approvals to move or disrupt utilities, and design approvals. If the correct permits cannot be obtained, the project can face significant delay.
Environmental	Major construction projects have numerous environmental risks which are dependent upon the type of construction being performed and the geographical characteristics of the surrounding environment. These risks need to account for potential prevention and clean-up cost for environmental issues and for the effect that unforeseen environmental issues may have on the overall schedule of the project.
Right-of-Way/utilities	Most major construction projects involve the acquisition of land and right-of-way entitlements. These are often handled by the public sector. Also, new construction may often encounter existing utilities (water, gas, electricity, sewage). The private and public sectors can work together to identify the utilities impacted by the construction and agree how to approach negotiations with utility companies.
Commercial/ procurement	There are several risks that can impact a project's procurement, such as having too few qualified contractors bidding on the project (which reduces competition), or having bidders that are not willing to accept the project allocation as set out in the draft Project Agreement. Commercial/procurement risks can generally be mitigated to some degree by conducting regular interaction with industry to assess market conditions during the project development phase and when structuring the procurement process.
Latent defect	These risks address undetected or unseen damages or deterioration of existing infrastructure or assets. These risks may occur during the construction phase for any existing assets, or during the operating phase once construction has been completed.
Operations	These risks address variables or conditions that may affect the operation of a project, such as disputes between asset operators and contractors when operational areas are not clearly defined for each contractor.
Maintenance	During the project's operating period, the cost and scope of maintenance functions may exceed the cost and scope set in the Project Agreement. For example, the road surface may deteriorate faster than anticipated and additional maintenance may be required to keep the road fully operational.
Availability	Availability risks impact the service level provided by the asset, which can impact project revenues. For example, a plant failure may shut down a tunnel's ventilation system, resulting in the tunnel being closed until the failure is rectified. Under a P3 with an availability payment, this may result in a penalty to the private sector under the Project Agreement. It may also result in a loss of revenue for the public sector tolling agency.

Risk Category	Description
Market demand	Market demand risks can impact project performance due to demand of services being greater or less than initially projected. Market demand risks may include risks related to variations from the traffic forecast assumptions or network changes that impact demand for the project.
Hand-back	Hand-back risks are specific to delivery methods where the private sector operates and maintains the asset and returns it to the public agency at the end of the contract. These risks involve identifying the key aspects of the asset which may deteriorate during the project's life cycle and determining what precautions are required to guarantee that the asset meets the agreed upon specifications when returned. Mitigation strategies for hand-back provisions usually include the agreement to recommend an independent engineer to analyze the asset and estimate the cost of the required repairs several years before the end of the concession, and account for payment deductions put into an escrow account to cover the estimated costs.
Financial & economic	Financial risks can include fluctuations in interest rates and availability of finance, which may have a dramatic effect on the project viability and financing structure. Similarly, changes in economic conditions such as inflation rates may also impact viability. At different stages in the project's life cycle, the allocation of financial and economic risks may vary.
Force majeure	Force majeure risks are risks that are outside the control of either the public or private sector, such as natural disasters. The approach to addressing these risks is typically agreed to in the Project Agreement.
Political	Political risk refers to government actions that may impact a project. For example, changing political priorities may impact funding availability or the timely receipt of approvals, which can result in delays and additional costs.
Insurance	Insurance risks are risks that insurance firms may not be willing to cover. For example, insurance companies may be unwilling to insure equipment during the construction of an underwater tunnel. The allocation of these risks can depend on the project delivery method and there may be uninsurable risks that are addressed in the Project Agreement.
Public sentiment	Public sentiment risks may range from simple public concern over a project's proposed scope or location to public protests blocking access to construction sites or reducing demand. The costs of these risks can include delays in the project and additional costs if scope changes are required, as well as revenue loss if they occur during the operations phase.
Changes in law & policy	Over the length of the project, there is the potential that governments may enact new laws or policies which impact the project or the private sector contractors. These risks can be separated into discriminatory changes which are focused on the particular project, contractors or P3s and non-discriminatory changes which are not directed specifically at the project, contractors, or P3.
Tolling	Tolling risks can include risks associated with toll collection, interoperability, toll enforcement and technical risks associated with the tolling equipment. These risks occur during the operating phase of a project and can impact project revenues as well as operating and maintenance costs.

Appendix C: Risk Mitigations and Considerations

The following draft risk mitigation strategies leverage past experience of other P3 projects in the transportation sector. The table may serve as a starting point to help a project team systematically think through the broad range of risk mitigation strategies that could be applied to the P3. The appropriate risk mitigation strategy will vary by risk, from project to project, and over time. It is important that this exercise is undertaken on all projects and revisited periodically over the life of the project to help certify that the strategies are effectively mitigating the risk.

Reminder: The following mitigation strategies are provided for general information purposes only.

Mitigation Strategies	Considerations
Public involvement	The public sector may wish to conduct an opinion survey with the goal of accurately gauging public opinion.
Public relations	The public sector and the private sector must agree on an appropriate public relations strategy and community involvement strategy.
Consideration of proposals at each stage	The public sector may wish to include the right to submit comments on the design at specific milestones. If the public sector does not retain this authority, the design will proceed and the public sector authority will cover any cost related to subsequent changes.
Design requirements in bids	The design requirements are to be agreed upon and finalized prior to financial close. The design submitted with the bid submission may be sufficiently advanced to allow the private sector sources of financing to decide that they are likely to be willing to commit funds.
Commissioning tests	Compliance with environmental requirements is rigorously assessed during commissioning.
Warranties	Flaws in design or construction may occur if rolling stock, infrastructure, electrical, mechanical, and civil works sub-contractors fail to meet the requirements of the project. These flaws may be covered by sub-contractor warranties. The public sector can have the ability to specify warranty requirements for the project.
Site investigations/ surveys	The public sector may be responsible for the initial identification of utilities on the site.
Withholding of public sector payments	The public sector may withhold a proportion of milestone payments, which may be paid on the completion of commissioning and acceptance.
Extensions of the concession term	The public sector may choose to extend concession milestones to retain operating period at the same duration.
Concession agreements	The scope of all change requirements is to be limited. The public sector may consider involving user groups in the design phase to avoid scope changes later. Cost overruns as a result of change requirements by the public sector will be fully funded by the public sector and the private sector will obtain compensation for loss of revenue and / or increase in operating costs arising from a change requirement requested by the public sector. The possibility of change in requirements during operation is covered by the concession agreement.
Indexation mechanisms in maintenance contracts	The public sector needs to consider that proponents may submit bids in real terms. Payments may need to be adjusted based on CPI.
Operating contracts	The private sector secures long-term maintenance contracts with established indexation mechanisms.

Mitigation Strategies	Considerations
Comprehensive insurance packages	As far as possible, cost overruns and loss of revenue resulting from the occurrence of a force majeure event may be covered under a comprehensive insurance package.
Buy-out rights	For projects where there is a significant risk that the public sector withdraws the project, the private sector is less likely to want to invest their own time and money and thus produce the possibility of a less than fully competitive procurement process. Buy-out clauses may be used to incentivize private sector participation.
Performance regimes to encourage service delivery	The private sector's remuneration will be adjusted in accordance with its delivery of the service and performance specifications. In certain circumstances, failure to meet standards may result in rectification orders, followed by the right of the public sector to take remedial action at the private sector's expense.
Independent engineers' signing of certificate of final completion	Independent engineers are fully satisfied with all the aspects of the infrastructure prior to the issuance of the operating permits.
Review mechanisms	A review mechanism can be structured to pass on cost savings or overruns on a cyclical basis from the private sector to the public sector.
Operating contracts	An operating contract can be entered into on a fixed price basis that includes a penalty / incentive scheme based on performance.
Maintenance contracts (between concession company and maintenance contractor)	Long-term firm price maintenance contracts may be signed with major suppliers for a period of time to be negotiated before financial close.
Quality and track record of operator	As part of the RFQ process, a review of all major sub-contractors to the concessionaire may be conducted.
Equity	Both the public and private sectors have sufficient capital to reasonably manage risk.
Hedging	If the public sector is assuming the interest rate risk between bid submission and financial close, a hedging strategy may be considered.
Share arrangements	Certain risks may become difficult to insure (to the point that transferring cost risk in relation to these items would not be economic). It may be more efficient for the public sector to procure/provide insurance.

Appendix D: References

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