Alternative Incentive-Based Project Delivery

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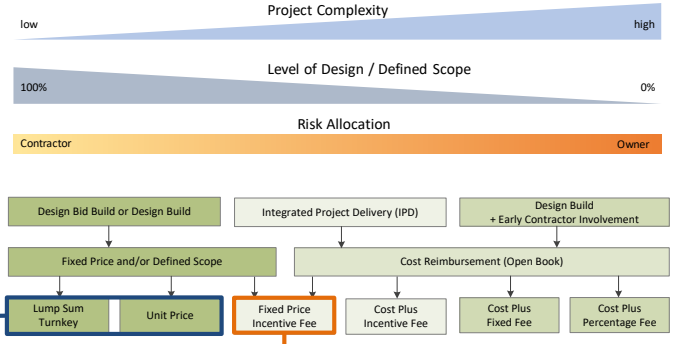
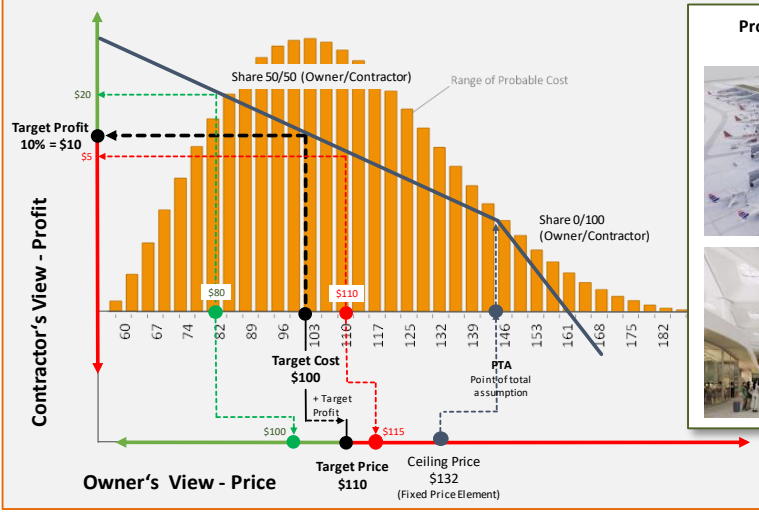
Traditional Contracting

The traditional contracting approach for many project owners is to attempt to **transfer as much of the risk as possible to the contractor**, e.g., by a **Lump-Sum-Turnkey** approach. Any attempt to allocate risks of complex project to different parties, no matter how well intentioned, may be little more than an illusion and can give rise to an adversarial culture that may **threaten the success of the project**.



The **Fixed Price Incentive Fee** delivery model (using NEC- or FIDIC-type contracts) is a way to implement shared goals, related to an established, negotiated target cost. It is an option for large, complex projects with a high level of risk and uncertainty and can establish a collaborative working environment using incentives based on a pain/gain mechanism.



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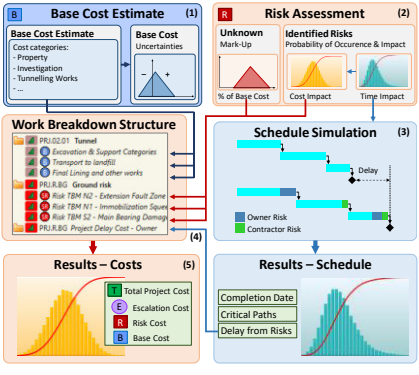

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Alternative project delivery based on a risk-based probabilistic approach

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ABSTRACT: Effective cost and risk management is essential for the success of large infrastructure projects, as demonstrated by a long history of cost overruns. In order to achieve cost transparency, risk-based probabilistic approaches are needed to determine the probability that project delivery can be accomplished within cost and schedule goals. In addition to some owners moving to a more collaborative and incentivized project environment, a significant number of owners and agencies are also considering alternative contracting models to deliver their projects. This paper describes the mechanics of Fixed-Price-Incentive-Fee (FPIF) firm target price contracts, provides a framework for analyzing such contracts, and demonstrates how FPIF pricing arrangements (pain/gain mechanism, target cost, ceiling cost, etc.) can be applied with a risk-based probabilistic approach.

1 INTRODUCTION

Effective cost and risk management is essential for the success of large infrastructure projects, as demonstrated by a long history of significant cost overruns. In order to manage cost to established budgets and to achieve cost transparency, it is necessary to adequately consider cost and schedule uncertainties (risks), which means risk-based probabilistic approaches are needed. This allows us to estimate the probability that project delivery can be accomplished within cost and schedule goals and to define and manage risks that might negatively affect meeting those goals.

In addition, some owners are moving to a more collaborative and incentivized project environment, and a significant number of owners and agencies are also considering alternative contracting models to deliver their projects (Ross 2003, ICE 2018). This paradigm shift is driven by the fact that more traditional delivery methods, e.g., fixed price contracts, often fail to meet objectives due to factors that the authors have described in previous papers.

The purpose of collaborative working agreements and more integrated supply teams is to align the client, design consultants, contractors, sub-contractors, and vendors in a structure, often with incentives, to ensure that everyone works together efficiently to achieve agreed (shared) goals. Such teams are better able to create an environment where outstanding results can be achieved, with incentives leading to improved outcomes for owners and contractors.

This paper describes the mechanics of Fixed-Price-Incentive-Fee (FPIF) firm target price contracts, provides a framework to analyze such contracts, and demonstrates how FPIF pricing arrangements (pain/gain mechanism, target cost, ceiling cost, etc.) can be applied with a risk-based probabilistic approach. Since, in early stages, the project's outturn cost can only be

estimated using ranges, estimates of potential profit for the contractor and project price for the owner need to be made using a probability model for total project cost.

An application similar to the example is used for the Lima Airport Extension Program.

2 APPROACH

2.1 *FPIF and Delivery Methods*

The traditional contracting approach for many project owners is to attempt to transfer as much of the risk as possible to the contractor, e.g., by a Lump-Sum-Turnkey approach (Reilly et al. 2018). This is not necessarily effective for megaprojects. Any attempt to allocate risks of complex project to different parties, no matter how well intentioned, may be little more than an illusion and can give rise to an adversarial culture that may threaten the success of the project (Ross 2003, Reilly et al. 2018).

The FPIF delivery model (using NEC- or FIDIC-type contracts) is a way to implement shared goals, related to an established, negotiated target cost. It is not a full alliancing approach, where the owner, designer, and contractor are jointly bound to meet cost and schedule targets in a pain/gain environment, but it is an option for large, complex projects with a high level of risk and uncertainty and can establish a collaborative working environment using incentives based on a pain/gain mechanism.

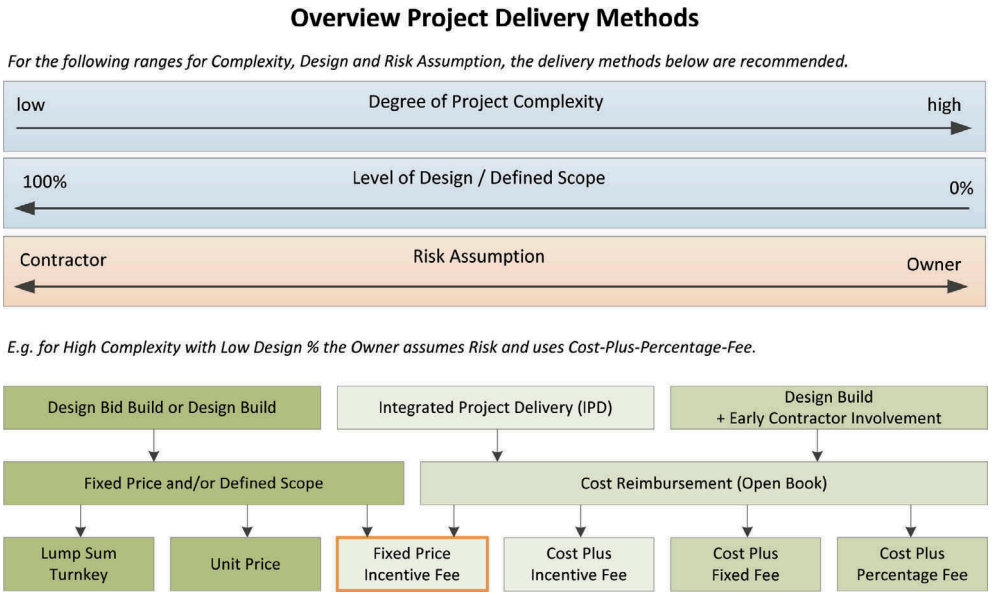


Figure 1. FPIF as hybrid delivery method.

By convention, contracting professionals use share ratios to depict the degree of risk assumed by the owner and contractor. The share ratio for Fixed-Price (FP) contracts is depicted as 0/100. The first number is always the owner's percentage of risk, and the second number is always the contractor's percentage of risk. The 0/100 share ratio means that the contractor assumes 100 percent of risk under an FP contract. Conversely, a Cost-Plus-Fixed-Fee (CPFF) contract share ratio is depicted as 100/0. Since a CPFF contract requires a contractor's "best efforts" and they get paid the fixed fee regardless of their achievement under the contract, the government assumes 100 percent of the risk (Cuskey 2015). The Cost-Plus-Fixed-Fee delivery method allows the owner more control over his or her budget than the Cost-Plus-Percentage-Fee contract. As the total project cost increases, the fee paid to the contractor also increases. Nevertheless, these

contracts are more flexible to project changes and reduce the contingency that the contractor has at the time of the bidding (Ibbs et al. 2003).

The differences between the Cost-Plus-Incentive-Fee (CPIF) and FPIF pricing arrangements occur when contract costs are substantially above or below target cost. The CPIF contract pricing arrangement must include a minimum fee and a maximum fee that define the contract range of incentive effectiveness (RIE). When costs are above or below the RIE, the Government assumes full cost risk for each additional dollar spent within the funding or cost limits established in the contract.

While there is no universal optimized FPIF model, contract parameters can be adjusted to best suit both sides. Flexibility does come with greater complexity, but when properly executed, FPIF contracts can be highly effective in motivating contractors to control cost (Hurt et al. 2015).

2.2 *Probabilisitc Methods*

We believe the reader is familiar with basic concepts of risk, risk management, and risk mitigation and the use of probabilistic cost-risk processes versus deterministic ones (Reilly et al. 2015, Sander et al. 2015). The probabilistic approach, compared to the simpler and more common deterministic approach (unit prices times unit costs plus a contingency), offers more useful information with respect to the range of probable cost as well as cost "drivers" and better quantifies the effects of risks, opportunities, and variability. This improves understanding and leads to a better potential for profit (or loss) for contractors and added value for owners.

2.3 *CEVP-RIAAT Process*

To determine an accurate estimate range for both cost and schedule, significant risks must be identified and assessed. Formerly, cost estimates accounted for risk based on the estimator's experience and best judgment, without necessarily identifying and quantifying such risks—project uncertainties and risks were included in a general "contingency" that was applied to account for such uncertainties. In order to include risk and uncertainty, and to independently validate costs, the Washington State Department of Transportation (WSDOT) in the USA developed CEVP, the "Cost Estimate Validation Process," (Reilly et. al. 2004) to implement better cost estimating and to include the influence of uncertainty (risk) on project delivery.

In CEVP, estimates consist of two components: the base cost component and the risk component. Base cost is defined as the planned cost of the project if everything materializes as planned and assumed. The base cost does not include contingency but does include the normal variability of prices, quantities, and like units. Once the base cost is established, a list of risks is identified and characterized, including both opportunities and threats, and listed in a Risk Register. This risk assessment replaces a general and vaguely defined contingency with explicitly defined risk events that include the associated probability of occurrence plus the impact on project cost and/or schedule for each risk event. The risk is usually developed in a CEVP Cost Risk Workshop (Sander et al. 2018).

RIAAT (Risk Administration and Analysis Tool – http://riaat.riskcon.at) is an advanced software tool that combines base costs, base variability, risks, opportunities, and schedules to indicate ranges of probable cost and schedule, plus risk management and change tracking and documentation (Sander et al. 2017).

3 FPIF CONTRACTING

As part of the application of CEVP and RIAAT to a major project in South America, the opportunity to include advanced risk management and delivery processes was evaluated. The result was the decision to apply the FPIF process using the CEVP-RIAAT process as input and to help establish an agreed target cost. The FPIF approach is based on US Department of Defense (USDOD) strategies for different types of procurement in different circumstances.

The rationale for selecting this particular contract form, based on the USDOD approach, is that:

1. For projects where there are established historical data regarding outturn costs, the program is stable, and many units are to be delivered with few change requirements, a fixed-price lump sum is appropriate.
2. For projects that are uncertain, with substantial unknowns, such as new weapons systems or components that require significant research and development, a cost-plus negotiated procurement is most appropriate.
3. For projects with some unknowns, but with stable scopes, a process between a fixed-price lump sum and a cost-plus negotiated procurement—a process with characteristics of both approaches—is best. This means a firm upper-cost ceiling, with a defined target cost and a pain/gain mechanism to incentivize reduced cost for the owner, with a defined scope. This is the FPIF form of contract.

FPIF models keep a fixed-price approach but also allow for a certain degree of control over the total price by creating a more collaborative environment with the contractor.

4 DEFINITIONS RELATED TO FPIF

FPIF Contract: Specifies a target cost, a target profit, a ceiling price, and a profit adjustment formula. These elements are all negotiated at the outset. The profit earned by the contractor varies inversely with the project cost by application of a pain/gain mechanism. When the final project cost is negotiated, the contractor's profit is calculated, and the price paid by the owner is the final project cost plus the so-calculated contractor profit. All project transactions and costings are 100% open book and subject to audit.

Target Cost (TC): Expected total cost of the project (direct plus project-related overheads), excluding contractor profit. It should be reasonably challenging but achievable. It is based on a reasonable best-case scenario of contract performance based on an analysis of available information. It includes the contingency allocated to the risks associated with the delivery of the project, agreed by the parties.

Target Profit and Target Price (TP): The Target Profit is the profit earned by the contractor for achieving the Target Cost. The Target Price is the sum of the Target Cost plus the Target Profit.

Share Ratio (S/R): Percentage that each party shares in cost underruns and cost overruns from the negotiated Target Cost. The first number corresponds to the owner, the second to the contractor. For example, an Underrun S/R of 60/40 indicates that the contractor's profit is increased by forty cents for each dollar under the target cost. The same sharing principle applies for an Overrun S/R.

Pain/Gain Mechanism: Formula applied to calculate the final price paid by the owner, based on the agreed S/R for underruns and overruns. When the final negotiated cost of the project is lower than the target cost (i.e., there has been an underrun), application of the S/R results in a final profit greater than the Target Profit; the price paid by the owner is the final negotiated cost plus the (higher) profit so calculated. Conversely, when the final negotiated cost is higher than the Target Cost (i.e., there has been an overrun), the contractor earns a profit lower than the Target Profit, and the owner pays for the final negotiated cost plus the (lower) profit so calculated.

Ceiling Price (CP): Maximum price paid by the owner to the contractor, except for any adjustment under other contract clauses.

Point of Total Assumption (PTA): Overrun cost point at which the Pain/Gain Mechanism results in the owner paying the Ceiling Price, i.e., the negotiated cost of the project plus the profit earned by the contractor as per the Pain/Gain Mechanism equals the Ceiling Price.

$$CP = \text{Cost @PTA} + \text{Profit @PTA}$$

The S/R becomes 0/100 at the PTA because the owner no longer shares in a cost overrun. Therefore, the contractor is assuming the extra cost at the expense of his profit, dollar per dollar.

The formula to calculate the PTA is as follows:

$$PTA = TC + (CP - TP) / (\text{Owner Overrun Share Ratio})$$

Example:

With the data: TC = 100; Target Profit = 10 (therefore TP = 110); CP = 118 and Overrun S/R = 60/40

$$\text{PTA results in: } PTA = 100 + (118 - 110) / 0.6 = 113.3$$

Therefore, for this example project where the TC = 100, if the final negotiated cost is 113.3, the owner would pay the CP = 118 and the contractor would make a profit of 118 - 113.3 = 4.7, which is less than the target profit of 10. If the project cost exceeds 113.3, the owner still pays the CP = 118, therefore the contractor reduces his profit one dollar per every additional dollar of project cost.

Figure 2 shows the defined parameters applied to a probability distribution. This basic model is used to define the model for application in a project. The following example is a guide through the steps.

5 APPLICATION EXAMPLE

An application similar to the example is used for the Lima Airport Extension Program.

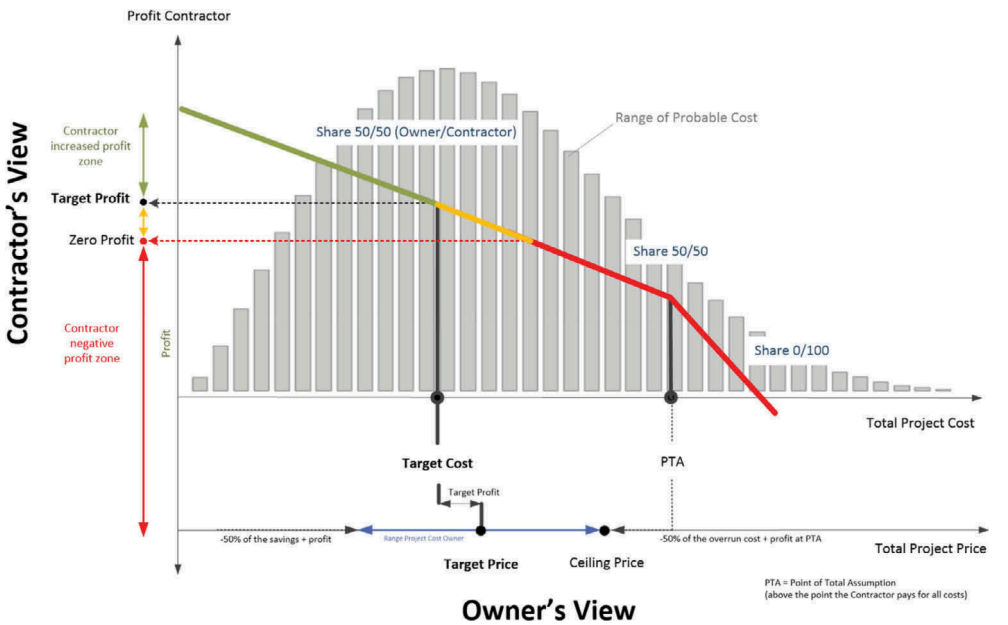


Figure 2. Visualization of terms.

5.1 *Probable Cost Range*

The Probable Cost Range is the result of the CEVP-RIAAT application. As usual the range depicts the Base Cost + Risk and Escalation. It does not include the contractor's profit. Figure 3 shows a typical result using the probability distribution and the probability function.

5.2 *FPIF Model Set Up*

Table 1 lists all the parameters, formulas, and calculated values that are used to set up the FPIF model for our example.

Figure 4 applies the FPIF on the Probable Cost range (compare to Figure 2).

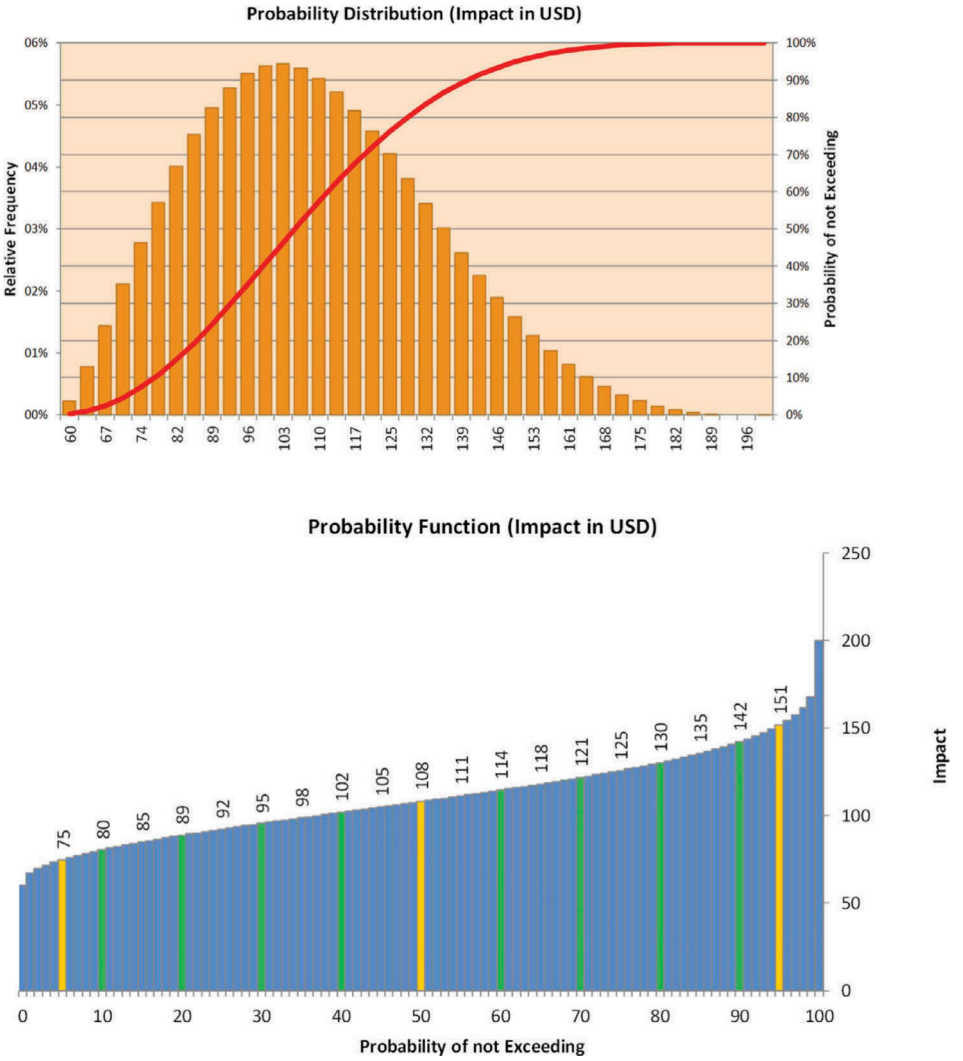
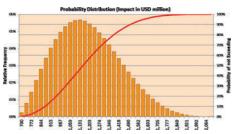


Figure 3. Probable Cost as result of the CEVP-RIAAT application.

Table 1. Calculation of the FPIF parameters.

Parameter	Formula	Value
Probable Cost Range	Is given in a range as result from the CEVP workshops (see 5.1.).	
Target Cost (TC)	TC	$100
Profit	10% Profit for Contractor: Profit = TC * 0.1	$10
Target Price (TP)	TC + Profit	$110
Ceiling Price (CP)	Set to $132	$132
Owner Share Ratio (OSR)	Owner/Contractor share ratio: 50/50	50%
Point of Total Assumption (PTA)	PTA = TC + (CP - TP)/(OSR) PTA = 1.0 + (1.32 - 1.1)/0.5	$144

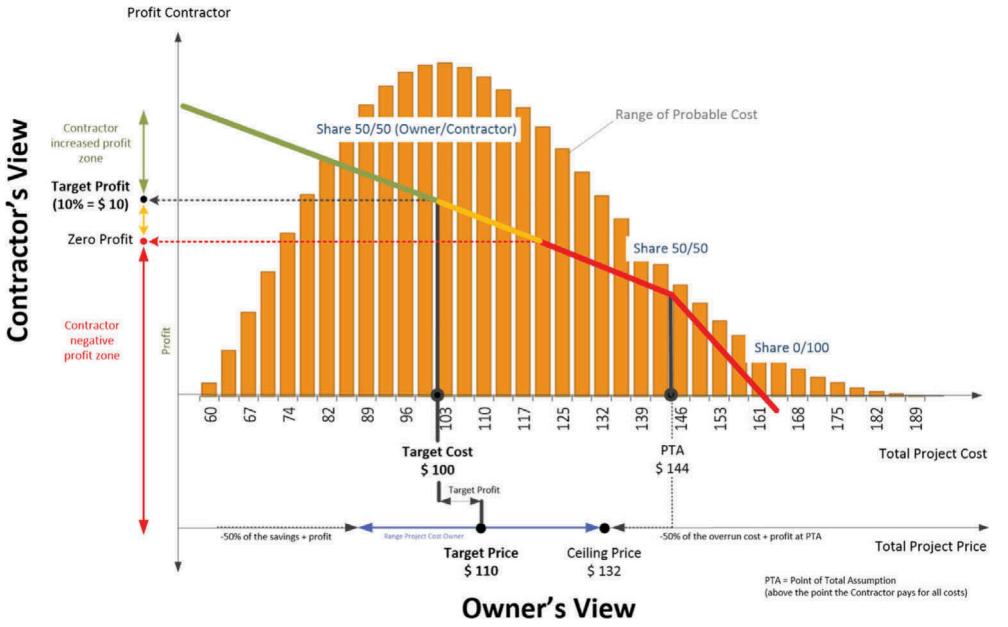


Figure 4. FPIF model applied to the Probable Cost Range.

5.3 *Deviation From Target Cost*

Since there is a Share Ratio in the case of a cost overrun or underrun, the potential deviation from the Target Cost is essential for calculating the potential pain/gain for the owner and contractor. Figure 5 depicts the probability function that shows the potential deviation. There is a chance of about 38% that the cost will come in below the Target Cost but also a probability of 62% that the final cost will be higher than the Target Cost. For example in 42% (P80 minus Target Cost → P38) of all cases the cost overrun will not exceed $ 30.

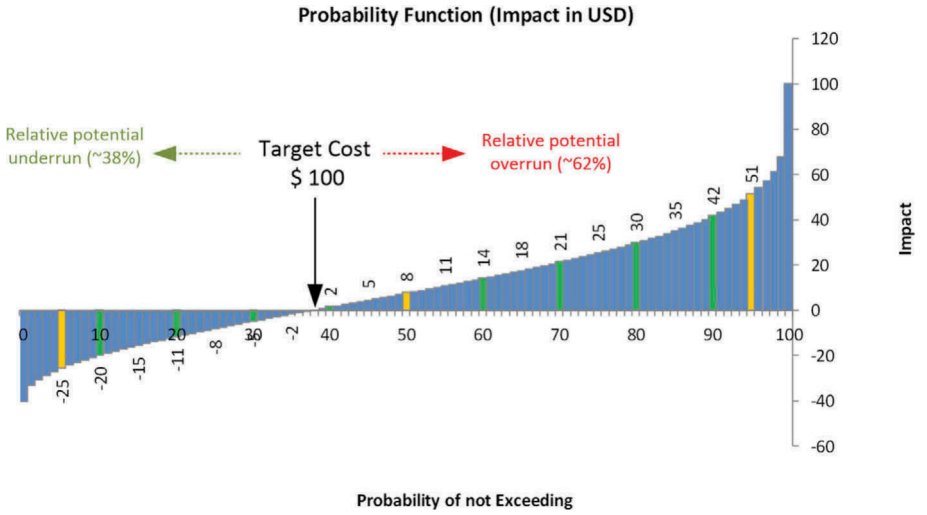


Figure 5. Potential deviation from the Target Cost.

5.4 *Point of Total Assumption – 0/100 Share Ratio*

If the final cost exceeds the PTA of \$144, the contractor takes all the risk. Figure 6 visualizes a cost impact with a 9% probability that the final cost will exceed \$144.

5.5 *Contractor's View*

From a contractor's view, there is a probability of 32% that he will drop into the loss zone, but also a probability of 38% that he will have increased profit above \$10 (Figure 7 and Figure 8).

If the PTA is exceeded (9% probability), the contractor takes all the risk, which will rapidly increase his loss. This is depicted by the steep curve in Figure 7 and the flat tail in Figure 8.

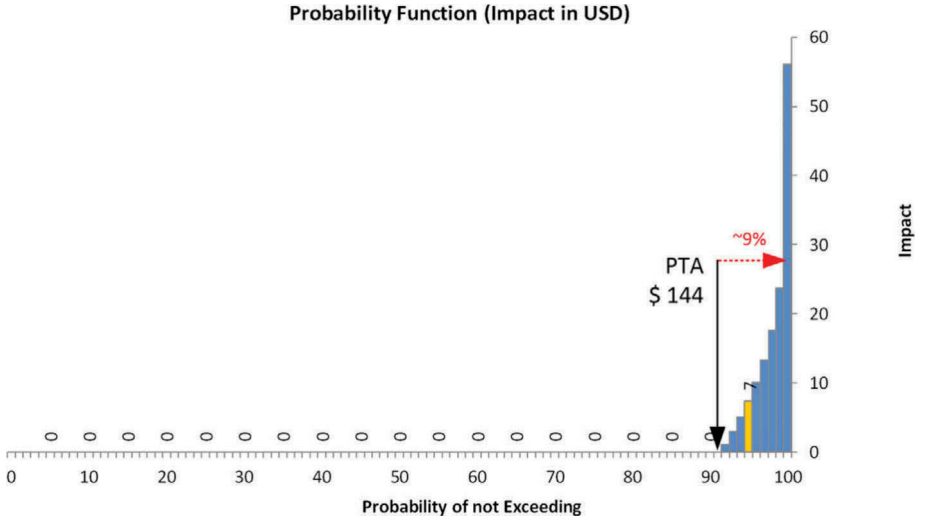


Figure 6. 100% Contractor Risk Potential beyond PTA.

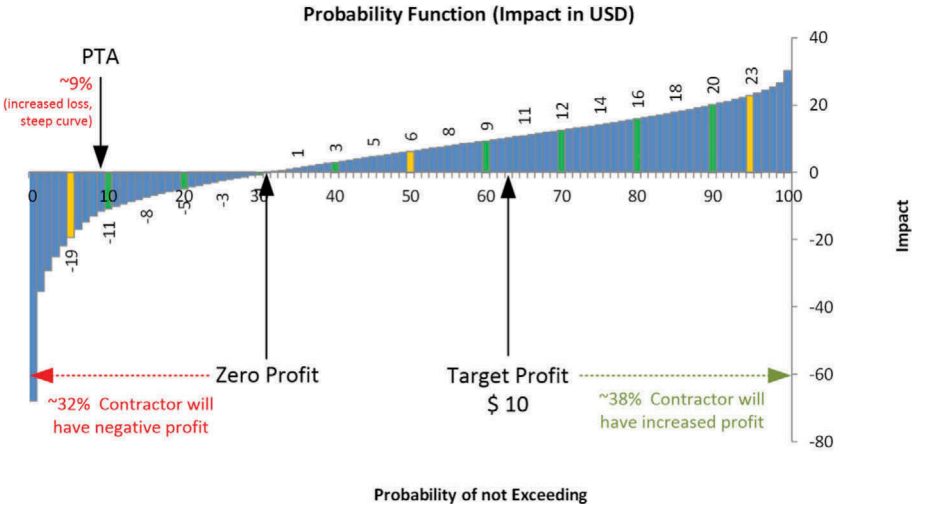


Figure 7. Contractor's view of Profit/Probability Function.

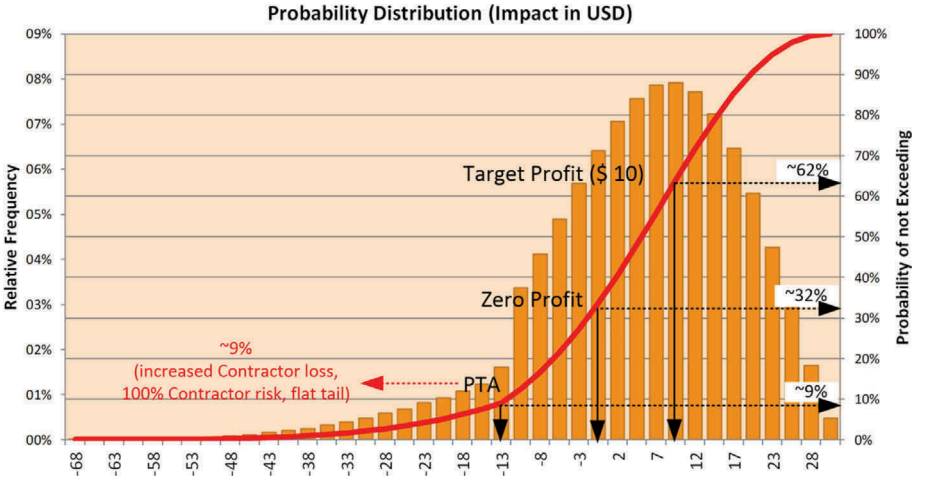


Figure 8. Contractor's view of Profit/Probability Distribution.

The analysis does not consider the potential increased efficiency by the contractor in order to generate higher profit.

5.6 *Owner's View*

From an owner's perspective, there will be a 38% chance that his cost will be lower than the Target Price (Figure 9 and Figure 10). This chance might be higher if the contractor is incentivized to gain more profit and works with increased efficiency.

If the PTA is exceeded, the contractor takes all of the risk. This defines the Ceiling Price of $132 for the owner. There is a probability of 9% that the PTA will be exceeded and the Ceiling Price mechanism will be triggered.

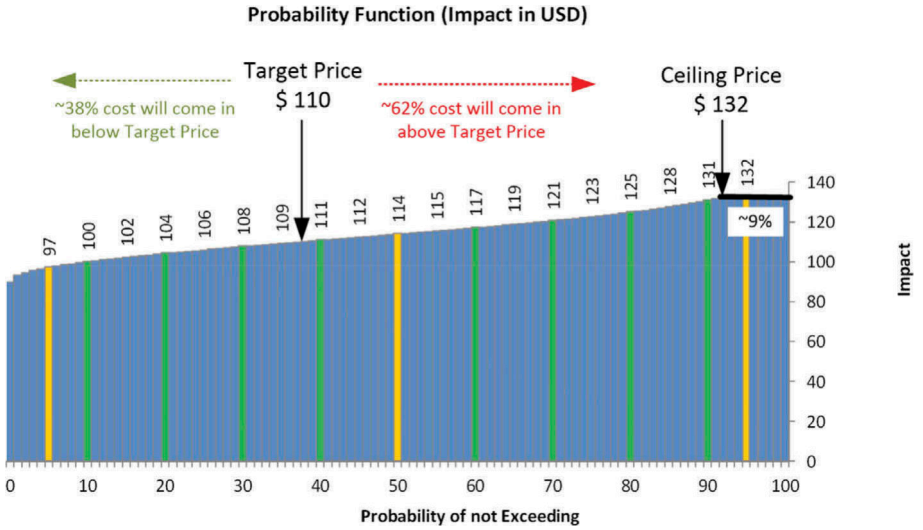


Figure 9. Owner's view of Cost/Probability Function.

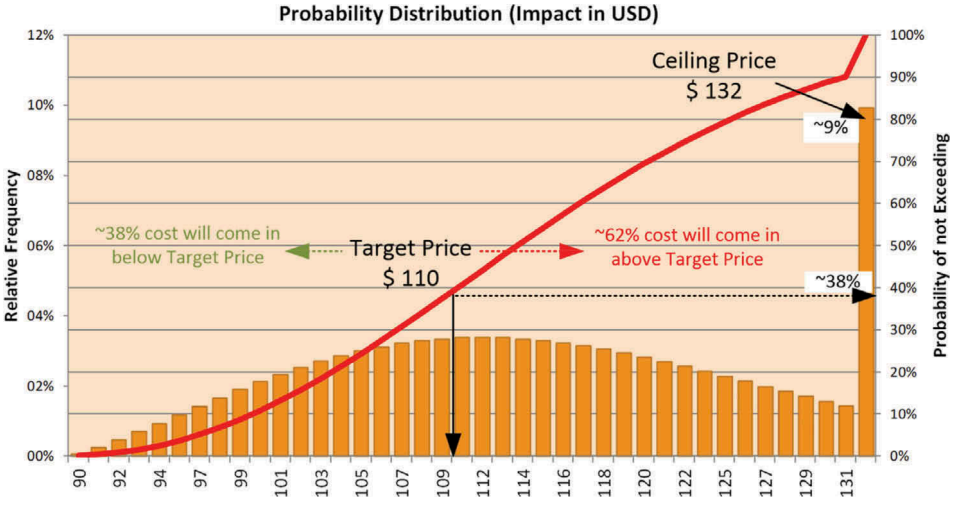


Figure 10. Owner's view of Cost/Probability Distribution.

6 CONCLUSION

The FPIF contract model is a way to implement shared cost goals and to establish a collaborative working environment, using incentives based on a pain/gain mechanism. One key to the FPIF contract is a consensual agreement on the target cost. The individual risk potential for a chosen target cost for the contractor and owner should be calculated using probabilistic methods. For the contractor, the probability is relevant in estimating the potential to increase his profit or risk to suffer loss. For the owner, the deviation from the target price with the corresponding probability is the basis for the evaluation of the contract. The probabilistic results transparently show the risk potential of both parties (Figure 11), allowing contract negotiations to be conducted from a common basis.

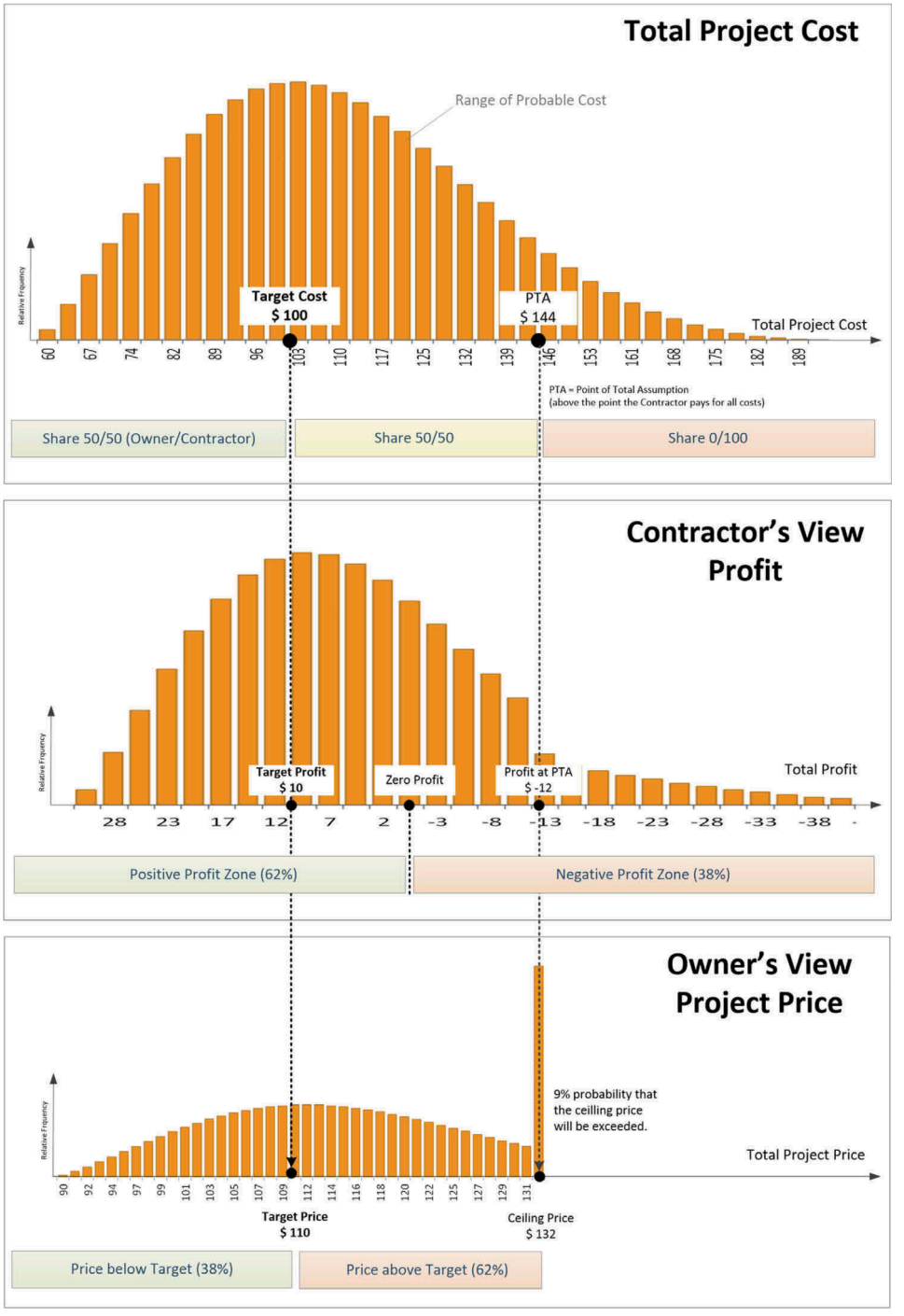


Figure 11. Combined results – Contractor's and owner's view.

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