Fundamentals of FPI Contract

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IBM Japan, APTO
### FPI Positioning

<table>
<thead>
<tr>
<th>Seller’s Risk</th>
<th>Buyer’s Risk</th>
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<tbody>
<tr>
<td>Price Fixed</td>
<td>Cost Reimburse</td>
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</tbody>
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**Firm Fixed Price**
- Fixed Price Incentives
- Time & Material

**Cost Plus Incentive Fee**
- Cost Plus Award Fee
- Cost Plus Fixed Fee

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<thead>
<tr>
<th>FFP</th>
<th>FPI</th>
<th>T&amp;M</th>
<th>CPIF</th>
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FPI Key Parameters

- Target Cost: $100,000
- Target Profit: $10,000
- Target Price: $110,000
- Ceiling Price: $120,000
- Share ratio: 70/30 (buyer/Seller)

Example
FPI Rule

- Target Cost (T_cost) $100,000
- Target Profit (T_profit) $10,000
- Target Price (T_price) $110,000
- Ceiling Price (C_price) $120,000
- Share ratio (S) 70/30 (buyer/seller)

- A_cost < 100,000 (T_cost)
  Saving "100,000-A_cost" is shared by both

- 100,000 < A_cost < 120,000 (C_price)
  Exceeding "A_cost−100,000" is shared by both

- 120,000 < A_cost
  Buyer pays only 120,000.
FFP Firm Fixed Price

- Contract Price : \( T_{\text{Price}} \)
- Actual Cost : \( X \)
- Profit : \( Y \)

\[
\text{Profit} = \text{Contract Price} - \text{Actual cost}
\]

\[
Y = T_{\text{Price}} - X \quad (1)
\]
Seller’s Risk under FFP

Gross Profit

Y

T_Price

Target Profit

Target

Cost

Target

Contract

Price

FFP seller’s Risk

Actual Cost (A_Cost)

X

FPI

Y = T_Price - X

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**FPI without ceiling**

Sharing ratio : \( S \) (Seller’s share)

Profit = \( T_{\text{Profit}} - \text{Sharing Ratio} \times (A_{\text{cost}} - T_{\text{Cost}}) \)

\[
Y = T_{\text{profit}} - S \times (X - T_{\text{cost}}) \\
= T_{\text{profit}} - S \times X + S \times T_{\text{cost}} \\
= T_{\text{price}} - T_{\text{cost}} - S \times X + S \times T_{\text{cost}} \\
= T_{\text{price}} - (1 - S) \times T_{\text{cost}} - S \times X \quad (2)
\]

“\( S \)” indicates the degree of the cost risk for the seller.
**Seller’s Risk under FPI w/o ceiling**

![Graph showing the relationship between Gross Profit, Target Profit, Target Cost, and Target Contract Price with formulas for FFP and FPI w/o Ceiling.]

- **FFP Seller’s Risk**
  
  \[ Y = T_{\text{Price}} - X \]

- **FPI w/o Ceiling Seller’s Risk**
  
  \[ Y = T_{\text{Price}} - (1-S)T_{\text{cost}} - S^*X \]

“\( S \)” indicates the degree of cost risk for the seller.
FPI (with ceiling) -1-

Y: profit
X: Actual cost

0 < Actual Price < Celing Price

Y = T_price - (1-S)*T_cost - S*X \quad (2)

Ceiling price < Actual price

same as FFP, then it will be

Y = C_price - X \quad (2')
Y: profit
X: Actual cost

Calculate Turning Point Cost (TP_cost)

\[ Y = T\_\text{price} - (1 - S) \times T\_\text{cost} - S \times X \quad (2) \]
\[ = C\_\text{price} - X \quad (2') \]

\[ X = T\_\text{cost} + \frac{(C\_\text{price} - T\_\text{Profit})}{(1 - S)} \]
Seller’s Risk under FPI with ceiling

\[ Y = C_{\text{price}} - X \]

FFP Seller’s Risk

FPI w/o Ceiling Seller’s Risk

Target Profit

Target Cost

Target Contract Price

Turning Point

FFP

Actual Cost (A_Cost)

FPI

FPI w/o ceiling

\[ Y = T_{\text{Price}} - (1-S)\cdot T_{\text{cost}} - S\cdot X \]
# FFP Cost Structure

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# Expectable FPI Cost Structure

**FFP**

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**FPI**

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End of Presentation
1. Background

Fixed Price Incentive (FPI) contract is one of the typical contract type and is described in educational textbooks of the project management (PM). It also appears in several PMP exam preparation books with calculation examples. However, it is difficult to find a book or an article that describes the fundamentals of FPI clearly. For example, in page 231-232 of “The Principles of Project Management” from PMI, 1997, it is described as follows.

“The most complex type is the fixed price-plus-incentive-fee contract, which is composed of a target cost, target profit, target price, ceiling price ad share ratio. Based on a ceiling price of $120,000, target cost of $100,000, target profit of $10,000, target price of $110,000, and share ratio of 70/30, for every dollar the seller can reduce costs below $100,000 the saving will be shared by the buyer and seller based upon the negotiated sharing formula which reflects the degree of uncertainty faced by each party. Assuming the seller tries to maximize profits, he or she is provided an incentive to reduce his or her costs by producing more efficiently. If costs exceed the ceiling price of $120,000, the seller receives no profit and the maximum price to the buyer is $120,000, regardless of the costs incurred by the seller. Consequently, risk is shared by both the buyer and seller. This incentive type of contract is usually used when contracts are for a substantial sum and involve a long production time. This enables the seller to develop production efficiency during the performance of the contract.” This is all the description about FPI in the book. Probably, we can understand it in general but not clearly.

From the point of view of the contract risk, it is said that the seller holds entire risk under FFP (Firm Fixed Price). To reduce the seller’s risk under FFP, FPI is introduced. The risk is shared by both the buyer and the seller. FPI seems reasonable but something difficult to understand its mechanism and to use it with confidence. This paper tries to provide the mathematical foundation of FPI contract and also considers the meaning of FPI from the point of view of the contract risk.

2. FPI contract

FPI is a contract based on FFP with the incentive or the penalty which is derived from the difference between the actual cost and the target cost. The incentive or the penalty is shared by both the buyer and the seller based on the pre-defined sharing ratio. The ceiling price is set as the maximum payment amount of the buyer in order to prevent from unlimited payment of the buyer.

In other words, if the actual cost becomes smaller than the target cost, the saved amount is distributed to both side based on the pre-defined sharing ratio and if the actual cost exceeds the target cost, the exceeded amount have to be covered by the both side based on the pre-defined sharing ratio until the actual price reaches to the ceiling price. When the actual price exceeds the ceiling price, all the exceeded amount have to be covered by the seller.

3. Seller’s risk under FFP

In order to analyze the FPI, we have better to start from reviewing the FFP. Let’s assume the following.

<table>
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<th>Contract price</th>
<th>T_Price</th>
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<tr>
<td>Actual cost</td>
<td>X</td>
</tr>
<tr>
<td>Profit</td>
<td>Y</td>
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Then the profit of FFP is expressed by the following linear formula.

\[ Y = T\_Price - X \]

As shown in fig-1, if X(actual cost) is smaller than the target cost (X < T_Cost), Y(profit) is greater than the target profit (Y > T_Profit). This means that the seller will gain the profit more than expected which is 100% of the saved cost. This is thought as a business opportunity. However, the X falls into the range between the target cost and contract price (T_cost < X < T_price), the seller’s profit is reduced by 100% of the exceeded cost to the target cost (reduced profit = A_cost – T_cost). This is still thought as a business opportunity to have a profit even though the amount becomes smaller than expected. If the actual cost exceeds the contract price (X > T_price), the profit becomes negative (Y < 0). This means that the seller have to cover the exceeded expense (A_cost – T_cost) by himself which is 100% of the exceed amount. This is thought as a business risk related to the FFP.

The characteristics of the FFP’s opportunity or risk is 100%. The saved cost or exceeded cost influences to the profit by 100%. In other words, only the seller holds the 100% of the business opportunity or the business risk under FPP.

4. Sharing business risks without ceiling
To reduce the business risk of the seller under FFP and to share the part of the risk by the buyer, it will be reasonable to define the sharing ratio of the cost risk before the execution of the contract. That is to share the saved or exceeded profit by the buyer and the seller based on the predefined sharing ratio. Let’s assume the ration as 70% for the buyer and 30% for the seller. If the actual cost exceeds the target cost by $100, the seller pays $30 and the buyer pays $70 to cover the exceeded $100. As the seller pays his $30 from the target profit, actually the profit is just reduced by $30 from the target profit. This is considerably small if it is compared by $100 under FFP. Then, the business risk of the seller is reduced and shared by the buyer.

However the sharing ratio is applied even to the saved cost. Then with the above example, the only 30% of the saved cost is given back to the seller and 70% of the saved cost is given back to the buyer if the actual cost becomes smaller than the target cost. Then, not only the business risk but also the business opportunity is shared by both side.

This mechanism is expressed by the following formula.
Let’s denote the sharing ratio of the seller side as “S”.
Profit = Target Profit – sharing ratio * ( Actual Cost – Target Cost )
Y = Target Profit + S * ( Actual Cost - Target Cost )
= Target Price - S * Actual Cost
= Target Price - (1 - S) * Target Cost

Figure 2 shows (2) comparing with (1) of FFP. The changes are (a) the coefficient of the linear equation is changed from 1 to S which is smaller than 1 and (b) the constant is changed from Target Price to “Target Price - (1 - S) * Target Cost” which is in between Target Price and Target Cost. In other words, the inclination becomes slower which shows the risk or opportunity is moving less drastically and the cross to the X axis become longer which means that the cost point of the zero profit become longer and then the cost risk of the seller become reduced.

However from the point of view of the buyer’s risk, the formula gives buyer the possibility of the unlimited risk share. It seems reasonable to share the risk at around the target cost because the target cost is just an estimate and the actual cost may defer from the estimate a little bit. But it will not be reasonable and will cause another business risk of the buyer if the risk share continues unlimitedly. That is why the ceiling price is introduced.

5. Sharing business risks with ceiling
To avoid the buyer’s risk caused by unlimited risk share, the ceiling price is introduced. It is know as the maximum amount of the payment for the contract. It means that the regardless of the risk share, the buyer will not pay anymore than the ceiling price.

Once the ceiling price is set, the actual price (total payment amount) is compared with the ceiling price and if it exceeds the ceiling price, the ceiling price is used instead of actual price. This is thought that the risk share of the buyer is quit and seller holds all risk. When the payment is exceeding the ceiling price, the formula (1) is applied.

It will be convenient to know the point where the ceiling price is used. The point is calculated by the following formula.

\[ \text{Turning point cost} = \text{Target cost} + \frac{(\text{Ceiling price} - \text{Target price})}{\text{Buyer share ratio}} \]

Proof)
Price = Cost + Profit
\[ \text{C_price} = \text{T_cost} + \frac{\text{T_profit}}{\text{S}} \]
\[ \text{D_cost} = \text{TP_cost} - \text{T_cost} \]
\[ \text{C_profit} = \text{D_cost} \]
\[ \text{S} = \frac{\text{S}}{\text{T_cost}} \]

From \( D \text{_cost} \) definition,
\[ \text{D_cost} = \text{TP_cost} - \text{T_cost} \]

Then,
TP_cost = T_cost + D_cost

By substituting D_cost by (a), we will get following
TP_cost = T_cost + (C_price - T_profit) / (1-S)

Proof end)

Then, with ceiling, FPI will be express by following.
0<X<= Turning point, apply (2). Y=T_price - (1-S)*T_cost - S*X
X> turning point, from definition Y=C_price - X (3)

Figure 3 shows total view of the FPI.
Even though there are lots of variables used in the explanation and the proof, required parameter for FPI contract are as follows.
- Target price (contract price)
- Target cost
- Ceiling price
- Sharing ratio

6. Seeking for risk balance and contract price reduction
Figure 4 shows the rough pricing structure of the FFP contract. Under FFP, all the risks after the contract establishment are on the seller. It is thought that the success of the project will be determined by the amount of the project reserve fund. Then, the project managers tries to get the reserve fund as much as possible. This is why the contract price becomes high under FFP. However thinking about the risk share by both the seller and the buyer, the project reserve fund is the fund to be shared by both. Figure 5 shows how the risk reserve can be shared under FPI. With this approach, risk reserve under FFP is taking out from the target price and put it back into the contract as the shared risk fund which enables the buyer to supply for the ceiling price. Even though the maximum payable price (ceiling) is same as the contract price of FFP, the target price (contract price) will be reduced and the final actual price has the possibility to be reduced.
Therefore the FPI is a contract worth to think about.

References
1. Adams, R.A ; Principles of Project Management, PMI, 1997
2. Wideman, R.M, Editor ; Project & Program Risk Management, PMI, 1992

BIO
Mr. Toru Nohzawa , PMP, BS, is a project manager in APTO( Asia Pacific Technical Operation), IBM Japan where he has been working for over 26 years. He has been engaged the development of the IBM 3767SNA Terminal, IBM3276 Display Controller, IBM5550 Multi-station, Japanese Word processor, Japanese PC DOS, IBM9103 Pen PC . He is the author of the Japanese PM book entitled “ the PMBOK and EVMS, the global standard of the project management “ from JUSE press, Tokyo. He holds Master’s certificate in project management from George Washington University and is a certified ISO9000 auditor.
Seller’s risk under FFP

Figure 1. Seller’s risk under FFP

\[ Y = T_{price} - X \]
Seller’s risk under FPI without ceiling

Figure 2. Seller’s risk under FPI without ceiling
Figure 3. Seller’s risk under FPI with ceiling
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Figure 4  FFP cost structure

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Figure 5  FPI cost structure example