A survey of payment mechanisms for public-private partnership transportation projects: Comparisons of the US, India, and Mexico

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I. Introduction

The past few years have seen an increasing focus on infrastructure investments. The emergence of infrastructure as a separate asset class with stable returns over long periods has resulted in a large number of investment funds being set up. This increased interest on the part of the financial investor is matched by the demand for new infrastructure by developed and developing countries. Developed countries like the US and UK are unable to provide public funding for the redevelopment of existing infrastructure due to budget constraints. Developing countries like India and Mexico need new infrastructure to support their double-digit growth rates. Private participation has arisen to fill this gap in funding.

Even in the current climate of tightening credit markets and a recessionary global economy, there remains sufficient interest in infrastructure. Placement agent Probitas Partners estimated that 77 infrastructure funds were hoping to raise nearly $92 billion in capital as of year-end 2008. Morgan Stanley estimated that the total investment in infrastructure funds amounted to $180 billion as of January 2009. [1]

With the global economy headed for a recession, governments are increasingly focusing on fiscal policies in infrastructure projects that will result in greater long-term benefits for the economy. The current environment thus provides ample opportunity for good infrastructure investments. However, governments will need to ensure that regulatory conditions are conducive to the successful implementation of projects. Infrastructure projects by their very nature tend to be quasi monopolies. As a result, the private participation in projects needs to be highly regulated so as to ensure that private players do not get undue advantage at the expense of the general public. Additionally since infrastructure projects provide a positive externality that extends beyond the immediate users of that infrastructure, private players need to be

[1] Borel (2009)

compensated adequately. Thus, the kind of payment mechanism so chosen will have a large impact on the viability of the infrastructure project. The government subsidies so provided will have a large influence on making the project viable.

This paper aims to establish the factors that are responsible for the success of public-private partnership (PPP) infrastructure projects -- specifically, transportation projects.

II. History of public-private infrastructure projects

US

Private participation in US infrastructure is not a new phenomenon. Roadways were first developed in the eighteenth century by the private sector in the form of tollways and turnpikes. The private sector was also involved in the nineteenth century in the development of canals and railroads. In the twentieth century, with the growing economy and the need for new infrastructure, the state governments and the federal government assumed the responsibility for providing infrastructure. As growth shifted towards suburban locations following World War II, the United States experienced unprecedented growth in car ownership and the demand for mobility.

Recognizing that the nation's highway system was inadequate to meet growing demands, President Eisenhower called for the construction of a comprehensive national system of high performance roads. This was achieved with the passage of the Federal-Aid Highway Act of 1956, which appropriated $25 billion to construct over 42,400 miles of interstate highways within a ten-year period. While the authority to levy user fees on existing toll roads was grandfathered, by law tolls were not allowed on the new Interstate Highway System. Instead the program was funded by a national fuel tax of four cents per gallon paid into a national Highway

Trust Fund, together with a vehicle excise tax. The trust fund paid for 90 percent of highway construction costs, with state governments required to pay the remaining 10 percent. [2]

However, the Highway Trust Fund was not able to keep pace with the growing demand for infrastructure. The 1980's saw a reemergence of private participation in public sector projects, especially in the rapidly developing western and southern states. In 1987, Congress also approved a pilot program authorizing 35 percent federal funding for government-sponsored toll road projects in nine states.[2] Australia and European countries had already successfully implemented public private partnership (PPP) projects. Virginia and California were among the first states to introduce the PPP nature of financing in their projects. The Dulles Greenway was the first project implemented in the US under the PPP model. In 1988 the Virginia Department of Transportation was the first to implement legislation enabling private participation. The California Department of Transportation followed suit in 1989. Currently 23 US states and Puerto Rico have enacted legislation to enable PPP implementation in transportation projects (see figure 1).[3]

[2] Perez (2006)
[3] http://www.fhwa.dot.gov/PPP/

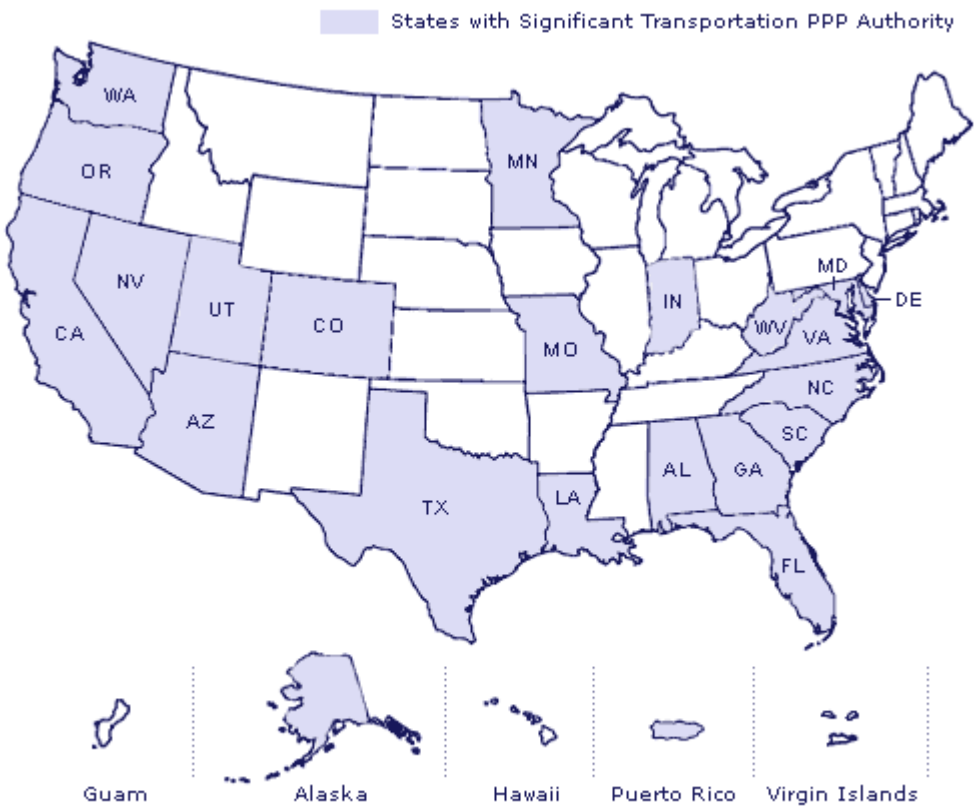

Figure 1. States with PPP enabling Statutes.[4]

India

PPP projects have been in existence in India for nearly a decade. However, a large number of these projects have been awarded in the past five years. For a developing economy like India, almost all infrastructure investments have been predominantly greenfield projects. Like the US, development across states has varied greatly. States such as Rajasthan, Andhra Pradesh, and Madhya Pradesh have the highest number of PPP projects implemented. The PPP India database[5] estimates that a total of 221 projects have been either successfully implemented

[4] http://www.fhwa.dot.gov/PPP/
[5] http://www.pppinindia.com/database.asp

or completion is imminent. A large proportion -- nearly 80% -- have been in the road sector. Ports are second and account for nearly 17% of the total number of projects.

The 11th Five year plan (2007-2012) estimates that a total investment of US $494 billion will be devoted to infrastructure projects. It aims to increase total investments from 4.5% currently to 8% of GDP. It estimates that the current funding requirement will not be met by public sector funding alone. Private participation will be essential through PPPs. The government has taken some key initiatives to enable successful implementation of PPP projects.

The PPPAC (Public Private Partnership Appraisal Committee) has been set up to streamline the PPP procurement procedure. A Viability Gap Funding Scheme (VGF) has been established to fill the funding gap for PPP projects that are not commercially viable. Up to 20% of the total project cost can be provided as upfront grant assistance. The Government of India (GOI) has also established the IIFCL (India Infrastructure Finance Company Limited), a wholly government owned company to provide financing to infrastructure projects.

Mexico

The rapid development of Latin American countries propelled the need for large infrastructure investments in the 1990's. Major PPP programs were initiated in Argentina, Brazil, Colombia, and Mexico.

Most of the Mexican projects followed the concession models, namely BT (Build Transfer) and OT (Operate Transfer)[6]. They were marked by a very high degree of renegotiations. The new toll roads and infrastructure investments were expected to jumpstart a relatively stagnant economy. The government budget deficits implied that private participation was necessary. The government awarded nearly 52 projects between 1987-1995. This became one of the largest PPP toll road programs in the world. However, Mexican projects were marked

[6] Refer to Appendix

by increased numbers of failed projects. It is estimated that the cost over-runs averaged 25% across all projects. Additionally, toll roads were required to have a parallel toll-free road. The government in turn guaranteed the traffic. However the Tequila crisis in 1994 of increasing interest rates aggravated the problem and a large number of projects needed massive government bail-outs.

The toll road concession failures in the 1990's gave way to more sustainable structures' being developed. Further the advent of experienced players in recent toll road projects have resulted in successful delivery. Local debt markets with more patient capital have replaced local bank short-term financing for road PPP projects.[7] All of these factors have resulted in the creation of an environment that is more sustainable for infrastructure development.

III. Previous Work

Extensive research has been carried out to determine the factors that influence PPP implementation. Hammami et al.[8] describe the common factors across countries that result in a larger number of PPP investments. That paper looks at the macroenomic factors that result in a larger number of projects implemented through the PPP model. The paper concludes that governments with heavy debt burdens, high aggregate demand, well established institutions, and less-corrupt countries have more PPP projects. However, the paper does not make a distinction between failed and successful projects.

The issue of the difficulty in determining the success of PPP projects has been widely addressed. Garvin et al.[9] describe the P3 Equilibrium framework as a means of determining the effectiveness of PPP implementation. They divide the success of a project into four main

[7] Aecom Consult (2007)
[8] Hammami (1999(
[9] Garvin, M.,(2007)

components: state, society, market, and industry. The success of a project is determined by mapping the four factors. A balanced project, wherein all factors are dominant, is considered to be a successful implementation of PPP projects.

Bosso et al.[10] determine the effectiveness of the PPP model for infrastructure projects in the United States. They apply the P3 framework developed by Garvin et al. to specific case studies and declare a project a success if it is able to balance all four components.

Our work is closest to the work by Saussier et al.[11] that studied water distribution systems in France. That paper determines how PPP projects are chosen and how PPP impacts performance.

IV. Data Selection

US

The data for the US are based on the 2008 toll road survey conducted by the US Transportation Department. All data that had project costs equal to zero have been eliminated. This sample is representative of all the toll roads present in the US. The research conducted by the US Department of Transportation has identified 235 toll highway improvement projects and 45 toll bridge or tunnel improvement projects since 1992.

It should be noted that the database provides the project cost information only for those projects where estimates were available. Our analysis uses only the subset of data for which cost estimates were available, reducing the number of projects to 196. The "innovative financing tool" flag is used to identify projects in which a new kind of financial instrument was used. This refers to any kind of new project financing technique that has been used -- for example, variable pricing, toll revenue bonds, etc. This classification is based on the "Innovative Financing Tool"

[10] Bosso, Doran J. (2008)
[11] Saussier, Stéphane (2006)

column present in the US transportation database. If a valid entry exists, implying that a new project delivery technique was used for that particular project, then a value of 1 (TRUE) has been registered.

The data variables are explained below:

Variable Name	Type	Description
Status	Dependent Variable	1= Success; 0= Failure. A failure is assigned to a project that has been cancelled or is on hold. All other projects are considered to be successes.
Key Dates	Independent Variable	The year in which the project is awarded.
Length	Independent Variable	Length of the toll road in miles
Type of Road	Independent Variable	Roads are classified as nonradial, intercity or radial.
Type of Financing	Independent Variable	If a project uses an innovative financing technique, it is assigned 1.
Greenfield	Independent Variable	If a project is a greenfield project it is assigned 1.
Cost	Independent Variable	The project cost in millions of dollars.

Summary

Statistics

	ln(lanes)	ln(length)	Status	Non-Radial	Intercity	Radial	Type of Financing	ln(cost)	PPP	Greenfield
min	0.00	-1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
max	3.58	5.39	1.00	1.00	1.00	1.00	1.00	8.96	1.00	1.00
range	3.58	6.50	1.00	1.00	1.00	1.00	1.00	8.96	1.00	1.00
Std. Dev	0.48	1.03	0.29	0.50	0.38	0.48	0.45	1.79	0.26	0.49
mean	1.20	2.61	0.91	0.45	0.17	0.34	0.27	5.61	0.07	0.62

India

The data for India are provided by the Indian government on the PPP website.

The data variables are explained below:

Variable Name	Type	Description
Status	Dependent Variable	1= Success; 0= Failure. A failure is assigned to a project that has been cancelled or is on hold. All other projects are considered to be successes.
Type of Project	Independent Variable	Projects are classified as Airports, Ports, Roads, or Railways.
Contract Period	Independent Variable	The project contract period implies the number of years that the government leases the infrastructure property to the private player.
Debt to Equity Ratio	Independent Variable	This refers to the debt equity ratios for the project.
Government to Private Equity Ratio	Independent Variable	This refers to the ratio of the subsidy that is provided by the government to the total equity that is provided by the private investor.
Tenure of Loan	Independent Variable	This refers to the term of the loan in number of years.
Project Cost	Independent Variable	This refers to the project cost in US $.

Summary Statistics

	Airports	Ports	Railways	Contract Period	Project Cost	Debt Eq Ratio	Govt. Pvt. Eq Ratio	Tenure Of Loan	Status
Min	0.00	0.00	0.00	1.00	0.95	0.00	0.00	0.00	0.00
Max	1.00	1.00	1.00	50.00	8600.00	46.98	1.17	17.00	1.00
Range	1.00	1.00	1.00	49.00	8599.05	46.98	1.17	17.00	1.00
Mean	0.02	0.10	0.02	18.38	419.28	0.80	0.03	1.39	0.91
Std Dev	0.15	0.31	0.13	8.98	955.01	3.68	0.14	3.96	0.28

Mexico

The data for Mexico are based on the World Bank database on PPP projects. The World Bank's PPP database constitutes the largest dataset for projects implemented through the PPP model. The data variables used in our analysis are explained below:

Variable Name	Type	Description
Status	Dependent Variable	1= Success; 0= Failure. A failure is assigned to the project that has been cancelled or is on hold. All other projects are considered to be successes.
Project Cost	Independent Variable	This variable refers to the project cost in US dollars
Type of project	Independent Variable	Projects are classified as Roads, Ports, and Airports
Contract Period	Independent Variable	The project contract period implies the number of years that the government leases the infrastructure property to the private player.
Government Subsidy	Independent Variable	This refers to the amount of government subsidy
Greenfield	Independent Variable	This refers to the whether the project is greenfield or brownfield. A value of 1 is assigned for projects that are greenfield.

Summary Statistics

	Greenfield	Roads	Railroads	Contract period:	Project Cost	Government Subsidy	Status
Min	0.0	0.0	0.0	12.0	17.6	0.0	0.0
Max	1.0	1.0	1.0	50.0	1031.0	37.0	1.0
Range	1.0	1.0	1.0	38.0	1013.4	37.0	1.0
Mean	0.6	0.9	0.1	25.4	166.9	1.7	0.7
StdDev	0.5	0.3	0.3	7.3	185.8	7.0	0.5

V. Results

Our analysis aims to determine the factors that influence the successful implementation of PPP projects. We present the regression results for the PPPs below.

US

The similarities between the qualitative results of the OLS and the logistical models should be noted. Results across projects for the US projects show some dependency on the nature of the road. The presence of financing has a strong statistically significant negative impact on the nature of the project. Private investors and government officials may be unsure of the factors that are necessary for implementation of new financial instruments. As a result, the use of a new innovative financing technique may result in projects becoming unsuccessful. The learning curve associated with the implementation of these projects may help explain why these projects have a higher likelihood of failing.

Logistic Regression

Predictor	Coef	P
Constant	25.44	1.00
ln(lanes)	-0.06	0.94
ln(length)	-0.66	0.15
Intercity	0.50	0.61
Radial	-1.25	0.06
Financing Involved	-1.60	0.01
ln(cost)	-0.05	0.87
PPP	1.29	0.18
Greenfield	-20.44	1.00

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Pearson	159.87	186	0.92
Deviance	84.07	186	1.00
Hosmer-Lemeshow	17.79	8	0.02

OLS

Predictor	Coef	P
Constant	1.13	0.00
ln(lanes)	0.04	0.57
ln(length)	-0.03	0.20
Intercity	0.01	0.83
Radial	-0.06	0.15
Financing Involved	-0.17	0.00
ln(cost)	-0.01	0.70
PPP	0.12	0.16
Greenfield	-0.15	0.01

S = 0.272378 R-Sq = 15.1% R-Sq(adj) = 11.5%

India

The regression results for India are presented in the table below. The similarities between the OLS regression and the logistic model regression should be noted. Both indicate a strong dependency on the contract period. The longer is the contract period, the higher is the likelihood of success. Most projects in India are greenfield projects. Thus, the ramp-up periods for traffic to pick up may be long. As a result, the longer the contract period, the more time private investors

have to recover their investment and generate profits. It should be noted that the level of debt or the size of the project do not seem to have a statistically significant impact on the success of the project. This is an important conclusion. Since projects are dependent on the contract periods, it is up to the government entirely to devise schemes in which the private player is granted a larger period of access to recover his investment.

Logistic Regression

Predictor	SE Coef	P
Constant	0.36	0.06
Aiports	4237.23	1.00
Ports	1772.84	1.00
Railways	5028.77	1.00
Contract Period	0.05	0.01
Debt Eq Ratio	441.21	0.99
Govt. Pvt. Eq Ratio	5682.38	1.00
Tenure Of Loan	133.23	1.00
ln(Cost)	0.14	0.54

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Pearson	101.57	173	1
Deviance	60.51	173	1
Hosmer-Lemeshow	6.95	8	0.54

OLS

Predictor	SE Coef	P
Constant	0.05	0.00
Aiports	0.16	0.49
Ports	0.08	0.03
Railways	0.21	0.62
Contract Period	0.00	0.00
Debt Eq Ratio	0.01	0.74
Govt. Pvt. Eq Ratio	0.22	0.33
Tenure Of Loan	0.01	0.73
ln(Cost)	0.01	0.03

S = 0.271721 R-Sq = 22.4% R-Sq(adj) = 19.8%

Mexico

The results for Mexico are consistent with India. The contract period is the single most important variable that determines the success of the projects. OLS and Probit regression provide consistent data. As in the case of India, emerging market data show that ramp-up periods form an important factor in the successful implementation of the projects. Since the effects of demand fluctuations are cancelled out over time, the private investor is able to recover his initial investment. This result is particularly interesting for Mexico, which during the 1990's awarded projects to investors with the shortest contract period. This period was marked by failed projects that went back for renegotiations with the government and have been successfully implemented since.

Logistic Regression

Predictor	Coef	P
Constant	10.45	0.42
Greenfield	-0.19	0.87
Roads	-13.77	0.36
Contract period:	0.27	0.02
Capacity	-0.01	0.22
Government Subsidy	1.00	1.00
ln(Cost)	-0.14	0.85

Goodness-of-Fit Tests

Method	Chi-Square	DF	P
Pearson	22.70	25	0.6
Deviance	26.05	25	0.4
Hosmer-Lemeshow	3.03	8	0.9

OLS

Predictor	Coef	P
Constant	0.371	0.57
Greenfield	-0.061	0.73
Roads	-0.156	0.8
Contract period	0.039	0.01
Capacity	-0.001	0.17
Government Subsidies	0.001	0.95
ln(Cost)	-0.078	0.45

S = 0.431808 R-Sq = 30.9% R-Sq(adj) = 15.9%

VI. Conclusion

PPPs are essential for the development of infrastructure projects. Without the involvement of the private sector, governments will not be able to meet the growing infrastructure demands of their countries. However, successful implementation depends in large part on correct government strategies. Emerging markets like India and Mexico have predominantly greenfield PPP projects. As a result, the ramp-up periods may be excessively long. Thus, governments should try increasing the leasing period. This may be politically controversial since most investors tend to be from foreign countries. Too large a lease period may encourage political arguments that the private player gets to take an undue advantage of the assets at the expense of the taxpayers' money.

On the other hand, increasing the lease period implies that the financial investor has a longer period of time to recover its investment. Emerging markets are especially prone to large variations in the ramp-up period. Since demand estimations are subject to greater uncertainty in emerging markets, the project success is highly dependent on the lease period. Additionally, infrastructure projects in the emerging markets are predominantly greenfield. For greenfield projects, past historical demand projections are not available.

However, the leasing period should be carefully determined by the emerging market governments on a case-by-case basis. Emerging markets need to reexamine past history and specific demand characteristics of the infrastructure project to determine the lease period. A one-size fits all approach may not be the best way to go. Projects with no supporting infrastructure -- for example, ports with no road/rail linkage -- will be a far riskier investment as compared with ports that are well connected to roads/rail. In the latter case, demand estimations can be assumed to be more robust. Thus, such a project will have a greater chance of recovering the investment in a shorter period. In such a case, the project lease period can be shorter.

Future research should focus on formulating an exact relationship between the number of years that is ideal for a contract period and its dependency on country macroeconomic factors -- such as projected GDP growth, fiscal and monetary policies -- and microeconomic factors -- such as project costs, kind of leverage, project type. The negative costs to taxpayers associated with long concession periods should also be considered in arriving at the concession lease period.

VII. References

Borel, Philip; Podkul, Cezary; De Bever, Leo, March 2009, "The New Infrastructure: A Real Asset Class Emerges"

Perez, Benjamin G. 2006, "Public-Private Partnerships and the Development of Transport Infrastructure: Trends on Both Sides of the Atlantic"

http://www.fhwa.dot.gov/PPP/

http://www.pppinindia.com/database.asp

Aecom Consult, US Department of Transportation, Work Order 05-002, "Case Studies of Transportation Public-Private Partnerships around the World Final Report"

Strong,John S., (2007) "Managing Risks of Infrastructure Investment in Latin America: Lessons, Issues, and Prescriptions", Working paper, Inter-American Development Bank

Hammami,Mona ; Ruhashyankiko,Jean-Francois ; Yehoue,vEtienne B. 1999 "Determinants of Public-Private Partnerships in Infrastructure", IMF Working paper

Bosso, Doran J. (2008)"Effectiveness of Contemporary Public-Private Partnerships for Large Scale Infrastructure Projects in the United States", Thesis submitted to the Faculty of the Virginia Polytechnic Institute

Garvin, M.,(2007). “Are Public-Private Partnerships Effective Infrastructure Development Strategies”. Construction Management and Economics 25th Anniversary Conference. University of Reading, UK.

Saussier, Stéphane (2006) "Public-Private Partnerships and Prices: Evidence from Water Distribution in France"

VIII. Appendix:

Public-private partnerships (PPP) refer to contractual agreements formed between a public agency and private sector entity that allow for greater private sector participation in the delivery of transportation projects [3].[12]

Public Responsibility — Private Responsibility

PPP Options			
New Build Facilities	Design Build	Design Build Operate (Maintain)	Design Build Finance Operate
Existing Facilities	O&M Concession		Long Term Lease
Hybrid			Lease Develop Operate

Source: [13]

The payment mechanisms for PPP projects vary widely, and the most widely used packages include Build-Operate-Transfer (BOT), Design-Build Finance-Operate-Transfer (DBFO), and performance based DBFO. The kind of PPP contract so chosen determines the level of private sector involvement. The above diagram ranges from the public sector; taking a majority of the responsibility (Design build, O&M) to complete private sector responsibility such as DBFO and long-term leases. The kind of payment structure chosen is crucial to the success of the project since it ties the private player's incentives to the government's goals. The following sections briefly describe various PPP schemes in use.

[12] http://www.fhwa.dot.gov/PPP/
[13] http://www.fhwa.dot.gov/PPP/

Design Build

The design-build model combines two separate contracts: the designing or engineering services with the construction service. In the design build model, the private player receives a fixed fee for both the engineering service and the construction of the project. The private player can either be a single form or a consortium of different players. The private player assumes the risk of variability in costs of construction. Typically, the winning bid is based on both the technical ability of the private player and the cost to the government in the form of the fixed fee.

Design Build Operate (Maintain)

The design build operate model combines the design build model with the maintainance and operation of the project. This is also known as the BOT (Build Operate Tansfer model) and turnkey model. The financing is procured by the public sector. Typically, the operating risk is borne by the public sector. The private players bears the risk of cost overruns and project construction and design.

Design Build Operate Finance

Under this approach, design, build operate is combined with financing. The private player bears of financial risk. This typically takes the form of toll revenue. Other forms include lease payments and shadow tolls, wherein the goevrnment pays the tolls and vehicle registration fees.

O&M Concession

In this form of PPP, the private player assumes the responsibility of asset operation and management. The private player is compensated either on a fixed fee basis or on an incentive basis.

Long Term Lease

In this form of PPP, the private player is leased the asset, and it can in turn levy tolls on the asset and collect revenues. In return the private player operates and maintains the government asset. Typically, the private player pays an upfront concession fee. In some cases, the concession is spread over the life of the asset, as in India. Typically procurement is through a bidding process, with the bid going to the highest bidder.

Lease Develop Operate

This is similar to the lease operate model, except the private player is expected to expand the existing facility. The private player typically has to inject capital for maintenance and enhancements to the asset.