A Re-Equilibrium Model for PPP Contracts

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ABSTRACT

PPP contracts are contracts with special nature that tend to have longer contract durations compared to other conventional procurement methods; hence, contract re-equilibrium becomes an inevitable need. The objective of the re-equilibrium process is to maintain the IRR of the private sector constant. In this paper, a framework is established to calculate the different re-equilibrium scenarios. The framework proposed in this paper, in addition to addressing a constant IRR, can also be customized to work with any other contractual financial ratio such as ROE. A spreadsheet model is developed with the aid of Microsoft Excel and VBA programming language.

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Introduction

Public Private Partnership (PPP)

Public Private Partnership (PPP) is recognized as a mechanism that achieves cooperation between the public and the private sectors. The agreement is usually referred to as the "concession agreement" while the duration of the contract is the "concession period". The durations of PPP contracts tend to be long compared to other conventional delivery methods. The heart of PPP agreements is that the private sector finances a PPP project, with the project ownership retained by the private sector then transferred to the public sector at the end of the project. Moreover, PPP agreements also include design, build, operate, maintain, develop, buy, or refurbish agreements. PPP contracts have many types that are basically combinations of the previously mentioned agreements. Examples of PPP contracts are design-build-finance-operate (DBFO) contracts, build-operate-transfer (BOT) contracts, and build-own-operate (BOO) contracts.

Importance of PPP

Governments strive to enhance the economic growth of their states. This requires enhancing existing services and working on developing beneficial strategic projects, such as infrastructure projects. According to the Construction Management Association of America (CMAA), Public Private Partnership is one of the mechanisms that governments employ to engage private sector financing in the development process (The Construction Management Association of America, 2012).

The importance of the Public Private Partnership approach is that it supports and helps governments achieve their strategic plans in shorter time periods. The private financing provided through the Public Private Partnership model helps in allocating governmental funds to other strategic projects and services. Moreover, the private sector partner is usually more efficient as its goal is to obtain higher profits.

This is why the private sector becomes more efficient than the government. This allows governments to achieve a greater number of goals in a relatively short period of time with high efficiency. This in turn boosts the economic growth of the state.

Moreover, the Public Private Partnership contracts are based on service availability, which means that the private sector is not to be paid unless the service is being provided to the users according to the contract specifications. In other words, the Public Private Partnership mechanism ensures that the private sector is not being paid for an incomplete or insufficient service. Hence, the private sector is keen to provide the service on time and according to the contract specifications in order to collect the expected revenues as planned. This minimizes the probability of time delays and cost overruns in PPP projects tremendously. Furthermore, Public Private Partnership contracts can be of great benefit to the end users of a service. In order to maximize its revenues, the private sector usually tries to provide the service earlier in the concession period in order to increase the operation period, thereby increasing revenue.

PPP Financial Model

The private sector is required to submit a financial bid during the tender stage of the project. The financial bid of the PPP project is different from conventional projects, as it includes detailed calculations comprising all costs and revenues associated with the PPP project. This is due to the complexity of the funding methods used in PPP projects. The financial model is usually done on a spreadsheet, such as Microsoft Excel. According to the Public Private Partnership Handbook issued by the Asian Development Bank, the main purpose of the private sector financial model is to calculate all the direct and indirect costs, contingencies, and profits in order to come up with the service fees, (Public Private Partnership Handbook, 2008).

The model includes assumptions, inputs, and outputs. Assumptions include inflation rates, taxes, etc. Moreover, the modeller should input the capital expenditure (Capex), the operating expense (Opex), equity and debt service data, revenues based on forecasted demands or production rates, etc. The model also includes calculations of the different financial statements of the Special Purpose Vehicle (SPV), including income statements, cash-flow statements, profit and loss accounts, and the balance sheets. The model also provides a group of financial indicators such as the Internal Rate of Return (IRR), Return on Equity (ROE), Annual Debt Service Coverage Ratio (ADSCR), and Loan Life Debt Service Cover Ratio (LLCR).

The Need for a Re-equilibrium Model

Despite its many advantages, PPP contracts are risky contracts due to their long term nature which make them prone to contract renegotiation more often than any other type of contracts. A need is rising for a tool which preserves, on the longer term, the rights of both the public and the private sectors. This tool should be able to return the equilibrium back to the PPP financial model in an unbiased manner. The following sections explain a framework of a re-equilibrium technique to be used in renegotiating the PPP contracts.

Results of Renegotiation

The output of the renegotiation process is usually a change to the financial model, which reflects a number of possibilities, such as a change to the service charge rate, a change to one or more of the different cost items, a change to the concession period, etc.

Ho, in his paper entitled "Model for Financial Renegotiation in Public Private Partnership Projects and Its Policy Implications: Game Theoretic View," develops a dynamic game model, which means that the decision makers in the model make their decisions in sequence; in other words, the government knows the decision of the private sector before making their new decision, and vice versa. A game theory model is a term describing "the study of mathematical models of conflict and cooperation between intelligent rational decision-makers" (Myerson, 1991). The aim of Ho's model is to help the public sector in developing new policies and regulations to avoid the opportunistic behavior of the private sector bidders by comparing the political cost of re-tendering the project versus the political cost of renegotiation (Ho, 2006).

When discussing the results of the renegotiation process, the question shall always be whether to accept or reject the renegotiation claim. Ho, in his paper entitled "Government Policy on PPP Financial Issues: Bid Compensation and Financial Renegotiation," has developed a model to answer this question.

Table 1. Renegotiation Outcomes (Guasch L., 2004)

Renegotiation Outcome	% Renegotiated Contracts
Delays on investment obligations targets	69%
Acceleration of investment obligations	18%
Tariff Increases	62%
Tariff Decreases	19%
Increase in the number of cost component which increase tariff	59%
Extension in the Concession Period	38%
Increase Annual fees paid by the Operator	17%
Decrease Annual fees paid by the Operator	31%

Ho recommends avoiding renegotiation as much as possible, as it usually favors the private sector and may harm

the competitive nature of the bidding process. Ho develops a game-theoretical model for the financial renegotiation process (Ho, 2009).

In the below table, Guasch, Laffont, and Straub demonstrate the percentage of negotiated contracts with a certain renegotiation outcome. As shown in Table, 69 percent of the renegotiated contracts in the selected sample agreed to delay the targets of the investment obligations of the private sector (Guasch *et al*, 2007).

Xu *et al* developed a pricing model to calculate the price of PPP contracts both before and after renegotiation in their paper entitled, "Developing a Concession Pricing Model for PPP Highway Projects", (Xu *et al*, 2012). They generated a simplified equation to calculate the concession price present value based on the in and out cash flows, considering the construction and operation costs, the loan repayment, taxes, and revenues. Equation shows the steps of calculating the concession price by considering the financial elements and price parameters of PPP. Xu *et al* developed a price adjustment mechanism in order to account for unforeseen risks and fluctuation in inflation and interest rates in the original pricing equation. **Error! Reference source not found.** shows the different PPP risks and their effect on the pricing equation (Xu *et al*, 2012).

$$P = \frac{P_t}{(1+INF)^t} \qquad P_t = \frac{\sum_{t=1}^{T_0}\frac{C_t}{(1+i)^t} - \sum_{t=T_{0+1}}^{T_c}(Y_{1t}+Y_{2t}Pl_t - L_tR_t - C_{0t} - TA_t - TB_t - TC_t)(1+i)^{-t}}{\sum_{t=T_{0+1}}^{T_c}Q_t(1+i)^{-t}}$$

Concession price P ,
Concession price in the tth year P$_t$,
Daily average traffic flow in the tth year Q$_t$,
Other operation income in the tth year (i.e. advertisement income etc) Y1$_t$,
Government subsidy in the tth year Y2$_t$,
Project capital fund in the tth year C$_t$,
Payment of loan principle in the tth year Pl$_t$,
Loan balance in the tth year L$_t$,
Interest in the tth year R$_t$,
Operation cost in the tth year C$_{ot}$,
Business tax in the tth year TA$_t$
Sales tax extra charges in the tth year TB$_t$
Income tax in the tth year TC$_t$
TC is the Concession Term.
T0 is construction period.
Inflation rate INF

Equation 1. PPP Pricing Equation (Xu *et al*, 2012).

The Re-Equilibrium Framework Development

During renegotiation, the only way to ensure the project success and viability is to make sure that all parties are compensated justly so that they can fulfill their obligations under the contract agreement. In other words, if the private sector is not getting a sufficient rate of return, the project will not function properly. This will eventually harm the interests of the public sector. In order to achieve this objective, a framework is developed in order to facilitate the PPP contract renegotiation process.
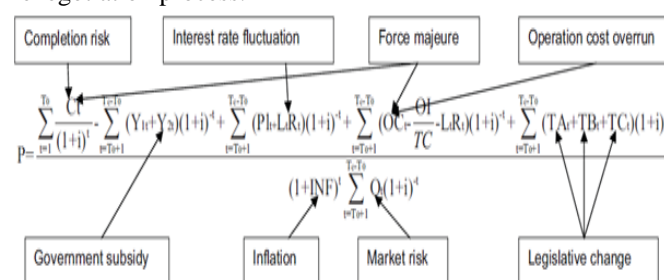
Equation 2. The Effect of PPP Risks on the Pricing Equation (Xu et al, 2012).

The proposed framework has five modules: a user-interface module, a risk allocation module, a PPP valuation module, a

financial model re-equilibrium module, and a scenarios development module. Each of the above modules has a number of sub-modules, as shown in Figure 1. The user-interface module has the project general information, risk allocation information, the initial payment information, and the updated payment information. The risk allocation module has the initial risk matrix corresponding to the contract. The PPP valuation module has the initial payment distribution and the PPP value calculations. The financial model re-equilibrium module has the updated payment distributions and the updated PPP value calculations. Finally, the scenarios development module has the re-equilibrium scenarios calculations.

User-Interface Module	PPP Valuation Module
Project General Information	Initial Payment Distribution
Risk Matrix	PPP Value Calculations
Risk Allocation Information	
Risk Impact	**FM Re-equilibrium Module**
Initial Payment Information	Updated Payment Distribution
Updated Payment Information	PPP Updated Value Calculations
Risk Allocation Module	**Scenarios Development Module**
Risk Allocation Tables	Re-equilibrium Scenarios Calculations

Figure 1. The Framework Sub-modules.

The User-Interface Module

The user-interface module networks with all the other modules. This module's function is to provide inputs to the risk allocation module, the PPP valuation module, the financial model re-equilibrium module, and the scenarios development module based in an interactive dialogue among those different modules and the user-interface module. There exists a continuous interaction between this module and the other modules along the operation of the framework. A set of inputs is entered, and based on the obtained results from a specific module the following set of inputs become ready to be entered.

The first set of inputs includes the project name, the PPP contract type, the payment mechanism, the payment amount, and the payment intervals. It also contains some information with regard to the risk allocation module about the risks profile of the project, including possible risks, their allocations, and their expected impacts on the project valuation process. The framework provides both options of having a standardized risk sheet and an inputted one. The risk sheet contains the PPP risks, and their preferred allocations and expected impacts on the valuation process.

Then, the user is asked to enter the second set of inputs: some information regarding the PPP valuation module, such as the initial payment distribution of the project, like the capital expenditure distribution along the lifecycle of the project, and other costs and revenues as well. The third set of inputs are for the financial model re-equilibrium module, such as the main reasons for the re-equilibrium of the contract. It also includes the updated payment distributions.

The above inputs are used in the scenarios development module in order to obtain the three common re-equilibrium scenarios:increasing the service charges, increasing the concession period, or paying a lump sum amount to the private sector.

The Risk Allocation Module

The risk allocation process is a very important process in construction projects, and it is even more important when dealing with long-term PPP projects. The significance of risk allocation is clear during the renegotiation process. As stated in the literature, the government shall only compensate the private sector for the portions of the risks that are allocated to the public sector; hence, a clear definition of risk allocation should exist in the PPP contract and be included in this proposed framework.

The inputs of the risk allocation module come from the user-interface module, while the outputs of the risk allocation module are heading for the PPP valuation module and the financial model re-equilibrium module. In the proposed framework, there are two options for obtaining the risk allocation percentages of the public sector and the private sector. The first option is the user-interface module via inputting the actual values of the risks allocation stated in the PPP contract, which is the ideal choice.

On the other hand, the risk allocation percentages can be obtained from a predefined risk allocation matrix. This is not the optimal choice, as it will not reflect the exact risk allocation percentages in the PPP contract; however, this option can be used when doing a quick check, or when the re-equilibrium value is already agreed upon and there is no need to look into the responsibilities and risk allocations in detail.

The risk allocation module also includes a section that studies the effect of certain risk occurrences on the different parts of the PPP valuation process. This will not only affect the PPP valuation process, but will also affect the financial model re-equilibrium module. Risks are the main triggers of renegotiation, which means that the events leading to renegotiation should be studied thoroughly and assigned to their corresponding risks in order to define the bearer of such risk. The financial model re-equilibrium module shall only account for a portion of the risks that are allocated to the public sector.

The PPP Valuation Module

The PPP valuation process is a very long and tedious process. In general, PPP project valuation is done through a financial model that incorporates all direct and indirect costs of the project; it also includes the revenues and contingencies. The purpose of the financial model is to come up with the service charge and the internal rate of return (IRR) of the project. The financial model also provides different forms of financial statements, such as the income statement, the cash-flow statement, and the balance sheet. Moreover, it calculates some financial ratios to help in evaluating the financial standing of the Special Purpose Vehicle. The financial model is quite important as it is considered the basis of any adjustments through the lifecycle of the PPP contract.

Xu et al developed a pricing equation that is used in the valuation process in their paper entitled "Developing a Concession Pricing Model for PPP Highway Projects" to calculate the PPP highway project price (Xu et al, 2012). In this paper framework, Xu et al equation is edited to suit various types of PPP projects. Some symbols are changed for the ease of notation as shown in Equation. The PPP price at a certain point in time is the summation of all the cash in and cash out flows of the project. The equation considers only the items that will have a significant effect on the PPP value and ignores minor items.

The cash in items are the operation income (OI) and the government subsidies (GS), while the cash out items are the capital expenditure (Capex), the loan principle (LP), the loan interest, which is the loan balance (LB) multiplied by the loan interest (Li), the operation cost (Opex), and taxes (T). All the

above costs and revenues are discounted at a fixed interest rate (i) to get the present value of the PPP concession at time (t). The value of the PPP concession can be determined at any time along the construction period (T0) or the concession period (TC).

In this framework, a benchmark is taken at the beginning of the construction period to calculate the PPP value. The above terms are adjusted to account for inflation as per the PPP contract terms. Finally, the internal rate of return (IRR) is calculated for the free cash flow by equating Equation to zero and solving for the interest rate, which will be the IRR.

$$P = \sum_{t=1}^{T_0} Capex_t \, (1+i)^{-t} - \sum_{t=T_0+1}^{T_c}(OI_t+GS_t)(1+i)^{-t} + \sum_{t=T_0+1}^{T_c}(LP_t+LB_tLi_t)(1+i)^{-t}$$

$$+ \sum_{t=T_0+1}^{T_c} Opex_t \, (1+i)^{-t} + \sum_{t=T_0+1}^{T_c} T_t(1+i)^{-t}$$

Where:

Construction Period	T_0
Concession Period	T_c
Capital Fund at time t	$Capex_t$
Operation Income at time t	OI_t
Government Subsidy at time t	GS_t
Loan Principle at time t	LP_t
Loan Balance at time t	LB_t
Loan Interest at time t	Li_t
Operation Cost at time t	$Opex_t$
Taxes at time t	T_t
Interest Rate	i

Equation 3. PPP Valuation Equation.

The inputs of the PPP valuation module are taken from the user-interface module and the risk allocation module. The outputs of the PPP valuation module are used in the scenarios development module.

The inputs coming from the user-interface module are the start and end dates of the project, the concession period, the contractual construction period, the interest rate that will be used to discount the different cash flows, the base inflation rate used in the contract, as well as the initial distribution along the lifecycle of the project of the capital expenditure distribution (Capex), the operation income distribution (OI), the government subsidies distribution (GS), the loan principle distribution (LP), the loan balance distribution (LB), the loan interest (Li), the operation cost distribution (Opex), taxes distribution (T) and the output quantity distribution (Q). The above distributions should be identical to the ones in the base financial model of the PPP concession to reflect the same internal rate of return in the contract. Moreover, the risk allocation module will also affect the PPP valuation module by affecting the cost of contingency added to the above equation.

The scenarios development module uses the base concession value in its calculations of the different re-equilibrium scenarios. Finally, the PPP valuation module results will be reported to the user.

The Financial Model Re-equilibrium Module

During the lifecycle of a PPP, which tends to be very lengthy compared to conventional procurement methods, many events may arise that result in the need for re-equilibrium or contract renegotiation, such as variation orders, unforeseen risks, or refinancing gains. The only way to reflect those changes on the PPP value is by constructing a re-equilibrium model similar to the financial model but adding the cost and time impact of those events.

Figure 5 shows the financial model re-equilibrium module's relationship with the rest of the framework modules. The financial model re-equilibrium module is similar to the PPP valuation module as it gets its inputs from the user-interface module and the risk allocation module, and the outputs go to the scenarios development module. However, the inputs of the PPP valuation module are different than the ones for the financial model re-equilibrium module. For instance, the concession period (TC) is not an input, as it cannot be changed before agreeing on choosing the scenario that corresponds to adjusting the concession period. Moreover, the interest rate (i) remains constant in order to compare the present value obtained from the PPP valuation model to the present value obtained from the financial model re-equilibrium module.

The inputs coming from the user-interface module are the actual start and actual end dates of the project, the re-equilibrium date (RD) that the scenarios are calculated with reference to, the actual construction period (T0), the actual inflation rate, and the updated distribution along the lifecycle of the project of the capital expenditure distribution (Capex), the operation income distribution (OI), the government subsidies distribution (GS), the loan principle distribution (LP), the loan balance distribution (LB), the loan interest (Li), the operation cost distribution (Opex), taxes distribution (T), and the output quantity distribution (Q). However, this updated distribution shall reflect the impact of the events that led to renegotiation of the contract. This is the role of the risk allocation module, as it is important to note that the updated distributions shall only include the portion of the risks allocated to the public sector, for the public sector has already waived the other risk portions to the private sector as per the PPP concession contract. Equation shall be used again but with the updated values rather than the base values to determine the updated concession value. Then, Equation is equated to zero in order to obtain the updated rate of return (IRR) that reflects those changes. Finally, the outputs of the financial model re-equilibrium module are used in the scenarios development module.

The Scenarios Development Module

In order to gain the financial model re-equilibrium back, certain actions should be taken. The commonly used re-equilibrium scenarios in PPP are paying a lump sum amount to the private sector, increasing the service charges, increasing the concession period, or a combination of the one or more of the above. The sole aim of the renegotiation process is to maintain the investors' initial IRR constant. Figure 6 illustrates the relationship between the scenarios development module and the other modules. The scenarios development module inputs come from the user-interface module, the PPP valuation module, and the financial model re-equilibrium module.

The inputs coming from the PPP valuation module and the financial model re-equilibrium module are the present value of the PPP concession value and the PPP updated concession value at the start date of the PPP project, respectively. The difference between the present value of the PPP concession value and the PPP updated concession value is the re-equilibrium payment that is the basis for the different scenarios development process.

In case of positive re-equilibrium payment, it means that the public sector shall compensate the private sector.
The opposite is also true. Furthermore, in the case of a negative re-equilibrium payment, three scenarios of the four scenarios shall actually not be applicable: paying a lump sum amount to the public sector; decreasing the concession period;

and the fourth scenario which is the combination between the other scenarios. This is because the payment of a lump sum amount from the private sector to the public sector shall distort the private sector cash flow. Decreasing the concession period is not allowed due to the obligations the private sector may have towards third parties until the end of the concession period. Moreover, in PPP projects where the private sector is directly paid by the service users, the fourth scenario which is decreasing the PPP payment may also not be applicable. For example, in the case of transportation projects, the private sector cannot decrease the toll, as it will create a market distortion.

The re-equilibrium date (RD) is considered the base date of the calculations of the different scenarios. The first re-equilibrium scenario is to pay a lump sum amount to the private sector. The re-equilibrium date (RD) is considered the date upon which the lump sum payment shall be made. Hence, in order to calculate the required lump sum payment, the future value of the difference between the present value of the PPP concession value and the PPP updated concession value is obtained at the re-equilibrium date using Equation, where, in this case, (FV) is the lump sum payment, (PV) is the difference between the present value of the PPP concession value and the PPP updated concession value at the beginning of the project, (i) is the fixed discount rate, and (N) is the number of periods between the start date of the the the project and the re-equilibrium date.

$$FV = PV \times (1 + i)^N$$

Equation 4. Future Value given Present Value.

The second re-equilibrium scenario is to increase the service charges. This scenario depends on the nature of the payment in the contract. The user-interface module supplies this module with the payment mechanism used (user charges, usage payments, or availability payments), the amount of the periodic payment, and the frequency of payment (i.e., annually, semi-annually, quarterly, etc.). The adjusted value of the service charge is obtained using Equation, where the (A) is the adjusted amount, (PV) is the lump sum payment at the re-equilibrium date obtained in the first scenario, (i) in this case is the fixed discount rate divided by the number of periods in one year in order to get the effective discount rate, and (N) is the number of periods, which equals the number of periods from the re-equilibrium date until the end date of the project. Finally, the adjusted amount is then added to the original payment amount to be the adjusted periodic payment, which is to be paid starting from the re-equilibrium date until the end of the concession period.

$$A = PV \times \frac{i(1 + i)^N}{(1 + i)^N - 1}$$

Equation 5 Annuity given Present Value.

The third re-equilibrium scenario is to increase the concession period. This is done through a number of steps. The first step is to calculate the future value of the difference between the present value of the PPP concession value and the PPP updated concession value at the end date of the project using Equation, where, in this case, (FV) is the required payment at the end date of the project, (PV) is the difference between the present value of the PPP concession value and the PPP updated concession value at the start date of the project, (i) is the fixed discount rate, and (N) is the number of years of the concession period. The second step is to get the required number of periods after the concession

period for this amount to be paid with an extension of the service payment. This is done by using Equation, where the (A) is the project initial service charge, (PV) is future value calculated in the previous step, (i) in this case is the fixed discount rate divided by the number of payments in one year in order to get the effective discount rate, and (N) is the additional number of periods required to reach re-equilibrium after the end date of the project. Finally, the additional number of periods are added to the original concession period in order to obtain the adjusted concession period.

The fourth scenario is a combination of any two of the above scenarios. The user-interface module provides the exact combination required for the fourth scenario after getting the reports for the three scenarios. This is to allow the framework to avoid breaking the maximum values required of the above scenarios. For instance, there can be a maximum number of years that the concession period cannot exceed. In order to add this limitation to the framework, the user-interface module shall provide the scenarios development module with a combination for the fourth scenario, which includes the increase of concession period scenario. This input shall be limited to fix the concession period to a value between the original concession period and a maximum value defined by the user-interface module. This process serves to exclude the unwanted or unfeasible re-equilibrium scenarios.

The Framework Application

The following section elaborate on how the above framework can be applied using computer software. In order to demonstrate the application of the framework developed, dummy data were used. In each of the modules, the data used shall be explained in their context.

The User-Interface Module

The user-interface module interacts with the user dynamically along the different stages of the model, as it is linked to almost all of the other modules. It provides the inputs for some modules while receiving the output from the others to present them to the user. The welcome screen of the model consists of the model name. The user is directed to the following user-interface page, shown in Figure 2, to start inputting the data that will be used in the following modules.

Figure 2. The Model User-Interface.

The first set of data required are the project name, the PPP contract type, the risk matrix used, the payment mechanism, the payment amount, and the payment intervals. The project name is entered then the contract type which can vary depending on the PPP approach used.

The payment mechanism is chosen in this case to be availability payments in which service availability is the key condition for the payment. As for the "risk matrix used" field, the user selects from a dropdown menu whether to use a default risk matrix or input a risk matrix as per the contract, as shown in Figure.

When the "user input" option is selected, a hyperlink appears on the right, marked with arrow no.1, which directs the user to the risk allocation module in order to input some information with regard to the risks profile of the project, including all possible risks, their allocations, and their expected impact on the project valuation process. The rest of the user-interface module shall be explained along with the following modules, for the model is to be explained in the right sequence.

The Risk Allocation Module

The risk allocation process in general is very important through the lifecycle of any PPP project, especially during the renegotiation of the PPP contract. Risk allocation and their impacts on Equation are used in the different calculations in the model. They affect the valuation process of the PPP project, and at the same time, they are important for determining which risks should be accounted for when calculating the re-equilibrium value.

The user input risk table and the default risk table have the same formatting with respect to the table columns and their headings. However, the default risk table has already been filled with data to be ready for use in case of quick access to the other modules in the model. On theother hand, the user input risk table is to be filled with the exact percentages of allocations as per the contract.

The user input risk matrix is more accurate and recommended to be used when possible. Figure 1 shows the default risk table used in the model. As shown in the figure, the first column contains a set of standardized risks, and the following column contains their typical allocations to the public sector, the private sector, or shared among them. The following three columns show the exact percentages of the risks allocations carried by the different parties or shared. The risks are then divided into three main risk categories: country-related risks, sector-related risks, and project-related risks. An example of a country risk is macroeconomic risk, while an example of sector risk is market risk. The project risks are risks related to the nature of the project itself, such as permits risk.

The column headings in the right half of the table start with "Impact." This part of the risk table identifies which terms of the PPP valuation equation are affected when a risk materializes. This is important in order to study which part of the equation is going to be adjusted when calculating the re-equilibrium value of the contract if renegotiation is required, as will be shown later.

The PPP Valuation Module

After preparing the risk table, the user is referred to the third screen of user-interface module by clicking the button at the bottom of Figure 1.

Risk	Allocation	Risk Allocation Public	Risk Allocation Private	Risk Allocation Shared	Risk Allocation Total	Impact T_0	Impact T_c	Impact $Capex_t$	Impact OI_t	Impact GS_t	Impact LP_t	Impact LB_t	Impact Li_t	Impact $Opex_t$	Impact T_t	Impact Q_t	Impact inf
Country Risks:																	
Interest Rate Fluctuation	Both	32%	12%	56%	100%							✓	✓				
Inflation	Both	24%	20%	56%	100%							✓					✓
Foreign exchange fluctuation	Project Dependent	36%	16%	48%	100%			✓						✓			
Public Credit	Both	20%	28%	52%	100%					✓					✓		
Political Risk	Both	28%	8%	64%	100%					✓					✓		
Nationalization/expropriation	Private	56%	16%	28%	100%			✓							✓		
Government corruption	Private	60%	12%	28%	100%			✓						✓	✓		
Sector Risks:																	
Price Change	Both	40%	8%	52%	100%			✓	✓					✓			
Revenue Risk	Project Dependent	36%	24%	40%	100%				✓								
Market competition	Both	36%	12%	52%	100%				✓								
Supply and demand	Both	24%	16%	60%	100%				✓								
Change in Market demand	Both	12%	24%	64%	100%				✓								
Legislation changes	Project Dependent	32%	20%	48%	100%			✓	✓	✓				✓	✓		
Change in tax regulation	Project Dependent	36%	20%	44%	100%										✓		
Government policy	Both	24%	16%	60%	100%										✓		✓
Political/Public opposition	Both	12%	24%	64%	100%	✓				✓							
Swings in Public Opinion	Both	20%	16%	64%	100%				✓	✓							
Regulatory/Contractual Risk	Project Dependent	44%	8%	48%	100%							✓	✓	✓			
Government Intervention	Project Dependent	40%	16%	44%	100%	✓		✓	✓	✓		✓					
Poor public decision making process	Project Dependent	36%	24%	40%	100%		✓	✓	✓	✓							
Inadequate law and supervision system	Project Dependent	36%	32%	32%	100%				✓						✓	✓	
Lack of supporting infrastructure	Both	12%	20%	68%	100%		✓	✓	✓								
Project Risks:																	
Operation cost overrun	Private	76%	0%	24%	100%				✓					✓			
Inability of concessionaire	Both	36%	8%	56%	100%			✓	✓		✓	✓	✓	✓			
Subjective Project evaluation method	Both	24%	12%	64%	100%						✓	✓	✓				
Insufficient project finance supervision	Both	44%	4%	52%	100%			✓			✓	✓	✓				
Performance Security Risk	Private	56%	4%	40%	100%				✓								
Permits Risks	Both	20%	8%	72%	100%		✓										
Delay in project approvals/permits	Both	20%	16%	64%	100%		✓	✓									
Dispute resolution	Both	28%	0%	72%	100%	✓	✓										
Imperfect contract documents	Both	20%	16%	64%	100%		✓	✓									
Deficiency of design	Both	32%	12%	56%	100%		✓	✓									
Quality Assurance	Both	36%	8%	56%	100%		✓	✓									
Quality Control	Both	32%	8%	60%	100%		✓	✓									
Latent Defect Risk	Private	52%	0%	48%	100%		✓	✓									
Project/operation changes	Private	52%	8%	40%	100%									✓		✓	
Inability of concessionaire	Private	32%	8%	60%	100%							✓	✓	✓		✓	
Transformers, substations or backup power	Both	38%	8%	56%	102%		✓	✓						✓			
Construction Risk	Private	76%	0%	24%	100%		✓	✓									
Organization risk	Private	64%	0%	36%	100%		✓	✓				✓	✓	✓		✓	
Coordination risks	Both	44%	4%	52%	100%					✓		✓		✓		✓	
Land acquisition	Both	22%	32%	56%	110%		✓	✓									
Physical Obstacles that cannot be avoided	Both	28%	20%	52%	100%		✓	✓									
Maintenance Risks	Private	60%	12%	28%	100%		✓	✓								✓	
Access and delivery of site	Project Dependent	32%	20%	48%	100%		✓	✓						✓			
Connection of Public utilities to site boundaries	Project Dependent	20%	36%	44%	100%		✓	✓		✓				✓		✓	
Connection to boundary of Site	Project Dependent	24%	44%	32%	100%		✓	✓						✓			
Labor unavailability	Private	72%	4%	24%	100%		✓	✓									
Material shortage	Private	72%	4%	24%	100%		✓	✓						✓			
Third party delay/violation	Private	56%	0%	44%	100%		✓	✓						✓			
Planning risks	Private	52%	12%	36%	100%		✓	✓									
Inspection of Construction works	Private	68%	4%	28%	100%		✓	✓									
Technological Risks	Private	60%	12%	28%	100%		✓	✓	✓					✓			
Completion risk	Project Dependent	48%	4%	48%	100%		✓	✓									
Sustainability Risk	Project Dependent	24%	32%	44%	100%		✓	✓									
Antiquities Risks	Project Dependent	20%	36%	44%	100%		✓	✓									
Unforeseen Weather conditions	Private	56%	4%	40%	100%		✓	✓									
Unforeseen geotechnical conditions	Private	52%	8%	40%	100%		✓	✓									
Force majeure	Both	20%	0%	80%	100%		✓	✓		✓				✓		✓	

Figure 1. Risks Default Table.

The following screen is shown in Figure 2. This screen is for inputting the project payment information. In other words, it summarizes the financial model submitted to the government, which is part of the contract. It has all the base values for the cash in and cash out of the project. As shown in the figure, the milestones are inputted by the user, including the project start date, the project end date, the construction period, and the concession period. The user is also asked to enter the re-equilibrium date, which is the effective date or a benchmark from which the re-equilibrium scenario is calculated. For instance, if the increase in the availability payment scenario is chosen, the adjusted availability payment is assumed to be paid starting from the re-equilibrium date until the end date of the project. The interest rate is the rate at which the cash flows are to be discounted to obtain the concession value at the project start date. The producer price index (PPI) is used to adjust the cash flows to account for the effect of inflation.

Figure 2. The Model User-interface no.3.

The user then clicks the "Input Payment Distribution" to the right of Figure 2 in order to move on to the cash flow table and enter the values for the payment distribution as stated in the base financial model and the concession contract. The table used for the entry of the initial payments in and out cash flows is shown in Figure 3. The first column contains the equation parameters in order to insert the cash flows corresponding to each category. The header of the second column is set to the project start and continues by adding one month to each column until reaching the project end date. The table in Figure 3 is trimmed for illustration purposes.

As stated before, this table is the summary of the base financial model in the concession contract. The first item in the table is the capital fund which is the investment costs paid by the private sector. The investment cost has two sources: debt and equity. In this example, the equity constitutes 30 percent of the total investment cost, while the debt constitutes 70 percent. The investment cost is paid during the construction period over the first two years of the concession period, as per the financial model. The investment cost includes the engineering, procurement and construction (EPC) contract value of the project, which is a subcontract. It also includes the contingency, the advisors' fees, the bid bond commission, the performance bond commission, general and administrative charges during the construction period, and any other pre-operation expense.

Figure 3. Initial Payment Distribution.

Figure 4. Risk Factor Filtration.

The second line in the table is the loan payments, which shows the profile of the debt portion of the capital expenditure. It is paid on a quarterly basis for the same period of the capital expenditure from January 2010 until December 2011.

The third item is the operation income, which includes the availability payment paid by the public sector during the operation period from January 2012 until December 2029. The operation income includes capacity charges, fixed operation charges, variable operation charges, sludge revenues, and interest income on the debt service reserve account (DSRA).

The fourth item is the government subsidy, which in this example is the electricity charges. The following items are the loan principle payments and the loan interest payments. The loan terms in this project are 15 years with a two-year grace period. The operation expenses include the operation and maintenance costs of the wastewater treatment and the sludge treatment. They also include the general and administrative charges during the operation period.

The last two rows of the table are the taxes and the quantity of output produced, which is, in this example, the amount of treated wastewater in cubic meters. Finally, the user is referred back to the user interface sheets by clicking on the button at the bottom of Figure 3.

The Financial Model Re-equilibrium Module

After inputting the initial payment information, the user is directed to the following screen of the user-interface module in order to enter the events that led to the contract renegotiation. Figure 5 shows the following user-interface screen. In this screen, the user is asked to enter the reasons for re-equilibrium. The user is also asked to select the corresponding risk factor to which the event belongs.

In the project, the events that led to renegotiation of the contract were delays in the operation start date, a delay by the authorities to deliver the influent water (the wastewater to be treated by the plant), and a delay to provide the effluent pumping station. All the above risks belong to the risk category of connection of public utilities to site boundaries. The user may prefer to enter three events all at the same time or separately, yet the model shall give the same results in all cases.

Figure 5. The Model User-interface no.4.

In the background, those risk categories are filtered to consider the share of risk belonging to the public sector only. The filtration process is shown in Figure 4, where the model recalls the exact percentages of allocations belonging to a certain risk category and which part of the equation will be impacted. This part is not shown to the user, as the user will be directed to the following user-interface screen shown in Figure 6. The message at the beginning of the screen is a variable, which changes to inform the user of the events that will be considered in the renegotiation process. The user is asked to re-enter the same information that is required in the PPP valuation module, but after reflecting the impacts of those filtered events on the payments values. The user is directed to a screen similar to the previous module shown in Figure 7 to enter the updated distribution of the payments cash flows.

Figure 6. The Model User-interface no.5.

One of the major changes between the base cash flow and the updated cash flow is the missing operation income, missing government subsidy, and missing output in the period from January 2012 until March 2013, as the new operation start date is April 1, 2013. All cash flows are discounted up to January 2010, which is considered the benchmark or time zero.

The discount rate (i) used is entered by the user in the screen shown in Figure 4. Figure 10 shows a summary of the present values of the payment distribution items for both the initial values and the updated ones. Using Equation 3, the value of the concession at time zero for the base value is almost 37 million Egyptian Pounds, while the updated value is almost negative 161 million Egyptian Pounds. The difference between the two values is considered to be the re-equilibrium value at time zero, which is almost 198 million Egyptian Pounds.

Figure 7. Updated Payment Distribution.

Figure 8. PPP Concession Value and Re-equilibrium Value at t = 0.

The Scenarios Development Module

As stated in previous sections, the common three scenarios used to regain the financial model equilibrium are paying a lump sum amount to the private sector, increasing the service charges, or increasing the concession period. The re-equilibrium value calculated in the previous module is to be used as the basis for calculating the values of the above three scenarios as well as an additional fourth scenario, which is a combination of any two of the above scenarios. All the calculations are done in the background, as the user will only get to see the final results of the scenarios. Figure 9 shows the scenarios development tables.

Figure 9. Re-equilibrium Scenarios Calculations.

The first scenario is paying a lump sum amount to the private sector. The value of the lump sum payment is assumed to be paid at the re-equilibrium date, which is April 2013. Hence, the lump sum payment is calculated using Equation where (i) is the discount rate ten percent, (N) is the number of periods from time zero (January 2010) until the re-equilibrium date (April 2013), (PV) is the re-equilibrium payment at time = 0, and finally the (FV) calculated is the lump sum value to be paid by the public sector to the private sector, which is almost 270 million Egyptian Pounds.

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The second re-equilibrium scenario is adjusting the availability payment paid to the private sector. The model shall automatically select the payment mechanism used in the contract and calculate the additional payment required to

reach re-equilibrium. The project payment mechanism is availability payments which are paid by the public sector as long as the service is available or provided by the private sector. The payment amount is almost 32 million Egyptian Pounds paid quarterly by the public sector to the private sector.

The amount of the added payment is calculated via Equation where the (A) is the adjusted amount, (PV) is the lump sum payment at the re-equilibrium date obtained in the first scenario, (i) in this case is the fixed discount rate of 10 percent divided by the number of periods in one year, which is four, in order to get the discount rate per period, and (N) is the number of periods from the re-equilibrium date until the end date of the project.

The adjusted amount is then added to the original payment amount as shown in the scenario two calculations of Figure 9. Finally, the new calculated availability payment is adjusted to be almost 40 million Egyptian Pounds, paid quarterly starting from the re-equilibrium date until the end of the concession period.

The third option to return the contract equilibrium is adjusting the concession period. This is calculated by first using Equation to get the future value of the re-equilibrium value at the end of the project in December 2029. (FV) in this case is the required payment at the end date of the project, (PV) is the difference between the present value of the PPP concession value and the PPP updated concession value at the start date of the project, or simply the re-equilibrium value, (i) is the fixed discount rate of 10 percent, and (N) is the number of years of the concession period, 20 years.

This value is to be considered the present value in Equation. The (A) is the 32 million Egyptian Pound; the (i) is the discount rate per quarter. The equation is solved to get (N), which constitutes the number of periods remaining to be able to regain the financial model re-equilibrium. The maximum concession period for PPP contracts in Egypt is 30 years, as stipulated by the Egyptian Law of PPP. However, in this example, after adding the (N) obtained to the original concession period, the adjusted concession period exceeded 30 years, violating the law and making scenario three inapplicable.

All the previous calculations are done in the background, as after the user enters the updated payment distribution in Figure 6, the user will be directed straight to the preliminary three re-equilibrium scenarios in Figure 11. The user will then be directed to Figure 10 in order to enter the elements of the fourth scenario. The user chooses a combination from the above three scenarios in order to calculate their values. The user is also asked to fix one of the two options selected. In the example, the concession period is to be set to the maximum which is 30 years, as per Egyptian Law.

Figure 10. The Model User-interface no.6.

The calculations of the fourth scenario are shown in Figure 9. The first row is the limitation which is what the user

defines in the user-interface screen. The limitation shall always be a figure greater than the contractual value. Without entering a limitation, there would be an infinite number of combinations for scenario four. The second row is the remaining value which is the difference between the limitation and the base value. In other words, it is the value that shall be transferred into the other form of the combination.

In the example, the combination chosen for the fourth scenario is to adjust the concession period and the capacity charge. The limitation for the concession period has been set to 30 years. The remaining value is 10 years. An adjusted quarterly payment is to be paid starting from the re-equilibrium date until the end of the 30-year adjusted concession period. In order to calculate the amount to be added to the base quarterly payment, the following steps should be followed.

A new re-equilibrium payment should be calculated to deduct the value of the payments to be paid in the additional 10 years of the concession period. This is done using Equation where the (A) is the 32 million Egyptian Pounds payments paid in the additional 10 years, (i) in this case is 10 percent fixed discount rate divided by four periods in order to get the effective discount rate, and (N) is the number of periods in the additional 10 years, which is 40, as the payments are paid quarterly. The (PV) obtained is discounted until the project start date.

The (PV) is to be plugged into Equation as the future value, (i) is the fixed discount rate of 10 percent, and (N) is 20. The (PV) obtained from Equation shall be deducted from the re-equilibrium value at time zero to obtain the new re-equilibrium value, which shall be plugged into Equation to obtain the (FV) at the re-equilibrium date, then Equation shall be used to obtain (A), which is the adjustment that shall be added to the base capacity charge of the project. The adjusted payment in this case is almost 35 million Egyptian Pounds. The final set of scenarios are presented to the user, as shown in Figure 12.

Scenarios	Scenarios Description	Concession Value at time 0 (M EGP)	IRR %	Lump Sum Payment (M EGP)	Payment (M EGP)	Concession Period # of years
Base Scenario	Contract Information	37.52	19.95%	-	32.00	20.00
Updated Scenario	Updated Information	(160.81)	0.00%	-	32.00	20.00
Re-equilibrium Scenario 1	Lump Sum Payment at RD	37.52	19.95%	270.34	32.00	20.00
Re-equilibrium Scenario 2	Adjusted Payment	37.52	19.95%	-	40.36	20.00
Re-equilibrium Scenario 3	Adjusted Concession Period	37.52	19.95%	-	32.00	N/A

Figure 11. The Preliminary Re-equilibrium Scenarios.

Scenarios	Scenarios Description	Concession Value at time 0 (M EGP)	IRR %	Lump Sum Payment (M EGP)	Payment (M EGP)	Concession Period # of years
Base Scenario	Contract Information	37.52	19.95%	-	32.00	20.00
Updated Scenario	Updated Information	(160.81)	0.00%	-	32.00	20.00
Re-equilibrium Scenario 1	Lump Sum Payment at RD	37.52	19.95%	270.34	32.00	20.00
Re-equilibrium Scenario 2	Adjusted Payment	37.52	19.95%	-	40.36	20.00
Re-equilibrium Scenario 3	Adjusted Concession Period	37.52	19.95%	-	32.00	N/A
Re-equilibrium Scenario 4	Combination of the above	37.52	19.95%	-	34.50	30.00

Figure 12. The Final Re-equilibrium Scenarios.

Conclusion

This research aims to develop a framework for a re-equilibrium model for PPP Contract. Although, public private partnership contracts have many advantages over the other types of delivery methods, PPP contracts tend to be long in nature which make them very prone to contract renegotiation. The framework presented suggests five modules to be the basis of the re-equilibrium model: a user-interface module, a risk allocation module, a PPP valuation module, a financial model re-equilibrium module, and a scenarios development module. The outputs of the model are the re-equilibrium scenarios: paying a lump sum amount to the private sector, increasing the service charges, increasing the concession period, or a combination of the one or more of the above. The paper provided a framework for a re-equilibrium model that develops a number of re-equilibrium scenarios. The model facilitates the re-equilibrium process.

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