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System Dynamic Model for Public Private Partnership of Higher Educational Institution Project in Malaysia

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ABSTRACT

Malaysian Higher Educational Institution (HEI) needs to allocate adequate building spaces and facilities to support the increasing number of tertiary student population, particularly and consequently realising the objective to make Malaysia the Asian Education Hub by 2020. However, a huge sum of capital is required to develop the projects, and relying upon the government funding alone is almost impossible. Therefore, both public and private sectors need to cooperate to accumulate all the necessary resources including capitals. For this reason, Public Private Partnership (PPP) was launched to attain financial resources purposely for higher educational projects. Nevertheless, the concession price is the main capital problem in PPP HEI projects and finding the concession price itself is a tedious task. Thus, the research aims to establish a system dynamic model based on concession price model (financial model) for Higher Educational Institution. The developed price model for PPP HEI projects is created using data from observation and case study. The prototype of concession price model (system dynamic model) consists of a set of cause-effect diagrams. It is verified by Net Present Value (NPV) graft that exceeds zero and keeps on increasing with time. The developed system dynamic model provides better pricing of PPP projects that are going to be a useful tool for all stakeholders.

Keywords: Concession Price, Financial Model, Public Private Partnership, System Dynamic Model

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INTRODUCTION

Public-private partnership (PPP) is a contractual agreement between government and private sectors (Thomas Ng *et al*., 2007). This agreement is awarded to the

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private sector (concessionaire) to finance, design, build, develop, manage and operate the government projects (Zhang, 2009). PPP has been known in both developed and developing countries. PPP is obtained to help the funding of HEI projects in Malaysia. However, the major funding issue of PPP Higher Educational Institution project is concession price. To support this statement, Clerck, Demeulemeester, and Herroelen (2012) claimed that, in real situation of PPP projects, there are a lot of complications in determining concession price and no consensus has been established. The determination of the concession price is very important to the success of a PPP project. Concession price is a commercial profitability of project and a very important parameter at an early stage (Shen *et al*., 2007). It is very imperative to decision makers to determine or forecast the exact pricing on project and win the bid for the private sector. Meanwhile, for the public sector, it is very important to figure out which one will be cost effective and value for money (Xu *et al*., 2012). Thus, this research aims at establishing Prototype System Dynamic Model for PPP Higher Educational Institution projects – based on concession price. This research provides a realistic study based on an actual project in Malaysia.

PROBLEM STATEMENT

Decision on determining concession price is a very important step. Private or public sector tends to use discounted cash flow, which applies Net Present Value (NPV) and Internal Rate of Return (IRR) decision making criteria (Sontamino & Drebenstedt, 2013). However, it is quite complicated and prone to errors when using a calculator or Microsoft Excel software to solve for NPV and IRR in complex situations. Therefore, the developed Prototype System Dynamic Model is one of the best tools to solve these issues. Major concession price issues summarised from previous research studies are shown in Table 1.

TABLE 1
A summary of major concession price issues from the previous research studies

Issues - PPP concession pricing	The determination of concession price is complex & Uncertainty	Complicated to make decision making	Renegotiation	Previous model is unsystematic	Difficult to quantify non-monetary terms	Lacks theoretical foundation & scientific pricing rule	Lacks consideration on views from stakeholders	Political legal system stipulations of policy and economy	Unrealistic assumptions	Longer concession period is more difficult
Xu *et al*. (2012)	√	√		√	√	√	√			
Bovis (2010)					√					
Demirag & Kandaroo (2011)	√									
Cruz & Marques (2013)	√		√							

TABLE 1 (continue)

Chiang & Chen (2009)		√								
Tang & Shen (2013)				√						
Waldman (2007)								√		
Wibowo *et al*., (2005)	√									
Jeerangsuwan *et al*. (2012)	√	√			√					
Ashuri *et al*. (2012)	√			√		√			√	
Gross *et al*. (2009)	√									
Hu & Zhu (2012)	√									
Islam & Mohamed (2009)	√									
Lv *et al*., (2013)	√									
Mccowan & Mohamed (2007)	√									
Vassallo *et al*. (2012)								√		
Xiong & Zhang (2014)	√		√							
Xu & Moon (2014)										
Yu *et al*. (2014)										√
Liou & Huang (2008)					√					

Determination of concession price is complex and uncertain

Determining PPP concession price is extremely difficult to do (Xu *et al*., 2012; Gross *et al*., 2009). Some components can be quantified and cannot be quantified especially in non-monetary terms such as risk, efficiency, time, effort, etc. (Xu *et al*., 2012). In the perspective of the public sector, value for money (VFM) is an important criterion for the success of government's project. It can be changed if there are differences in the culture, processes and mechanisms in accountability (Demirag & Khadaroo, 2009). Thus, the concession price is also affected and considered. There are many arguments in relation to the relationship between accountability and performance of VFM. The measurement of VFM is difficult in terms of estimation future cash flows, discount rates and risk mitigation (Demirag & Khadaroo, 2009).

In the PPP project, there are major uncertainty components such as construction cost, construction schedule, concession period, future revenue, initial and future rate and macroeconomic condition (Wibowo *et al*., 2005; Hu & Zhu, 2012; Lv *et al*., 2013; Mccowan & Mohamed, 2007; Xiong & Zhang, 2014). These components will cause decision or proposal to become uncertain (Wibowo *et al*., 2005; Islam & Mohamed, 2009). Cruz and Marques (2013) mentioned that uncertainty comes from two aspects of external conditions and the system. External conditions can be derived from economic environment, the cost of capital and the evolution on demand. For the system, external conditions are derived from production cost, reliability, effectiveness, risk and efficiency, among others. All these uncertainties will not help

to value correctly. Hence, selection of key components at an early stage of a project is important and contributes to the financial viability evaluation (Jeerangsuwan *et al*., 2012). The private sector can request funding from the government to share the financial risk if the project is overestimated (Ashuri *et al*., 2012). Certainly, this happens when the revenues are lower than the expected.

Complicated to make decision

Concession price is a semi-structured decision making and part of the components in predicting the success of the projects. It has had difficulties in setting changeable decision. Some variables can be quantified and cannot be quantified; thus, it is hard to make a decision (Xu *et al*., 2012). Several financial institutions faced critical decisions in offering loans to the private sector (Chiang & Cheng 2009). The concessionaire (private sector) has to estimate the project possibility with restricted information and make decision critically on choosing concession components (Anon., 2012). In other words, the concessionaire has to be careful in estimating the project.

Renegotiation

Renegotiation always happens in PPP contract. If the demand is greater than the limit, it will cause surplus and the concessionaire has to compensate (Cruz & Marques, 2013). The government generally accepts certain serious risks of concession renegotiation. However, international PPP practices show that renegotiation has conflicted results (Xiong & Zhang, 2014). The Prototype System Dynamic Model can be used to solve this issue.

Previous model is unsystematic

Systematic price adjustment and parameters for PPP concession price still do not exist (Xu *et al*., 2012). There is no systematic consideration in the NPV analysis, and there is no method to adjust the discount rate which is reflected to the risk reflecting the risk (Ashuri *et al*., 2012).

Difficult to quantify non-monetary terms

Non-monetary terms such as risk cannot be quantified (Xu *et al*., 2012). Thus, there is a limitation in the ability to quantify (Anon., 2012). Research conducted by Liou and Huang (2008) disregarded the impacts of non-financial risk factors on NPV in automated contractual-negotiation model. From Bovis (2010), pricing in contractual agreement will be affected if risk allocation is included. Thus, it is difficult to determine the characteristic of an acceptable transfer of risk in a contract between the public and private sectors.

Lacks of consideration in the theory fundamental and scientific pricing rule

The concession price can be high and low because there are no rules and laws (Xu *et al*., 2012). A review of the previous literature showed that many researchers used quantitative approach such as Net Present Value (NPV), Monte Carlo simulation, non-linear regression, Cost

Benefit Analysis (CBA) and Capital Asset Pricing Model (CAPM) to determine concession price (Xu *et al*., 2012). Thus, there is no specific standard (Ashuri *et al*., 2012).

Lacks of consideration on view from stakeholders

There are different perspectives among stakeholders and the application model generally lacks their perspective. From the perspective of the private sector, it is important to win the bid and gain the maximum profit. Meanwhile, from the perspective of the public sector, it is important to share the knowledge, experience, expertise and funding the project effectively (Xu *et al*., 2012). Thus, it is revealed that different perspectives give different concession price.

Political, legal system, stipulations of policy and economy

The political, legal system, the stipulation of policy and economy can incur financial risks. These problems will affect fund delivery (Waldman, 2007). Thus, these will be affecting the business performance of the concessionaire (private sector) (Vassallo, Ortega, & Baeza, 2012).

Unrealistic assumptions

There are a lot of unrealistic assumptions when estimating and analysing financial projects such as demand, time, interest rate, etc. (Ashuri *et al*., 2012).

Longer concession period is more difficult

The longer the concession period, the more maintenance and operation costs will be needed. These will impose financial risks and the project will be transferred back to the government. In practice, the determination of concession period is usually determined by the concessionaire (Yu, Lam, & Yung, 2014).

Nonetheless, a dynamic system for the concession price for PPP Higher Educational Institution projects is still not available. Thus, this research aimed to establish prototype system dynamic model to solve all the said flaws.

LITERATURE REVIEW

The following literature review is divided into three main parts: pricing/parameters methodology, concession price variables (infrastructure projects) and System Dynamic Model.

Pricing Methodologies / Parameters

Many PPP practitioners and research studies improvised concession price model (Thomas Ng *et al*., 2007; Xu *et al*., 2012). Among other, Xu *et al*. (2012) designed a concession pricing model (System Dynamic Model) via cost-benefit analysis based on an NPV calculation (Discounted Cash Flow technique), which was verified by a typical case. Meanwhile, Shen *et al*. (2007) and Lv *et al*. (2013) designed concession period model by using the Nash Negotiaton theory. Shen and Wu (2005) proposed a BOT CCM model by taking into consideration risk impact of

formulating a concession period by using Monte Carlo Simulation. Ng *et al*. (2007) proposed a Fuzzy simulation model for optimising the concession period of public-private partnership schemes. Zhang and Asce (2009) proposed a win-win concession period by combining Critical Path Method and Monte Carlo Simulation technique. Ke, Liu, and Wang (2008) developed an equitable financial evaluation method through Discounted Cash Flow method and Monte Carlo Simulation. Lee *et al*. (2012) used Critical Path Method and Stochastic system to forecast a project cash flow. Islam and Mohamed (2009) used a fuzzy simulation to develop financial performance measure. Sun and Zhang (2015) proposed a model that could determine minimum revenue guarantee (MRG) level in a project by revising NPV and Monte Carlo simulation Technique. Last but not least, Xu *et al*. (2014) developed construction cost model to determine a concession period by using stochastic process. A summary of these methods is shown in Table 2.

TABLE 2
A summary of research studies related to concession period and pricing

Method Used	Critical Path Method	Nash Negotiation theory	Monte Carlo Simulation	Fuzzy Simulation	Discounted Cash Flow	System Dynamic Model	Regression Analysis	Stochastic System
Zhang (2009)	√		√					
Ng *et al*. (2007)				√				
Shen *et al*. (2007)		√						
Shen & Wu (2005)			√					
Xu *et al*. (2012)					√	√		
Ke *et al*. (2008)			√		√			
Lee *et al*. (2012)	√							√
Islam & Mohamed (2009)				√				
Lv *et al*. (2013)		√						
Sun & Zhang (2014)			√		√			
Xu & Moon (2014)								√

Concession Price Variables – Infrastructure projects

In order to support variables affecting the concession period and price in the literature, many research studies have been referred to. A summary of research studies is shown in Table 3.

De Albornoz and Soliño (2014) outlined six valueable key variables in the transport infrastructure; there are a return

of PPP projects, discount rate on the sale of PPP projects, length of the construction period, length of the PPP contract, transaction exit costs and growth factor for selling prices and costs. Besides, Anon (2012) made a comprehensive framework to set up key concession variables for PPP toll road projects, as follows: toll rates, an equity level, concession length and rate of return. Anon (2014) focused on availability payment which is the revenue to the private sector that comes from the government to assess potential PPP projects. Gross *et al*. (2009) stated that cost and time are crucial variables. They also listed primary variables such as toll rates, concession length and availability of payment. Other variables like the size of the investment, inflation rate and construction period might give a big impact on the viability of the project (Hu & Zhu, 2012). Islam and Mohamed (2009) found that there are three critical variables affecting the award of concession contract; base price, concession length and equity level. Lv *et al*. (2013) claimed that concession length is one of the greatest critical variables to the success of a project. Meanwhile, Mccowan and Mohamed (2007) listed financial variables such as interest rate, cost, revenue, Net Present Value (NPV), equity level, debt service coverage ratio and tax rate as important variables.

TABLE 3
A summary of the research studies related to the variables of concession period and pricing

Variable used	Albornoz & Solino (2014)	Jeerangsuwan *et al*. (2012)	Mladenovic & Queiroz (2014)	Gross *et al*. (2009)	Hu & Zhu (2012)	Islam & Mohamed (2009)	Lv *et al*. (2013)	Mccowan & Mohamed (2007)	Shen *et al*. (2002)	Yu *et al*. (2014)	Xu *et. al*. (2012)
Return of PPP Projects / rate of return	√	√								√	√
Total Income / Revenue			√					√			√
Discount Rate / interest rate	√							√		√	√
Length of the construction period	√				√						
Length of the PPP Contract / concession	√	√		√		√	√			√	√
Costs	√		√	√				√		√	√
Toll Rates		√	√	√						√	
Equity Level		√				√		√			
Loan Principal											√
Capital Fund											√
Availability Payment			√	√							
Inflation rate					√					√	

TABLE 3 (continue)

Investor's capital investment					√					√	√
Construction Investment											√
Base price						√					√
NPV								√	√	√	√
Debt service coverage ratio								√			
Tax rate								√			√
Traffic Volume			√							√	√

System Dynamic Model

This system was developed by Forrester in the late 1950s (Alasad, Motawa, & Ogunlana 2012; Xu *et al*., 2012). He created a set of techniques to simulate the complex, multi-loop feedback, non-linear system. He divided his model into four (4) aspects, as follows:

- "Stock" gathers all inflows and serves as a source from where outflows come
- "Flow" is a vehicle that delivers data information to and from the stock (the value can be positive or negative)
- "Converter" reacts as a utilitarian role to select proper values/ reacts as parameters
- Connector

This system is used to solve the complex system (Alasad *et al*., 2012) and generate the cause–effect relationships through stocks, flows and feedback loops. Meanwhile, Hashimoto (2009) developed a dynamic model for space projects. Furthermore, Golnam, Ackere, and Wegmann (2010) have integrated dynamics system and enterprise modelling to address dynamic and structural complexities of choice situations in the enterprise.

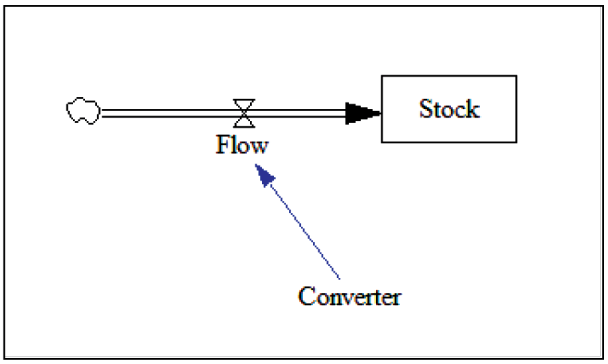

Fig.1: An example of System Dynamic Model developed using the Vensim Software

RESEARCH METHODOLOGY

The methodology is based on quantitative and qualitative approaches such as comprehensive literature review, observation and case study to validate the proposed Prototype System Dynamic Model. The research activities are based on the following objectives:

- To investigate the problems in determining concession price for PPP Higher Educational Institution Projects
- To analyse the critical components of systematic pricing for PPP Higher Educational Institution Projects
- To integrate the price within the system dynamic model of PPP Higher educational Institution projects.

Case Study

In order to clarify the accuracy of the proposed Prototype System Dynamic Model – based on the financial model concession price model, a Public Private Partnership (PPP) Higher Educational Institution Project in Malaysia was implemented as a case study. Data documentations such as feasibility report, financial model (concession price model) and progress report were collected for this purpose. This was followed by developing the prototype SD Model with all the variables as in the financial model. The model was processed by using task sequence (see Fig.2).

Model Processing Diagram

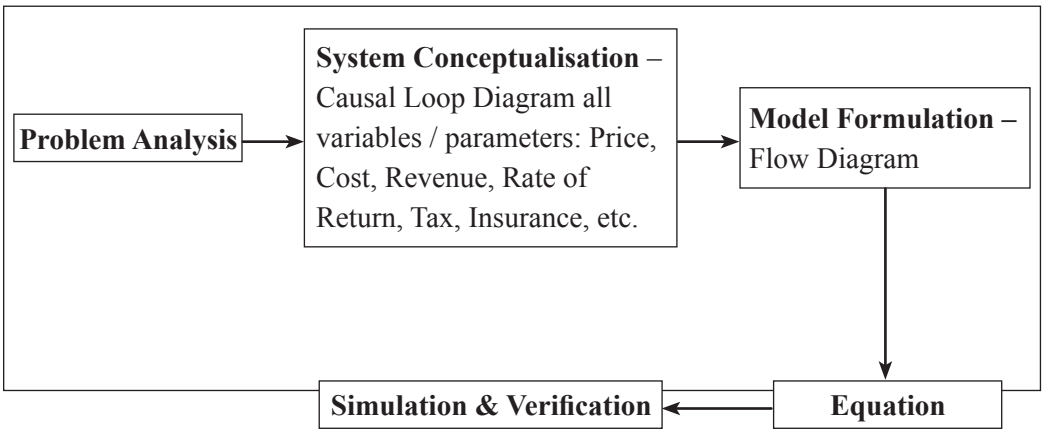

Fig.2: Model Processing Diagram

Details of the processing of System Dynamic Model are as follows:

- ***Problem Analysis***

Problems are identified (as described in statement of the problem). These identifications helped to recognise the gap of the research study.

- ***System Conceptualisation***

System conceptualisations made by previous research studies were compared.

Then, the gap was detected in terms of different project, variables/parameters, pricing system and problem statement. This System Dynamic model used the vensim software. This system consists causal loop with variables/ parameters that are actually picked from financial model such as costs, revenues, rate of return, tax, insurance, etc.

- ***Model Formulation***

The model was formulated by including all the selected variables. The tools used in this software are Flow, stock, converter and connector.

- ***Equation***

Each of the variables / parameters was equated and formulated. All the parameters were linked to each other to find the Net Present Value (NPV).

- ***Simulation and Verification***

The Model has resulted in the Net Present Value (NPV) that exceeded zero.

RESULTS AND FINDINGS

The concession period is 23 years and the Concession Price is RM33,527,326.63. These data were taken from the financial model and feasibility report.

The Established Prototype System Dynamic Model

The established Prototype SD model for Higher Education Institution project is shown in Fig.3 below.

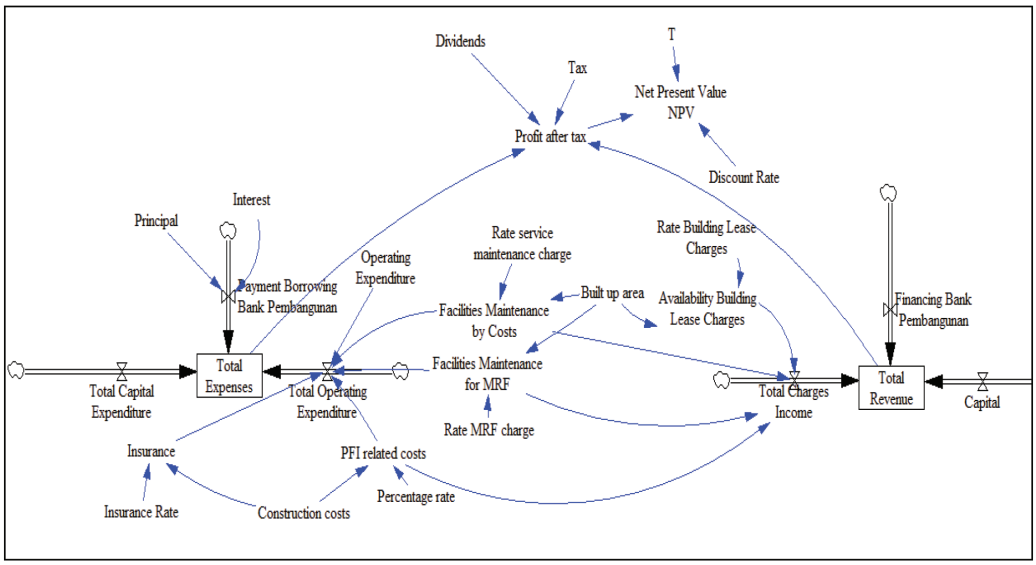

Fig.3: The proposed Prototype SD Model for Higher Educational Institution project

Equation, Simulation and Verification

TABLE 4
Equations SD Model in PPP Higher Educational Institution project

No.	Description	Equations
1)	Total Charges Income	= Availability Building Lease Charges + Facilities Maintenance Charges by Costs + Facilities Maintenance Charges for MRF + PFI Related Costs
2)	Total Expenses	= Borrowing Loan + Total Capital Expenditure + Total Operating Expenditure
3)	Total Revenue	= Capital + Total Charges Income + Financing Loan
4)	Profit after Tax	= (total Revenue – Total Expenses) – (Tax + Dividends)
5)	Net Present Value (NPV)	= Profit after Tax * $(1/(1 + \text{Discount Rate})^{\text{Time}}$
6)	Concession Period	23
7)	Discount Rate	0.0631
8)	Insurance	= Construction Costs * Insurance Rate
9)	Availability Building Lease Charges	= Built up area * Rate Building Lease Charge
10)	Facilities Maintenance Charges by Costs	= Built up area * Rate Service Maintenance Charge
11)	Facilities Maintenance Charges for MRF	= Built up area * Rate MRF Charge
12)	PFI Related Costs	= Construction Costs * Percentage Rate
13)	Total Operating Expenditure	= Facilities Maintenance Charges by Costs + Facilities Maintenance Charges for MRF + Insurance + Operating Expenditure + PFI Related Costs.
14)	Borrowing Loan	= Loan Principal + Loan Interest
15)	Loan Principal payment formula	$= P/((1 – (1/(1 + i)^n))/i)$
16)	Concession price	=RM33,527,326. 63
17)	Present Value	=Profit after tax*$(1/(1+\text{Discount Rate})^T)$

The price parameter equations for the Prototype SD model are summarised in Table 4. The verification of the Prototype SD model can be proven through simulation of the final Net Present Value (NPV) of RM39,000,000.00 at the concession price of RM33,527,326, as shown in Fig.4. It is verified that whenever NPV exceeds zero, the model is accurately viable. Furthermore, the calculated amount of each price variable/parameter in Prototype SD Model showed a close agreement to the calculated price parameters in the financial model (concession price model).

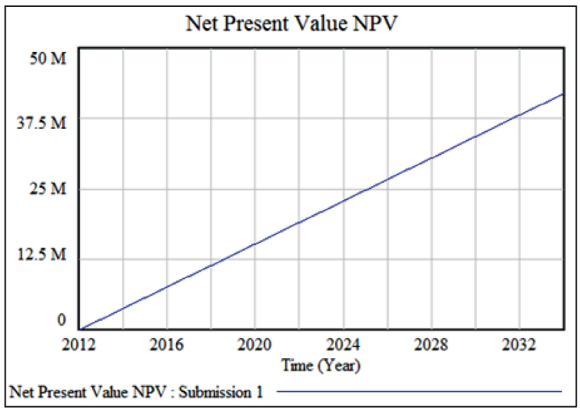

Fig.4: The Simulation of NPV in Graft

CONCLUSION AND DISCUSSION

There are many advantages shown for the developed Prototype System Dynamic Model. Firstly, the model can process dynamic and complex nature of real systems which cannot be done by a typical model. Secondly, the model helps to generate price elasticity in respect to various potential responses due to government's policies for infrastructure project developments. A cause-effect diagram, which is built from the concept of system dynamic, is integrated to develop the conceptual concession price model. Thirdly, the developed model helps to reveal and define the waves of different factors on price volumes through the generated causal structure of concession price system.

Therefore, one can rely on this model to speed up the process of determining concession price. In future verification of collaborated projects of Higher Educational Institution Project, the developed model can be utilised and exploited by taking into account some parameters like stakeholder ratios and used IRR. Last but not least, the public and private sectors may benefit from the Prototype SD Model through decisions made on the pricing of PPP projects.

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