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RISK ANALYSIS FOR PERFORMANCE BASED CONTRACTING ON THE ROAD CONSTRUCTION WORK

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ABSTRACT

Indonesian government has adopted a model of performance based contracting (PBC) as a solution for handling the road issues. The PBC model is an integrated contract form of design, construction and maintenance processes that using lump sum payment system. The PBC is applied to establish a condition that encourages contractors as providers of construction services to be able to properly manage risk, where during the time, the risk that caused by poor quality work of service providers has been always be a risk of project owners. But in the PBC, this risk will be under contractors' responsibility. The purpose of this study is to identify and analyze risks that occur and its influence on the PBC project performance. The study was conducted using the survey method where questionnaire as data collection instruments were distributed to the parties involved in the PBC projects in Indonesia, either the contractors or the owners. The data were then processed using factor analysis, regression analysis and path analysis to obtain structural equation relationship between risk and performance of the PBC project. The result shows that from of the 15 most important risks that highly influence on the PBC performance, most of them were borne by the contractor.

Keywords: risk, performance based contracts, integrated contract, contractor, owner, road project.

INTRODUCTION

Background

The study of Performance Based Contract (PBC) in Indonesia began in the 2000s with the involvement of many experts from abroad. However, for the construction work, the PBC began to be implemented in the national road since 2011 in 2 (two) roads: Ciasem - Pamanukan and Demak - Trengguli, and continued in 2012 in 3 sections: Semarang - Bawen, Bojonegoro - Padangan Padangan - Ngawi, and SeiHanyu - Tb Lahung (Central Kalimantan). More detailed information can be found in Table-1. Previous PBC concept has also been applied since 2011 to implement the Extended Warranty Period (EWP) in several national roads. EWP matter has now become part of the traditional contract for national roads where the Contractor shall guarantee the work for 2 (two) years for a single year contract and 3 (three) years for multi-year contracts.

PBC with the lowest level is the conventional road construction contract but with a two-year maintenance period. The next level of PBC was implemented in Indramayu and Demak with 3-5 year maintenance period, the length is only 18 km. The latest level one is to implemented at Medan, Jakarta, Semarang, and Makassar where the road length can reach 100-250 km within 10 years maintenance period. The government adopted the PBC and PBMC as a solution for handling the road issues, both from the government in order to provide a continuous path in good condition, and in terms of service providers who looked at this business profitable and attractive to them because of the condition of the contract that has a long period of time the length of the road is quite high. The PBC / PBMC contract which is an integration of three processes, namely the design, construction and maintenance of the road construction is equivalent to the Design and Build (DB) contract and system maintenance service contract with a lump sum payment system. The purpose of the application of PBC / PBMC is to build a condition that encourages contractors as construction service providers to be aware of the importance of quality and risk handling During the time that cause poor quality work of service providers has been always a risk of service users as project owner, but in this PBC, this risk will beunder contractor as the service provider.

As PBC clearly changes the nature of risk shifting increased risks on to the contractor's and away from the owners. Thus the risk is becoming an important issue that must be managed properly from a contractor's point of view. To date,little empirical study has been carried out on the management of risk under PBC in developing countries.

Research objectives

The purpose of this study is to identify the risks that may occur in the PBC project, evaluate the effect of risk on project performance PBC, and examine a model formulation structural relationship between risk and project performance PBC.

Research question

The research problem is formulated in the following questions:

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a. What risk that might occur in the PBC project?

b. How does the influence of these risks on PBC project performance?

c. How to formulate a structural relationship model between risk and project performance PBC?

Research scope and limitations

The scope of the study included literature study to identify the types of risks that may occur in PBC projects and conduct analysis to compare the effects of these risks on PBC project performance. Study report on PBC from the World Bank(Gericke, et al 2014) andIndonesian Road Institute (Vaza, 2014) become the main reference in identifying risk groups in this study.

This study is limited to the PBC project based on data from the Directorate General of Highways, the Government of Indonesia, so that the study population is limited to contractors and government agency as users who have been involved in the planning and implementation of PBC projects.

LITERATURE REVIEW

Risk

Risk is an event that is likely to adversely affect the performance of the project as a result of the uncertainty. Risks associated with the likelihood or probability of occurrence of events beyond the expected. Flanagan and Norman (1993) define risk as a factor contributing to the undesirable conditions that can cause harm, damage or loss.

Occurrences in the future can not be known with certainty. This incident or an output (output) of an activity or event can be either good condition or poor condition. If that happens is in good condition then it is an opportunity (opportunity), but if there is a bad thing then it is a risk. Kerzner (2001) explain the concept of risk in the project as a measure of the probability and consequences of not achieving the project objectives that have been determined. Risk has two main components to the event, which is the probability of occurrence and impact of events that occurred.

Construction risks have been identified bya number of authorities, including Ashley et al. (2006), who clearly identify and allocate the risks for road construction management from early design stage to completion and warranty period. According to Hill et al (2010), the risk in road projects in developing countries has not defined and well managed despite a lot of literature and studies are available. In other sectors such as the water and sanitation projects employ risk management of their network more effectively given the "unseen" nature of this infrastructure. Therefore, theyhave proposed a risk framework for the management of road networks. In this framework, road network management risks have been classified into four categories illustrated in Figure-1. The framework is believed to be used as a basis for developing similar risk categories that should be considered in setting up a PBC for developing countries including Indonesia.

Figure-1. Categories of risk for managing road network (Hill *et al*, 2010).

Opus (2009) also recommends the allocation of risk to the parties in the PBC project based on similar experiences in India. Examples of risk allocation is presented in the following table

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Table-1. Examples of risk allocation PBC projects (Opus, 2009).

Contract risk profile			
Risk description	**Contractor risk**	**Employer's risk**	**Risk boundary**
Legislative changes during contract period		Risk excluded	Verified adverse price, resource or time implications
Policy changes of Local Government		Risk excluded	Verified adverse price, resource or time implications
Stockpile and disposal sites	Risk included		Intractable land owner issues
Land entry agreements	Risk included		Intractable land owner issues

As many as 54 identified risksare allocated mostly to contractors as service providers, the remaining risk borne by the owner. In short, The risk responsibility for construction processes and some ongoing performance falls to the contractor.

Risk management

Risk management is an organized approach to find potential risks to reduce the occurrence of unexpected things. Risk management should be done as early as possible with the support of such information. The process is a preventive measure where the real conditions may become apparent before its too late and can avoid a greater failure (Kerzner, 2001).

Flanagan and Norman (1993) defines risk management is a way to identify and quantify all the risks in a construction project in order to take a decision on how to manage these risks.

In the field of road infrastructure sector, risk management has not been fully implemented properly. However, it is believed that contractors as service providers should understand risk better when compared to owner as users and as a consequence are also willing to take on risks in relation to the road network management as they offer revenue and profit opportunities.

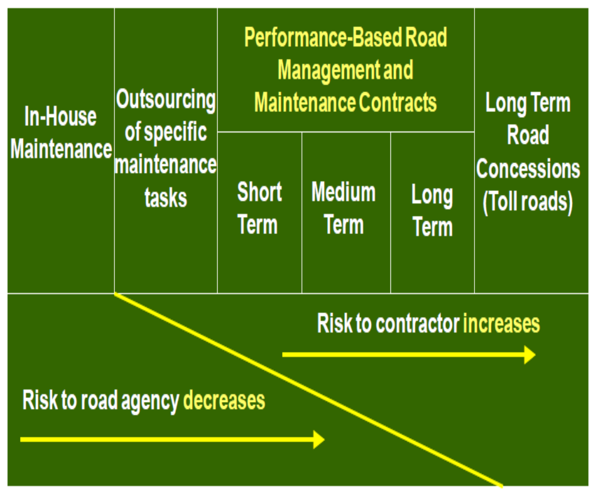

Figure-2. Allocation of risk by contract type (Zietlow, 2004).

As illustrated in Figure-2 above, the allocation of the risk that the owners (and conversely the contractor carries) decreases as the contracting model moves from fully in-house through to the long term road concession (DBMOT) type contracts. Therefore, risk allocation is an important aspect that should be considered as the great opportunities offered in the PBC contract if it is managed correctly and properly.

Risk management processes

The processes of risk management according to Flanagan and Norman (1993) is broken down into risk management framework in Figure-3 which shows the sequence fordealing with risk.

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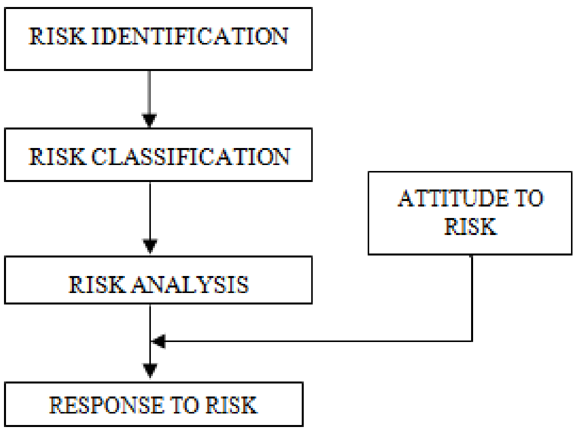

Figure-3. Risk management processes (Flanagan and Norman, 1993).

In general, the stages in the process of risk management are:

a. Risk identification

The identification of risk is to identify the conditions that give rise to the risk of uncertainty, the sources and type of risks.

b. Risk classification

Classification of risk considers the type of risk and its effect on orgnization

c. Risk analysis

The analysis evaluates the consequences associated with the type of risks, or combination of risks, by using analytical techniques, and assess the impact of risk by using various risk measuremen techniques

d. Risk attitude

Any decision about risk will be affected by attitude of the organization making the decision

e. Risk response

The response consides how the risk should be managed by either transferring it to anothe rparty or retaining it.

The most recently released risk management standard AS/NZS ISO 31000:2009 appears to an attempt to move towards an international standard. The Joint Australian/ New Zealand Committee OB-007, in the revision of AS/NZS4360:2004, decided on promoting the development of an international standard on risk management. Figure 4 shows the process for managing risk is reported by the standard (AS/NZS ISO:2009) as identical as that of AS/NZS 4360:2004.

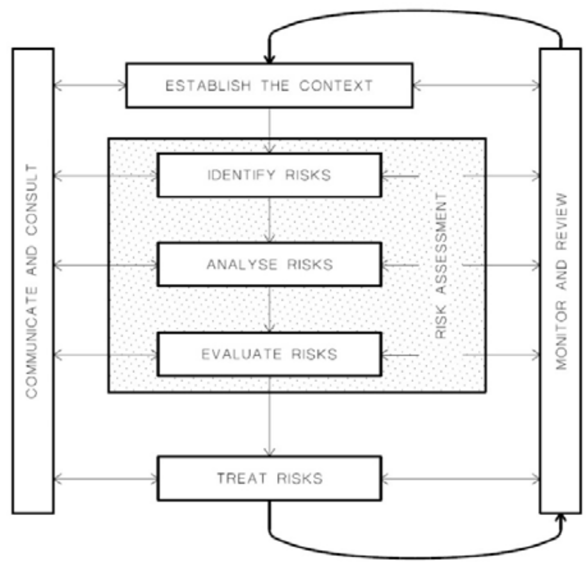

Figure-4. Risk management processes (AS/NZS 4360, 2004).

The main elements of the risk management process, as shown inFigure 4, are the following:

a) Communicate and consult

Communicate and consult with internal and external stakeholders as appropriate at each stage of the risk management process and concerning the process as a whole.

b) Establish the context

Establish the external, internal and risk management context inwhich the rest of the process will take place. Criteria againstwhich risk will be evaluated should be established and thestructure of the analysis defined.

c) Identify risks

Identify where, when, why and how events could prevent, degrade, delay or enhance the achievement of the objectives.

d) Analyse risks

Identify and evaluate existing controls. Determine consequences and likelihood and hence the level of risk. Thisanalysis should consider the range of potential consequencesand how these could occur

e) Evaluate risks

Compare estimated levels of risk against the pre-establishedcriteria and consider the balance between potential benefitsand adverse outcomes. This enables

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decisions to be madeabout the extent and nature of treatments required and aboutpriorities.

f) Treat risks

Develop and implement specific cost-effective strategies andaction plans for increasing potential benefits and reducingpotential costs.

g) Monitor and review

It is necessary to monitor the effectiveness of all steps of therisk management process. This is important for continuousimprovement.Risks and the effectiveness of treatment measures need to bemonitored to ensure changing circumstances do not alter
priorities.

Risk management can be applied at many levels in an organization. It may be applied to specific projects such as the PBC project, to assist with specificdecisions or to manage specific recognized risk areas.

METHODOLOGY

Research method

The research method is adopted to this study is a survey research. Survey research is sometimes regarded as an easy research approach, but it demands the same standards in research practice as any other research approach (Kelley et al., 2003). The research carried out in the form of a queatinnaire survey in order to capture the opinions or perceptions, experiences, and attitudes of respondents about the risk factors that affect performance of the PBC project.Survey questions were carefully designed in relation to this study's research questions: (i) What risk that might occur in the PBC project?; (ii) How does the influence of these risks on PBC project performance?; and (iii) How to formulate a structural relationship model between risk and project performance PBC?.

Research variables

There are two types of research variables are adopted i.e. independent variables (independent) and the dependent variable (dependent). Independent variables are variables that affect the dependent variable. Whilst dependent variables is the variable that inclueneed the independent variables.

In this study there is the independent variable is the level of risk for each risk factor. The variables comprised 74 items value risk (risk exposure) based on the classification of the World Bank study (Gericke, *et al.*, 2014) and theIndonesian Road Institute (Vasa, 2014). The variabels were divided into 4 groups:

a) Planning with 14 risk items
b) Management with 20 risk items
c) Delivery by 20 risk items
d) Physical with 20 risk items

While the dependent variable is the project performance indicators which consist of three variables: cost, quality and time. These are referred to as the 'triple constraint' (Project Management Institute, 2004)

Data collection

In this study, data collection tools and a structured questionnaire were used to survey information. Eisenhardt (1989) says that researchers generally combine multiple data collection techniques to construct a theory. This questionnaire is a technique where data collection is done by giving a set of questions or statements, written or online via the respondent to answer it. Survey questions were carefully designed in relation to this study's research questions.

The questionnaire was structured in three blocks (i) data from the interviewee and local company where it is plannedto collect information on experience, and position ofthe interviewee as well as the company experiences from the road construction sector; (ii) risk exposures. In this block isexpected to gather information on typical risks that might occur in the PBC project; and (iii) the risk impacton project performance.This last block is meant to identify opinions of thoseinterviewed about the opinion of projectsuccess, considering them as indicators of time, cost and quality performance.Before sending and collecting the informationa pre-test was conducted with specialists in the area of construction contract and with professionals.

The Likert scalewas used to gather respondents' perceptions about the projectrisks and performances. Once tabulated,the results were analyzed and the reports were written. In Likert scale, respondents assess a statement with 5 criteria value is from 1 to 5, where 1 for "Very Low or Very Less", value 2 for "Low or Less", value 3 for "Medium", value 4 "High or Large", and the value of 5 for "Very High or Very Large". Respondents is just puta mark on the value column in the questionnaire sheet.Once tabulated,the results were analyzed and the reports were written.

Sample and response rate

The study respondents were defined as project directors, project managers, and project members with involvement in the area of road construction project in general or on the PBC projects. The sample was defined by convenience, therefore, the sampleunits (projects) and the participants were chosen byease of access and their availability to respond to the study.

Among the questionnaire survey forms mail/emailed, 10 were returned undelivered and/or declined to participate. Five of the returned questionnaires

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were deemed invalid, and the final number of valid questionnaires was 40. The respondents were given 1 (one) week to respond, however, some respondents required longer time to finalise their responses. The composition of the respondent group and return the questionnaire can be seen in the following Table:

Table-2. Response rate.

Respondent	Number of forms		Response Rate
	Sent	Replies	
Owners	10	10	100%
Contractors	40	30	75%

The overall response rate of 80 % (of the 50 delivered) Owen and Jones (1994) argue that an average of 20% of questionnaires returned is considered satisfactory, while 40 percent is good. So, the response rate of this questionnaire is then exceptionally good.

Data analysis

The analysis of the data/information of the study will be based onthe model of regression and path analysis, a multivariate statistical technique used to predict or explain the relationships that influence a scaled dependent variable. Pallant (2007) suggests that multiple regression is also provides an assessment about the model as a whole (all subscales) and the relative contribution of each variable that make up the model (individual subscales).

Before doing the regression and path analysis, a factor analysis was conducted with Principal Component Analysis (PCA) and Factor Analysis (FA). The PCA is to reduces the dimensions of the data by analysis of covariance between factors. The main idea of this method is to form, from a set of variables, a new variable that contains as much variability in the original data. According to Decoster (1998), the PCAanalysis is based on the measured response, while the FA analysis assumes that the response is measured based on the underlying factors.

The major use of factor analysis according to Pallant, (2007) is as a 'data reduction' technique. It takes a large set of variables and looks for a way that the data may be 'reduced' or summarised using a smaller set of factors or components. The reduction conducted by looking at the interdependence of several variables that can be used as one that found variables called factors. Before performing this analysis, the reliability analysis, validity, linearity, multicollinearity was firstly checked to obtain satisfactory results.

Factor analysis was conducted in two steps. The first step is data assessment and extraction factor. From this stage, eigenvalues obtained fromSPSS' output table of Total Variance Explained and the value is to be compared with the value corresponding to the random outcome of a parallel analysis (Monte Carlo PCA). If the value of the SPSS output is greater than the value of the Parallel analysis criterion, then the factor retained for further analysis.

Once the number of factors have been determined, the next step is to try tointerpret them. To assist in this process the factors are 'rotated'.Within the two broad categories of rotational approaches there are a numberof different rotational techniques provided by SPSS (orthogonal: Varimax, Quartimax, Equamax; oblique: Direct Oblimin, Promax). This studyemployed the Varimax method, which attempts to minimise the number ofvariables that have high loadings on each factor.

Path analysis

Path analysis is an extension of multiple regression. This technique is used to examine the contribution of which is shown by the path coefficient on each path diagram of causal relationships between variables X1 X2 and X3 to Y and their impact on Z (Rutherford, 1993). Path analysis also aims to provide a model estimates the level of interest (magnitude) and significance (significance) in a hypothetical causal link a set of variables (Webley, 1997). The model is described in the form of a circle and an arrow image where a single arrow indicates the cause. Regression is imposed on each of the variables in the model as the dependent variable (response providers) while the others are enacted as the cause. Weighting regression predicted in a model that compared with the observed correlation matrix for all variables and also the calculation performed statistical alignment test. Streiner (2005) argues Path analysis is a powerful statistical technique that allows for more complicated and realistic models than multiple regression with its single dependent variable.

RESULTS AND DISCUSSIONS

Factor analysis

The 74 items of the risks were subjected to principalcomponents analysis (PCA) using SPSS Version 22. Inspection of the correlation matrix revealed the presence ofmany coefficients of .3 and above. The Kaiser-Meyer-Oklin value was exceeding therecommended value of .5 (Kaiser, 1974) and the Barlett's Test of Sphericity (Bartlett, 1954) reached statistical significance, supporting the factorability of the correlation matrix.

Using Catell's (1966) scree test, it was decided to retain two components for further investigation as shown in Table-3.This was further supported by the results of Parallel Analysis, which showed only two componentswith eigenvalues exceeding the corresponding criterion values for a randomly generated datamatrix of the same size.

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Table-3. Factor analysis of each group of PBC risk.

No.	Planning		Management		Delivery		Physical	
	1	2	1	2	1	2	1	2
1	,879	,833	,824	,863	,841	,883	,901	,886
2	,812	,720	,820	,791	,772	,773	,881	,854
3	,793	,674	,802	,729	,758	,706	,801	,751
4	,776	,652	,781	,727	,745	,705	,769	,703
5	,672	,598	,773	,582	,739	,661	,765	,662
6	,662	,530	,748	,579	,728	,661	,762	,635
7	,640		,733		,724	,624	,741	,567
8	,599		,722		,712	,590	,695	
9			,713		,635		,678	
10			,681		,627		,643	
11			,627		,594		,606	
12			,547		,565		,534	
13			,501				,526	
14			,443					

As can be seen from Table-3 above, each of the group of PBC risk shows a fine validity for further statistical analysis, i.e regression and path analysis.

Path analysis

The path analysis were conducted as a sequential multiple regression analysis. The beta weights from these multiple regressions are the path coefficients shown in the typical figures that are used to display the results of a path analysis. Figure-5 shows the result of path analysis for thegroup of planning risk:

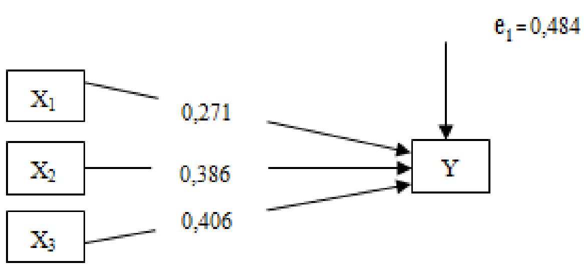

Figure-5. Path analysis of planning risk group.

The analysis regress the performance on these three causal variables and obtain R^2, β, ρ_1 for each risk variables as shown in the following table:

Table-4. Results of Analysis of Path Planning Group.

Typical risk	β	t-Value	Sig.	R^2
X_1 (ρ yX_1)	0,271	2,330	,026	0,765
X_2 (ρ yX_2)	0,376	3,794	,001	
X_3 (ρ yX_3)	0,406	3,854	,000	

The modelabove indicates that project performance (Y) is directly affected by typical risk 1(X_1), risk 2 (X_2) and risk 3 (X_3). Thus, structural equation of the planning risk model (Group 1)may be expressed as

Y_1= 0, 271X_1 + 0, 376X_2 + 0, 406X_3 + 0, 484 €$_2$ .... (1)

In similar analysis for othergroup of Management (Group 2), Delivery (Group 3), and Pyhsical (Group 4) risks, structural equations areobtained as follow:

Y_2 = 0, 279X_1 + 0, 399X_2 + 0, 269X_3 + 0, 600 €$_2$ .... (2)

Y_3 = 0, 483X_1 + 0, 256X_2 – 0, 099X_3 + 0, 442 X_4 + 0, 443€$_1$ .... (3)

Y_4 = 0, 201X_1 - 0, 327X_2 + 0, 257X_3 + 0, 477 X_4 + 0, 439 X_5 + 0, 349 €$_1$ .... (4)

From the four structural equation above, it can be seen that there are 15 variables that influence the risk of PBC project isX_4,X_{55}, X_{72}, X_2, X_{41}, X_{52}, X_{20}, X_{24}, X_{28}, X_{67}, X_{25}, X_{26}, X_{27}, X_{30}, and X_{40}.

Looking more closely, , the highest Beta (β) value found from the path analysis above and indicates that the most risk variables that affect the performance of the PBC project in Indonesia as shown in the following table:

Table-5. Beta value of each group.

Groups	Beta (B)	Variabel
Planning	,406	72
Management	,399	41
Delivery	,483	20
Physical	,477	30

From the point of risk allocation view, the risk distribution for all parties is obtained as shown in Table-6 below :

Table-6. Risk allocation of most influential risk.

Groups	Planning	Management	Delivery	Physical
Contractor	55, 72	52	20, 24, 28	25, 30,40
Owner	4	2, 41	67	26, 27

These results suggest that the allocation of the biggest risks to be borne by the contractor, which is in line with the argument of Zietlow (2004) which the allocation of the risk that the contractors increases as the deliverysystem moves from fully in-house through to the long term PBC type of contracts.

CONCLUSIONS AND RECOMMENDATIONS

This study has attempt to examine the impact of risks on the PBC project performance. It revealed evidence for the existence of 15 of the 74 risk variables that affect the performance of PBC project, i.e. X_4, X_{55}, X_{72}, X_2, X_{41}, X_{52}, X_{20}, X_{24}, X_{28}, X_{67}, X_{25}, X_{26}, X_{27}, X_{30}, andX_{40}.Four model of structural equations for each risk group wereobtained from the path analysis and indicates that project performance (Y) is directly affected by all typical group of risk (X_n).

This study also offers practical evidence of the dominant portion of contractors' risk (60%) which means the allocation of the risk of the contractors increases as the delivery system moves to the long term PBC contract.

As this study is the first specific study of the PBC risk in Indonesia, there may value inexploring the risk model in other emerging and developing countries where differentor similar condition prevails.

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