Risk Application on Infrastructure in Conventional Contract and Performance Based Contract from Perspective of Owner

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Abstract Performance Based Contract (PBC) is a contract that integrates the activities of technical planning and construction. This contrasts with the conventional contract, a contract that separates the parts of the job based on the project life cycle. The aims of this study are to find the factors of potential risks that often occur in the project, then analyze the global weight of each risk factor. Primary data was obtained by distributing questionnaires and interviews. Purposive sampling method was used to distribute the questionnaires to experts. The data was then processed to obtain the criteria and sub-criteria of risk that were used to construct a hierarchy and then processed using the AHP method. Risks involved in the project were analyzed using a conventional contract and Performance Based Contract, identified by the project life cycle: The Development And Concept Phase, Design Phase, Procurement Phase, Construction Phase, and Management Phase. The identified risks are the risk that occurs in the two types of contracts. Based Contracts with Analytical Hierarchy Process (AHP), the most risk is the poor of quality control in both of conventional contract and Performance Based Contract.

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1 Introduction

Road infrastructure is built to support the distribution of goods and service in order to accelerate the movement of the economy in all fields. An increase in road maintenance demonstrates that more people prefer to use road transportation. One of the most fundamental efforts to realize the management of quality roads is applying the role of quality control as a guarantor of quality by supervisory consultants together with directors of engineering. According to Rahadian [12], implementation and supervision should apply innovative forms of procurement and contract practices, to bring the owner and the service provider in the scheme of risk sharing in order to minimize the interest gap and harmonize the interests of the owner and the service provider as close as possible.

Among the innovative methods of contract is Performance Based Contracts, as part of the reform of the conventional contract, which was used in the procurement of goods and services in Indonesia. A Performance Based Contract is a contract that integrates the activities of technical planning and construction. These contracts are based on a performance-based specification, where the emphasis is not on the methods and material specifications but on the performance of the work (output oriented) which is measured by the standard of road operators. In contrast, the conventional contract is a contract which separates the parts of the job based on project life cycle. The principle of a conventional contract is based on the specification method: the method of implementation, material specifications, and tools predetermined by road operators, so there is no innovation of technology to support the effectiveness of implementation and the efficiency by the service providers.

The aims of this study are to find the factors of potential risks that often occur in the project, using the method of literature study coupled with validation to the owner, then analyze the global weight of each risk factor on conventional contract and Performance Based Contract (PBC) with Analytical Hierarchy Process (AHP).

2 Literature Study

2.1 Performance Based Contract

The variance in the conventional contracts and Performance Based Contracts is on the transfer of responsibility of the work in proportion, where normally the responsibility is on the owner. The division of roles in the management of the road disclosed by Wirahadikusumah and dan Abduh [16]. It was divided based on life cycle project; the phase of planning, design, construction, maintenance and management. At Conventional Contract, the division of roles at the phase of planning is owner, in phase of design is owner, in the phase of construction is contractor, in the phase of maintenance is owner, and in the phase of management is owner. While at Performance Based Contract, the division of roles at the phase of planning is owner,

in phase of design is contractor, in the phase of construction is contractor, in the phase of maintenance is contractor, and in the phase of management is owner. At Performance Based Contract, the role of the owner in the design and maintenance phase is taken over by the contractor.

Wirahadikusumah and dan Abduh [16] explained that contract for the roadworks is generally distinguished by the following characteristics: the contract form/manner of payment (cost-based vs. price-based); consideration of risk allocation and innovation (method-based specification vs. performance-based specification); and the term of the contract (short term, long term). In the terms of form of contract/payment method; at conventional contracts the payment method is based on the actual cost plus overhead and profit (cost-based), at performance based contract accordance with the performance (performance-based). In the terms of allocation of risk; at conventional contracts is method-based specification, at performance based contract is performance-based specification. In the terms of time period; at conventional contracts is short-term (up to 1 year), at performance based contract is long-term (several years, typically up to 5 years).

2.2 Risk Management

The definition of risk management as outlined by the Project Management Institute Body of Knowledge [9] is:

1. A formal process where risk factors are systematically identified, analyzed, handled.
2. A systematic method of managing the formal that concentrates on identifying and controlling the areas or events where unwanted changes potentially occur.

The stages of risk management at construction according to Duffield and Trigunarsyah [5] are:

1. Identification of risk,
2. Evaluation of risk,
3. Allocation of risk,
4. Reduction of risk.

2.3 Analytical Hierarchy Process

Risk Evaluation utilized the Analytical Hierarchy Process (AHP), a Decision Support System developed by Thomas L. Saaty. According to Saaty [13] the steps of AHP are:

1. Determination of the components (goals/objectives, criteria, sub-criteria and alternatives) and the preparation of the component hierarchy of decision; complex issues are easily understood broken down into various substantial elements and then arranged hierarchically.
2. Assessment criteria, sub-criteria and alternatives.

Criteria and alternatives are assessed through paired comparisons. For many problems, a scale of 1 to 9 is optimal to express the variance of opinions. The values and definition of qualitative opinion from per-comparison Saaty scale can be seen in Tables 1 and 2.

3. Prioritization of criteria, sub-criteria and alternatives

Each criterion and alternatives should be evaluated via paired comparisons (pairwise comparisons). The value of relative comparison is then processed to determine the ranking of all alternatives. The weight or priority are calculated by matrix or through mathematical equations.

The considerations on pairwise comparisons to obtain the overall priorities was through the following stages:

a. Multiply this matrix of pairwise comparison,
b. Calculate the sum of the values of each row, then do the normalization matrix.

4. Checking the consistency of ratings

All elements are grouped consistently according to a logical criterion. The matrix of weight that is obtained from the pairwise comparison should relate to the cardinal and ordinal. The steps of calculating logical consistency are:

a. Multiply the matrix with the corresponding priority,
b. Summing up the results of multiplications in a line,
c. The sum of each row is divided by the concerned priorities and the scores are added,
d. Results c divided by the number of elements, then will be obtained the maximum value of χ,
e. Consistency Index (CI) = $(\chi_{max} - n)/(n-1)$.

Consistency Ratio (CR) = CI/RI, where RI is a random index consistency. If the consistency ratio $\leq$ 0.1, the calculation can be justified.

Table 1 Grading scale pairwise comparisons

The intensity of interest	Definition
1	Both elements are equally important
3	Element that one a little bit more important than any other element
5	Element which one is more important than any other element
7	One element is absolute more important than the other elements
9	One absolutely essential element than the other elements
2, 4, 6, 8	Values between two values adjacent consideration

Source Saaty [13]

Table 2 Pairwise comparison matrix element thickness

	A1	A2	…	An
A1	1	A12	…	A1n
A2	A21	1	…	A2n
…	…	…	…	…
An	An1	An2	…	1

Source Saaty [13]

3 Methodology

The method used in this research was the descriptive qualitative method. The method aims to create a description, a systematic picture and factual and accurate information on the event or the relationship between risk that will be investigated. The qualitative descriptive method that used was a survey method.

In this study, researchers identify the factors of potential risks based on the project life cycle in the conventional method of contracts and Performance Based Contracts. The identified risks were analyzed using AHP to determine the priority of risks in each type of contract (conventional contract and Performance Based Contracts) from the perception of owner.

The samples in this research consisted of similar project. The sample of conventional contracts was the roadworks in Bawen—Salatiga and the sample of Performance Based Contracts was the roadworks in Semarang—Bawen.

Primary data was obtained by distributing questionnaires and interviews to identify risk, the weight of pairwise comparison of risk, the validation of criteria and sub criteria of analysis and the validation of the result from risk analysis using AHP. Purposive sampling method was used to distribute the questionnaires to experts, while secondary data was obtained from text books, journals, theses, relevant research, contract documents and relevant regulations.

The data was processed to obtain the criteria and sub-criteria of risk that were used to construct a hierarchy. There were 5 risk criteria for this research: the development and concept phase, design phase, procurement phase, construction phase and maintenance phase.

4 Data and Analysis

The method used to analyze risk was Analytical Hierarchy Process (AHP). analysis of pairwise comparisons were conducted to determine the priority of several criteria.

Risk identification was obtained from a review of previous research then validated by respondents. The results of the identification of potential risks based on the study of literature and validation by owner is shown in Table 3.

Table 3 The results of the identification of potential risks based on the study of literature and validation by owner

No.	Project life cycle	Potential risk	Source
1.	The development and concept phase	Feasibility study	Sandyafitri and Saputra [14]
2.		Land acquisition	Sandyafitri and Saputra [14]
3.		Incompatibility scope of work	Dipohusodo [4]
4.		Limitations of data or lack of data inaccuracies and utilities	Nurdiana [8]
5.	Design phase	Revision of financial budget	Interview to owner (2016)
6.		Delay in DED process and EE or basic design	Nurdiana [8], Dziadosz and Rejmentz [6]
7.		The procedure is not fixed	Interview to owner (2016)
8.		Less meticulous in delivery of EE and DED or basic design	Interview to owner (2016), Andi [1]
9.	Procurement phase	Less meticulous in classification process	Interview to owner (2016)
10.		Limitations of human resources to understand the reference/guidelines/rules used	Queiroz et al. [10]
11.		Delay in the preparation of procurement documents	Interview to owner (2016)
12.		Long auction process	Queiroz et al. [10]
13.		Political intervention	Sigmund and Radujkovic [11], Chowdhury et al. [2]
14.		Failed auctions	Interview to owner (2016)
15.	Construction phase	Design changes	Andi [1]
16.		Poor of quality control	Interview to owner (2016)
17.		Force majeur	Sigmund and Radujkovic [11], Chowdhury et al. [3]
18.		Claim contractor for additional costs beyond the contract	Nurdiana [8]
19.	Maintenance phase	Premature deterioration of the road before the design life	Interview to owner (2016)
20.		Permitting the use of road space	Chowdhury et al. (2012)

Source Data processed

From the risk identification that has been obtained, the data was then arranged into a hierarchical structure of the risk based on each phase as shown in Fig. 1. The results of pairwise comparisons for each criteria and sub-criteria is shown in Table 4.

From the analysis in Table 4, it is known that in the conventional contract, the greatest risk is of poor of quality control, with a global weight of 18.91% and the smallest risk is feasibility study that has global weight 1.03%. In Performance Based Contracts, the greatest risk is of poor quality control, with a global weight of 11.38% and the smallest risk is the risk of permitting the use of road space with a global weight 1.71%.

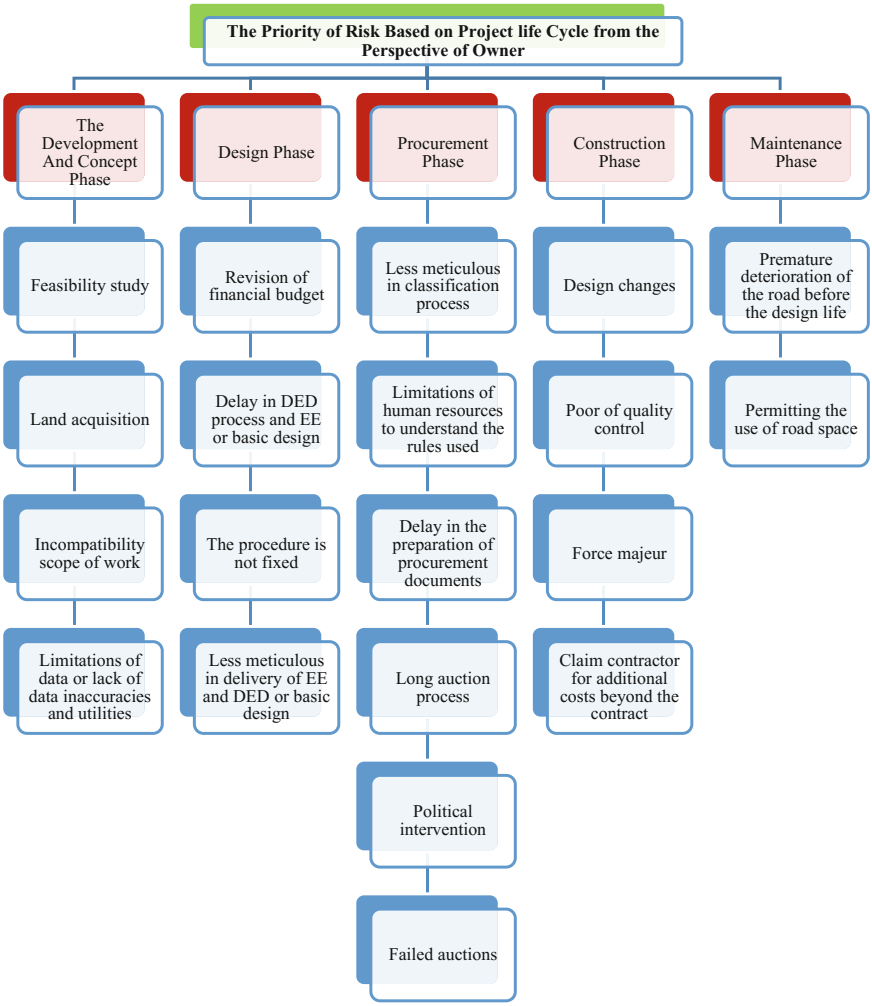

Fig. 1 Hierarchical structure for the comparison of each risk of sub-criteria on the project life cycle (*Source* data processed)

5 Discussion

Based on the results shown in Table 4, the Top Five priority risk can be seen in Table 5. These risks may cause construction failure from the validation to the owner.

From the different type of contract in construction, that is Private Private Partnership (PPP), Marques and Berg [7] found that risk in PPP project in Portugal were risks on regulation, financial, consumption, and other areas, a different model

Table 4 Value of global weight for conventional contracts and PBC

Rank	Conventional contract	% Weight	Performance base contract	% Weight
1.	Poor of quality control	18.91	Poor of quality control	11.38
2.	Premature deterioration of the road before the design life	11.55	Delay in DED process and EE or basic design	8.05
3.	Less meticulous in delivery of EE and DED or basic design	9.41	Less meticulous in delivery of EE and DED or basic design	7.38
4.	Design changes	8.21	Premature deterioration of the road before the design life	7.23
5.	Claim contractor for additional costs beyond the contract	7.30	Design changes	6.66
6.	Limitations of human resources to understand the rules used	5.77	Limitations of human resources to understand the rules used	6.40
7.	The procedure is not fixed	5.19	Limitations of data or lack of data inaccuracies and utilities	6.39
8.	Force majeur	4.30	The procedure is not fixed	6.24
9.	Less meticulous in classification process	4.16	Land acquisition	6.00
10.	Delay in DED process and EE or basic design	3.56	Incompatibility scope of work	5.06
11.	Revision of financial budget	3.36	Feasibility study	4.78
12.	Permitting the use of road space	2.61	Revision of financial budget	4.82
13.	Long auction process	2.40	Less meticulous in classification process	3.70
14.	Land acquisition	2.34	Claim contractor for additional costs beyond the contract	2.28
15.	Delay in the preparation of procurement documents	2.25	Force majeur	2.31
16.	Failed auctions	2.18	Long auction process	2.29
17.	Incompatibility scope of work	1.96	Political intervention	2.23
18.	Limitations of data or lack of data inaccuracies and utilities	1.84	Delay in the preparation of procurement documents	2.14
19.	Political intervention	1.70	Failed auctions	1.82
20.	Feasibility study	1.03	Permitting the use of road space	1.71

of risk compared to the result of this research. Different projects will have different project risk indices, different actions will be taken to minimise those risks, and different impacts will affect the project's performance. Because the project risk index had an indirect effect on the schedule performance index through progress performance, to obtain better performance, not only should risk factors be assessed at the beginning of the construction stage but also effective strategies should be carefully prepared to minimise those risks [15].

Table 5 Top 5 the significant risk

Rank	Conventional contract	% weight	Performance base contract	% weight
1.	Poor of quality control	18.91	Poor of quality control	11.38
2.	Premature deterioration of the road before the design life	11.55	Delay in DED process and EE or basic design	8.05
3.	Less meticulous in delivery of EE and DED or basic design	9.41	Less meticulous in delivery of EE and DED or basic design	7.38
4.	Design changes	8.21	Premature deterioration of the road before the design life	7.23
5.	Claim contractor for additional costs beyond the contract	7.30	Design changes	6.66

6 Conclusion

The risks involved in the project with a conventional contract and Performace Based Contract, identified by the project life cycle are as follows: The Development And Concept Phase, Design Phase, Procurement Phase, Construction Phase, and Management Phase. The identified risks are the risk that occur in the two types of contracts.

Based on the analysis of the global weight of each risk factor on a conventional contract with Analytical Hierarchy Process (AHP), the most risk is the poor of quality control while smallest risk is the feasibility study. Quality control according to the owner is a representation of the results of a work product to the specifications required and the attainment of the age of the plan that can reduce the cost of maintenance. The feasibility study is a planning of the construction work that is conducted during of new construction roads.

Based on the analysis of global weight in each risks factor on Performance Based Contracts with Analytical Hierarchy Process (AHP), the most risk is the poor of quality control while the smallest risk is the risk of permitting the use of road space. Quality is maintained service performance continuously in the duration of the contract. When the contract period is relatively long (in average seven years), the necessary quality control is the internal oversight of the service providers on performance-based contracts which is implemented by establishing a Quality Assurance Unit that is responsible for the implementation of quality programs and measuring performance using road appropriate reference standard that has been set by the contract. The road space utilization licensing is the responsibility of the owner.

Further research is the need for risk management assessment based on the perception of the performance-based contract by comparing the clause of FIDIC with the contract document, so it can be known the strengths and weaknesses of regulation that will be used as a reference document fixes for the PBC.

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