Owner Estimate (OE) and Winning Bid Price of Transportation Infrastructure Tender in Mathematical and Statistical Perspectives

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Abstract. The significant difference between the owner estimate (OE) and the winning bid price (COGS) is expected to cause non-optimal use of the budget for transportation infrastructure development which indirectly causes hampering the acceleration of regional economic growth in a region. This study aims to analyze the differences that occur using mathematical models and parametric statistical analysis. The analysis was carried out on all transportation infrastructure projects in the East Java region from 2017 to 2021, namely 464 projects. The results of the analysis showed that a simple linear regression model was chosen to be the model that best describes the relationship between the owner estimate (OE) and the winning bid price (COGS). Parametric statistical analysis shows that the level of difference between the two variables is still within reasonable limits.

Keywords: Transportation infrastructure · Owner estimate (OE) · Winning bid price

1 Introduction

One of the infrastructure development strategies is economic infrastructure which includes land, rail, sea, and air connectivity [1]. Connectivity creates the development of domestic main lines and integration between modes. Transportation became the main instrument of connecting means that brought various parties closer together [2]. The initial implication of infrastructure development is an increase in the mobility of people and goods which has a positive impact on economic activity [3]. Connectivity infrastructure development in East Java is an important instrument to continue to increase activity and accelerate the economic growth of East Java and the national economy. Transportation infrastructure reduces the problem of obstacles to smooth logistics through land, sea, and air modes [4].

The implementation of the tender for construction work begins with procurement preparation which is carried out after the Work Plan and Budget of the Ministry/Institution (RKAKL) which contains the Budget Ceiling approved by the House of Representative or the Work and Budget Plan of regional apparatus is approved by

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the Regional People's Representative Council [5]. This approved Budget Ceiling is then used as one of the guidelines in determining the Owner Estimate (OE) by the Commitment Making Officer (PPK) [5]. This OE is then used as a basis by service providers (contractors) to determine the bid price. The difference that occurs between the Budget Ceiling, OE, and Bid Price is unavoidable [6], but if the difference is significant enough, it actually causes losses to related parties [7]. The too low bid price of the OE caused an over-budget that could actually be utilized for other construction work [8]. Similarly, the OE that are too low from the Budget Ceiling also causes an excess of budget that can actually be utilized for other construction work [9, 10].

Issues related to differences in Budget Ceilings, OE, and Bid Prices and the importance of transportation infrastructure will be the main focus of this study, with specific objectives analyzing the differences between OE and winning bid price in mathematical model and statistical point of view. Until now, there has been no research that specifically highlights the differences in the Budget Ceiling, OE, and Winning Bid Price, so this research is urgently carried out in order to optimize the use of the budget. Optimizing the use of the budget is very important to support the infrastructure development strategy of the National Medium-Term Development Plan (RPJMN) 2020–2024 as an embodiment of the Nawacipta mission in the form of economic infrastructure (land, rail, sea, and air connectivity) [1].

2 Method

This study uses a Quantitative Descriptive method that will describe how big the difference is in The Budget Ceiling, OE, and Winning Bid Price, identify the causes of these differences, and model the relationship between the Budget Ceiling, OE, Winning Bid Price, and other characteristics of transportation infrastructure projects.

2.1 Population

The population of this study is transportation infrastructure construction work that is tendered electronically through e-procurement facilities and the compiler of the Budget Ceiling, OE, and Bid Price in The East Java Region. The selection of samples was carried out randomly stratified random sampling based on the value of the project and the type of transportation infrastructure.

2.2 Data Collection Techniques

The data used in this study is in the form of tender data for completed transportation infrastructure construction work obtained from the LPSE (Electronic Procurement Service) *website*. The tender data includes, among others, the name of the tender/project, the procurement method, the value of the package ceiling/budget ceiling, the OE value of the package, the type of contract, the location of the project, the business qualification, the number of bidders, and the bid price of the winner. The location of data collection is East Java Province.

2.3 Data Analysis

Data processing in this study was carried out through descriptive statistics in the form of average values (mean), standard deviations, sample variance, kurtosis, skewness, range, maximum and minimum values. Data processing is carried out after making the development of a price model to clarify the relationship between variables, including: Budget Ceiling (P_A), Owner Estimate (OE), and Winning Bid Price (H_{PP}). Operational research variables in this study include:

a. Identifying the type of transport infrastructure construction work package
b. Identifying price variables, namely the Owner Estimate (OE) and the Winner's Bid Price (H_{PP}).
c. Creating a mathematical model of the relationship between the Owner Estimate (OE) and the Winning Bid Price (H_{PP}).
d. Calculating the percentage magnitude of the Owner Estimate (OE) and the Winning Bid Price (H_{PP}).
e. Calculating the average value (mean), standard deviation, sample variance, kurtosis, skewness, range, maximum and minimum values.

3 Result and Discussion

The results of the analysis and tender for transportation infrastructure construction work start from the identification of the type of work until the statistics of the parameters can be calculated. The description of the results of the analysis is described in the following points:

3.1 Types of Transport Infrastructure Construction Work

The results of identification on tender data for transportation infrastructure construction work are divided into 12 types of construction work. The already identified types of work are presented in Table 1.

The overall total of all types of work is 452 work packages while the work with the largest number is on road maintenance work packages.

3.2 Mathematical Model

The results of mathematical modeling of the relationship between Owner Estimate (OE) and winning bid price (H_{PP}) are adjusted according to the types of transportation infrastructure construction work. A graph of the relationship between the Owner Estimate (OE) and the Winning Bid Price (H_{PP}) on the Road Reconstruction work can be seen in Fig. 1.

The mathematical model of the Winning Bid Price (H_{PP}) to the owner estimate (OE) on Road Construction work is $y = 0,8412x - 3E + 08$ with the value of the coefficient of determination (R^2) = 0.9892. A mathematical model graph of the relationship between the Owner Estimate (OE) and the Winner's Bid Price (H_{PP}) on the Road Reconstruction work can be seen in Fig. 2.

Table 1. Types of transport infrastructure construction work

No	Construction Package Type	Total
1	Road Construction	44
2	Road Reconstruction	53
3	Bridge Maintenance	16
4	Bridge Construction	44
5	Double Track Construction	8
6	Roadside Maintenance	25
7	Road Maintenance	89
8	Preservation	42
9	Road Equipment Procurement	33
10	Harbo	22
11	Paving	71
12	Station Facility Construction	5

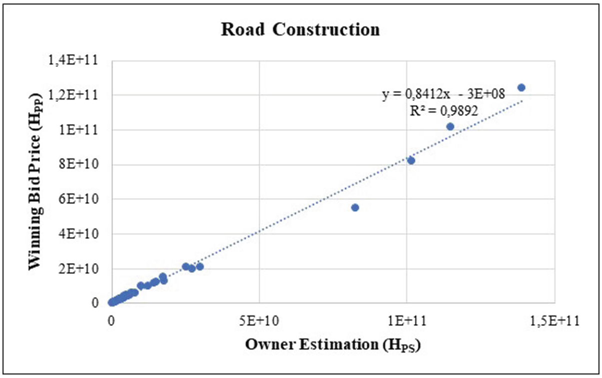

Fig. 1. Mathematical model for road construction.

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) in road reconstruction work is $y = 0, 6989x + 8E + 08$ with the value of the coefficient of determination (R^2) = 0.9919. A mathematical model graph of the relationship between owner estimate (OE) and winning bid price (H_{PP}) on bridge maintenance work can be seen in Fig. 3.

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) on Bridge Maintenance work is $y = 0, 7622x + 1E + 08$ with the value of the coefficient of determination (R^2) = 0.9997. A mathematical model graph of the relationship between owner estimate (OE) and the winning bid price (H_{PP}) on bridge construction work can be seen in Fig. 4.

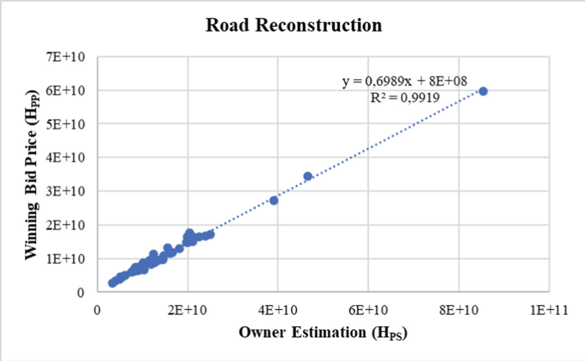

Fig. 2. Mathematical model for road reconstruction.

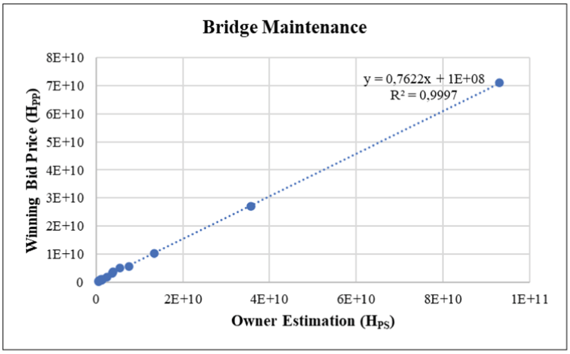

Fig. 3. Mathematical model for bridge maintenance.

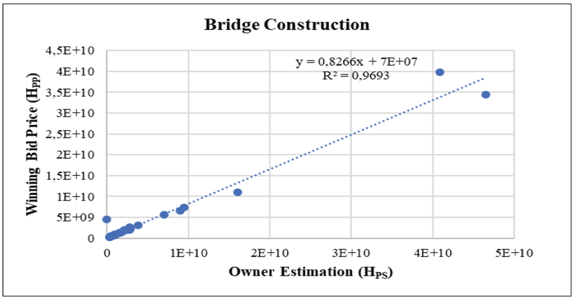

Fig. 4. Mathematical model for bridge construction.

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) in Bridge Construction work is $y = 0,8266x + 7E + 07$ with the value of the coefficient of determination (R^2) = 0.9693. A mathematical model graph of the relationship between owner estimate (OE) and winning bid price (H_{PP}) on double track construction work can be seen in Fig. 5.

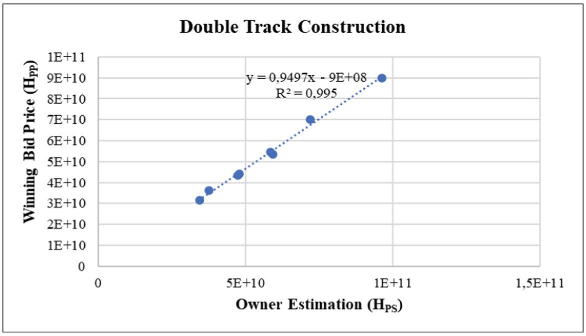

Fig. 5. Mathematical model for double track construction.

Table 2. Statistical Parameter for each project

Package Type	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min	Max	Count
Road Construction	84%	1%	84%	9%	1%	−0,95833	−0,03858	32%	67%	99%	44
Road Reconstruction	77%	1%	77%	6%	0%	−0,78847	0,288827	27%	64%	91%	53
Bridge Maintenance	80%	2%	77%	8%	1%	−0,36758	0,925492	25%	71%	96%	16
Bridge Construction	83%	1%	81%	8%	1%	−0,70591	0,53757	29%	69%	98%	44
Double Track Construction	93%	1%	93%	2%	0%	−0,36884	0,773334	7%	90%	97%	8
Roadside Maintenance	73%	1%	71%	7%	0%	−0,35767	0,798258	23%	63%	86%	25
Road Maintenance	77%	1%	76%	8%	1%	1,124461	0,680082	40%	60%	100%	89
Preservation	76%	1%	75%	6%	0%	−0,25914	0,26479	25%	65%	90%	42
Road Equipment Procurement	98%	0%	98%	2%	0%	4,888188	−1,90527	7%	92%	99%	33
Harbour	95%	1%	98%	7%	0%	11,50123	−3,2185	31%	68%	100%	22
Paving	78%	1%	77%	8%	1%	1,672501	0,19085	49%	50%	99%	71
Station Facility Construction	94%	2%	95%	4%	0%	1,673733	−1,27929	11%	87%	98%	5

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) in Double Track Construction work is $y = 0,9497x + 9E + 08$ with a coefficient of determination value (R^2) = 0.995. A mathematical model graph of the relationship between the Owner Estimate (OE) and the Winning Bid Price (H_{PP}) on Roadside Maintenance work can be seen in Fig. 6.

The mathematical model of the Winning Bid Price (H_{PP}) against the Owner Estimate (OE) on Roadside Maintenance work is $y = 0,7359x - 4E + 07$ with a coefficient of

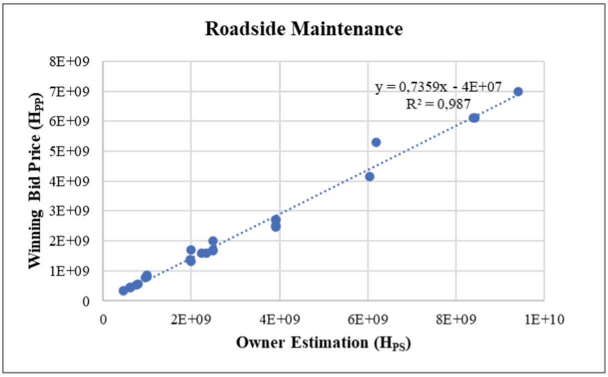

Fig. 6. Mathematical model for roadside maintenance.

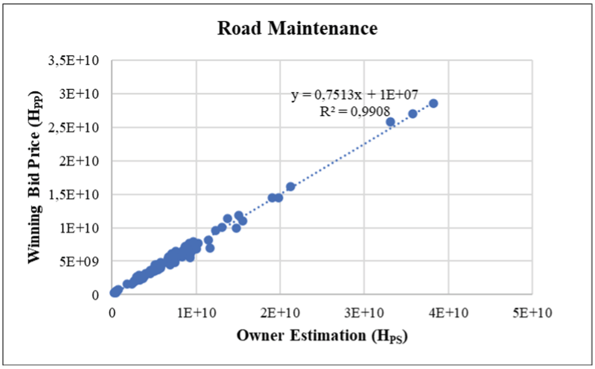

Fig. 7. Mathematical model for road maintenance.

determination value (R^2) = 0.987. A mathematical model graph of the relationship between owner estimate (OE) and winner bid price (H_{PP}) on road maintenance work can be seen in Fig. 7.

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) on Road Maintenance work is $y = 0,7513x + 1E + 07$ with a coefficient of determination value (R^2) = 0.9908. A mathematical model graph of the relationship between the Owner Estimate (OE) and the Winning Bid Price (H_{PP}) on the Preservation work can be seen in Fig. 8.

The mathematical model of the Winning Bid Price (H_{PP}) against the Owner Estimate (OE) in Preservation work is $y = 0,7525x + 4E + 08$ with the value of the coefficient of determination (R^2) = 0.9802. A graph of the mathematical model of the relationship between owner estimate (OE) and the winning bid price (H_{PP}) on road equipment procurement work can be seen in Fig. 9.

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) on Road Equipment Procurement work is $y = 0,964x + 4E + 07$ with a coefficient of determination value (R^2) = 0.9985. A graph of the mathematical model of the

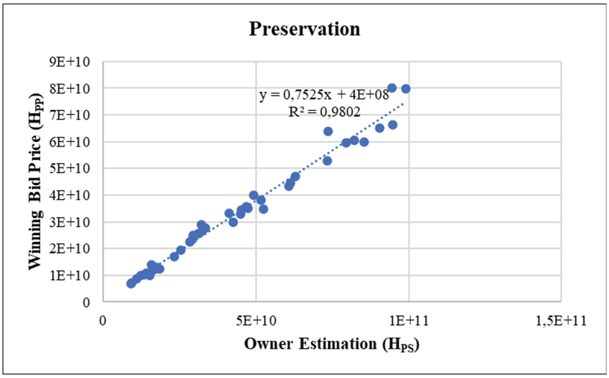

Fig. 8. Mathematical model for preservation.

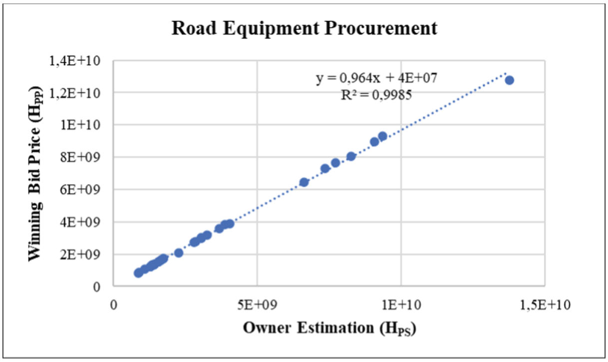

Fig. 9. Mathematical model for road equipment procurement.

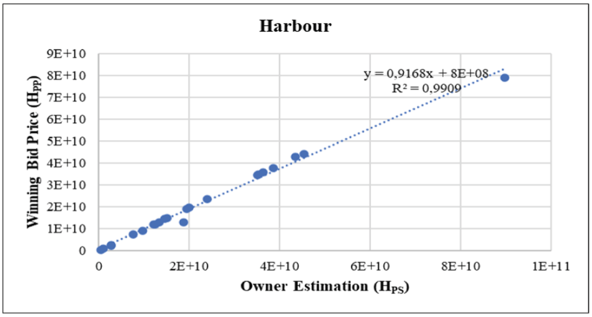

Fig. 10. Mathematical model for harbour

relationship between the Owner Estimate (OE) and the Winning Bid Price (H_{PP}) on the Harbor work can be seen in Fig. 10.

The mathematical model of the Winning Bid Price (H_{PP}) against the Owner Estimate (OE) on Harbour's work is $y = 0, 9168x + 8E + 08$ with the value of the coefficient of

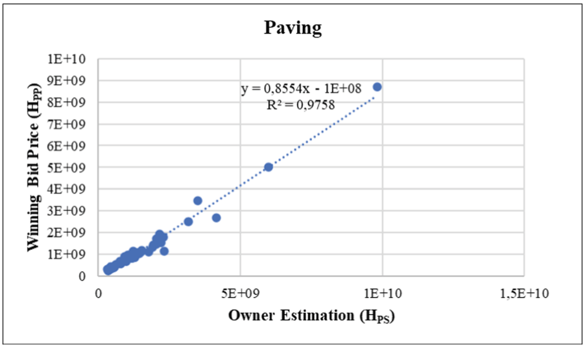

Fig. 11. Mathematical model for paving

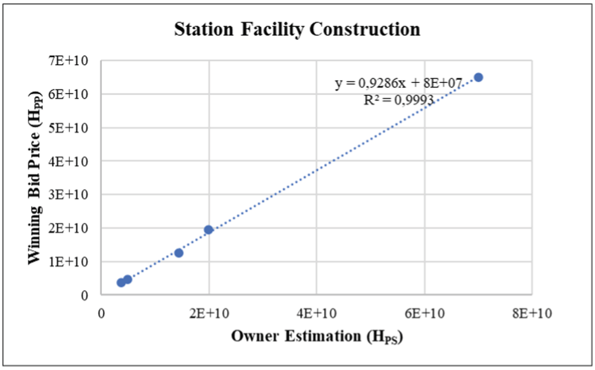

Fig. 12. Mathematical model for station facility construction.

determination (R^2) = 0.9909. A mathematical model graph of the relationship between owner estimate (OE) and the winning bid price (H_{PP}) on paving work can be seen in Fig. 11.

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) on Paving work is $y = 0,8554x - 1E + 08$ with the value of the coefficient of determination (R^2) = 0.9758. A graph of the mathematical model of the relationship between the Owner Estimate (OE) and the Winning Bid Price (H_{PP}) on the Station Facility Construction work (Fig. 12).

The mathematical model of the Winning Bid Price (H_{PP}) to the Owner Estimate (OE) on Station Facility Construction work is $y = 0,9286x + 8E + 07$ with a coefficient of determination value (R^2) = 0.9993.

3.3 Statistical Parametric

After formulating the most appropriate mathematical model, the author analysed the gap that occurred between the Owner Estimate (OE) and the Winning Bid Price (H_{PP}). This gap analysis is expected to provide information on the characteristics of tenders for transportation infrastructure projects related to the uniformity of prices that occur Table 2 shows statistical data on the decisions of the auction winners on transport infrastructure work. The results of the analysis of the standard deviation value of each transportation infrastructure construction work show that the winning bid price is still within reasonable limits. Data analysis on 15 types of work packages showed that the average Winning Bid Price (H_{PP}) tendered against owner estimate (OE) was between 72% and 97%.

4 Conclusions

The best mathematical model for describing the relationship between the owner estimate and the winner's bid price is a linear regression model because it has a high coefficient of determination value (close to 1). Statistical tests show that the difference between the owner estimate and the winner's bid price is still within reasonable limits. By breaking down the project into the scope of construction, scale, and duration of construction, the author will concentrate on a more in-depth examination in the future.

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Authors' Contributions. PM and MSHS conceived and designed the analysis. MFS, GAYPA, and MW collected the data. PM and MW performed the statistical analysis and drafted the manuscript. All author read and approved the final manuscript.

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