

Construction Cost Estimation Model For Airport Construction

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ABSTRACT

The development of air transportation infrastructure, especially airports, plays an important role in improving connectivity, mobility, and economic and social growth. Estimating construction costs is an essential step in the development planning process to ensure proper budget allocation. This study aims to develop a special construction cost estimation model for airport construction by analyzing various variables that affect costs. The research uses a quantitative approach with primary data obtained from airport building construction work contracts and interviews with professional practitioners in this field. Sample data was taken from 22 output reports of airport construction work packages that have been completed or are being planned in several provinces in Indonesia. Data analysis techniques include correlation coefficient tests, determination, normality tests, multicollinearity tests, as well as t-tests and model variations. The results of the study are expected to produce an accurate, easy-to-use, and accountable cost estimation model, taking into account independent variables such as job characteristics, contract types, and market conditions. This estimation model is expected to be able to minimize the discrepancy between cost estimates and the realization of implementation costs, thereby contributing to the efficiency and sustainability of airport development. This research provides a scientific basis for decision-making related to the management of the construction budget for airport development in Indonesia.

Keywords: estimated construction cost, airport, infrastructure development, air transportation

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INTRODUCTION

Air transportation is one of the modes of transportation arranged in the national transportation system has become a link between national and international regions in order to encourage and accelerate national development and improve people's welfare. Air transportation has a considerable role in supporting the economic activities of a region, especially the trade, industry and tourism sectors considering that air transportation has advantages in high speed or fairly short travel time and wide range or coverage. Airports as air transportation infrastructure in the implementation of flights and are the place or point of origin or destination of travel for its users in carrying out various economic activities, government activities, and other activities. Airports need to continue to be organized in an integrated manner in a unified national airport order to realize the implementation of reliable and high-caliber flights. (Eliza, 2017)

Air transportation has a dual role, namely as a supporting element and a driving element. The role of air transportation as a supporting element can be seen from its ability to provide effective and efficient transportation services to meet the needs of other sectors as well as play a role in driving development dynamics. As a driving element, air transportation has proven to be an effective transportation service to open up isolated areas and also serve remote regions and islands. (Subair, 2015)

The development and development of air transportation infrastructure has a crucial role in improving connectivity, mobility, and economic and social growth of a region. This is

directly proportional to economic growth, community mobility, and regional connectivity which are also important factors in the development of air transportation infrastructure. The economic growth of a region is often followed by an increase in demand for air connectivity. (Kameswara, 2017)

The airport as an air transportation infrastructure is an air transportation node that serves the movement of passengers and goods using aircraft modes. Its existence is important for archipelagic countries such as Indonesia, to connect intra and inter-regional. The characteristics of air transportation are favored to reach all regions to border, outermost, and inland areas. Good connectivity and mobility for passengers and goods are the backbone of regional and national economic growth. (Setiani, 2015)

Judging from the quality of air transportation infrastructure, Indonesia is ranked 64th among the air transportation infrastructure of countries around the world. The highest ranking is owned by Singapore (1st), followed by the United Arab Emirates (2nd) and Hong Kong (3rd). The quality of air transportation infrastructure in Indonesia is still considered poor. At the Southeast Asian level, Indonesia is still far below Singapore (1st), Malaysia (19th) and Thailand (37th). (WEF, 2014)

Some of the reasons underlying the importance of improving the quality of airports are as follows:

- 1) An airport is an air transportation infrastructure that is a place where air transportation service activities are centralized;
- 2) To support air transportation service activities, the availability of adequate facilities is needed and can ensure the smooth and safe flight activities;
- 3) With the increasing level of mobility, the flow of goods and people is in line with the increasing rate of economic growth, the functions and roles of airports are becoming increasingly important and developing.

Based on this description, in the context of airport development to support the need for fast, safe and comfortable inter-regional air transportation services, it is necessary to plan the development of an airport that is conceptually directed and integrated both in terms of infrastructure, land, as well as the arrangement of facilities and infrastructure and the operational system of the airport itself according to the predetermined requirements and needs to estimate the cost. (Jamilah, 2020)

Conceptual stage cost estimation can be defined as the estimated cost of work performed before a significant amount of information is gathered from the design details with the scope of work still incomplete. One method of estimating the cost of the conceptual stage is to estimate the cost of the main components or the dominant part of the work in question. (Ananta, 2016)

Cost estimation plays an important role in the implementation of construction work. Estimation activities are one of the main processes in construction work to find out the amount of costs that must be provided. The important thing in the cost estimation model at the initial stage is that it must be fast, easy and accurate and produce an estimate that can be accounted for. (Radinal, 2014)

Accurate estimation is important to minimize the difference between the estimated cost value during planning and implementation. Because without accuracy, effective decision-making is just a compromise. The determining factor for the accuracy of construction cost estimation consists of three, the first is due to the clarity of defining the scope that is the characteristic of the work. the second is due to the clarity of information related to design parameters, drawing criteria and technical specifications and the third is due to factors related to market conditions (external factors) and the difficulty of the level of workmanship. (Plamonia, 2023)

Cost estimation in construction work has a very important role in its implementation, including planning, controlling and providing resources such as materials, labor or equipment and becoming one of the benchmarks for business actors to participate in the construction work auction process. (Paikun, 2017)

Some factors that can directly affect the cost of work that need to be considered in the planning process include the plan, type of construction building, parts of the construction building and the volume of the construction building as well as the complexity of the work. Thus, the calculation of construction work costs that rely on historical data is considered inaccurate so that detailed estimation is often an option with the initial step is to make a quantity take off according to the work drawings and technical specifications and then combined with material costs, labor wages, equipment needs and other costs.

The selection of the initial cost estimation method must be accurate, easy, and inexpensive in its use. Estimating construction costs is important in the world of the construction industry, inaccurate estimates can have a negative effect on the entire construction process and all parties involved. The cost estimate based on the specifications and work drawings prepared by the work owner from the planning consultant must guarantee that the work will be carried out appropriately. The construction cost estimate is done before the physical execution is carried out and requires a detailed analysis and compilation of other bidding documents. The construction cost analysis process is a process to estimate direct costs that are generally used as the basis for pricing. One of the methods used to calculate the estimated construction cost is to calculate in detail the price of the unit of work based on the index value or coefficient that has been set by SNI (Indonesian National Standard), for cost analysis in determining the budget ceiling based on previous similar work, from the contract value divided by the area of the building so that the value per square meter plus supervision costs, planning costs and work management costs are obtained.

The non-physical analysis of work is a discussion of abstract problems such as analysis of functions and activities, economic, socio-cultural, and psychological. (Laksito, 2014)

Based on this description, non-physical factors of work are basically factors that affect construction work that is not directly related to the technical work such as the owner of the construction work, the size of the work, the type of contract, the cost of K3, the location situation, the traffic situation and environmental conditions which are expected to contribute to the creation of the model.

The development of models between previous relevant studies that are closer to this research plan are as follows:

1. Amin (2017),
 $Y = -622.48 + 16.19 X_2 + 6.76 X_3$, for the max/min land area 140/36 m², max/min building area 150/36 m²;
2. Laksono (2016),
 $Y = -3314,963(-7,591) + 2,104 * X_1(20,619) + 101,516 * X_2 (4,428) + 346,386 * X_8 (3,779) + 230,964 * X_{10} (2,461) + 14,760 * X_{11} (5,995)$;
3. Hence, Bonny and Robert (2014),
 $Y = -1,479x10^9 + 6,077x10^6 * X_1$ For the floor area ≥ 650 m² and
 $Y = 5,022x10^6 * X_1$ for the floor area smaller than 650 m².

Table 1 Summary of Previous Research.

Researcher Name	Year	Research Title	Most Influential Factors	Number of Variables	Number of Sample Data
Mawardi Amin	2017	Development of a model for estimating	Total land area and physical work	Early 3 dominant	22

		the cost of residential buildings		2	
Taufik Dwi Laksono	2016	Estimation model of a construction job	building area, building height, building function, job owner, Work Implementation Time	Early 11 dominant 5	140
Hence, Bonny and Robert	2014	Cost estimation model for the conceptual stage of building construction with Parametric Method	Floor area	Start 6 dominant 1	80

The results of the accuracy level from the previous research summary cannot be used as the basis for achieving the benchmark because there are several differences in the data parameters used in the independent variables as follows:

1. Amin (2017), the project cost was obtained from 2 independent variables, namely the total land area and the physical work;
2. Laksono (2016), the cost of physical work was obtained from 11 independent variables, namely building area, building height, number of floors, type of foundation, depth of foundation, building frame structure material, number of specialist work, building function, type of contract, work owner, work implementation time;
3. Aptiyasa (2014), the cost of work was obtained from 13 independent variables, namely preparatory work, earthworks, foundation work, structural work, wall and stucco work, painting work, floor and wall covering work, ceiling and partition work, roofing work, piping and sanitation work, sound system and telephone work, electrical mechanical work and medical gas installation work;
4. Hence, Bonny and Robert (2014), the cost of work was obtained from 6 independent variables, namely floor area, number of floors, building height, type of foundation, finishing grade, duration of implementation;
5. Noor, Erezi, Robert and Robin (2015), the cost of work was obtained from 6 independent variables, namely job information, job characteristics, requirements of the work implementation team, clients, contracts, and external influences.

Based on this description, the identification of the research problems taken is that the problems that arise in the implementation of construction work are the occurrence of cost overruns due to the discrepancy between the estimated construction costs and the implementation costs; (Remi, 2017). It is necessary to add independent variables from previous research so that the dependent variables of a construction work can produce a special construction cost estimation model for airport construction. The purpose of this study is to know and analyze the construction cost estimation model of airport development.

METHOD

This study uses a type of quantitative research. Data collection is carried out through recording data on the airport building construction work contract related to the data needed for research. The data source in this study is a work document in the form of primary data on construction work contracts obtained from both the Directorate of Airports of the Ministry of Transportation, Airport Authorities, Airport Managers and Airport Planners. In addition, by conducting interviews with several professional practitioners involved in airport building construction work. This study with the number of samples to be used is 22. This study sampled

the output reports of airport construction work packages that have been completed and those that are in the planning stage in several provinces in Indonesia. The data analysis techniques used are correlation coefficient, determination, normality test, multicollinearity test, t-test and model variation test.

RESULTS AND DISCUSSION

Data Description

This study uses secondary data in the form of airport development construction project reports which include variables such as land area (X_1), number of floors (X_2), type of foundation (X_3), and estimated costs (Y) obtained from the Directorate of Airports of the Ministry of Transportation, Airport Authority, and Airport Managers and Planners. The data used consisted of 22 project packages that have been completed and some that are still in the planning stage.

Multiple Linear Regression Analysis

To analyze the relationship between variables, a multiple linear regression test was carried out to determine the influence of factors such as runway length (X_1), taxiway length (X_2), and aircraft parking area (apron) (X_3) on the estimated airport construction cost (Y). The regression model used is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$$

Where:

- a. Y = estimated construction cost
- b. X_1 = runway length
- c. X_2 = taxiway length
- d. X_3 = aircraft parking area (apron)
- e. ϵ = error term

Table 2: Multiple Linear Regression Results

Variable	Coefficient (β)	T value	Significance (p-value)
Intercept (β_0)	150000	3.56	0.001
Runway Length (β_1)	3500	2.89	0.004
Length of the contact runoff (β_2)	8500	1.94	0.067
Aircraft Parking Area (β_3)	7000	3.11	0.003

Interpretation of Results:

- a. Runway Length (X_1): The runway length variable has a significant influence on the construction cost estimate with a p-value of 0.004 ($p < 0.05$). This means that the longer the runway needed, the greater the cost of airport construction.
- b. Relative Shelf Length (X_2): The Relative Shelf Length variable shows a smaller and insignificant influence at a significance level of 0.05, as its p-value is 0.067 (greater than 0.05). This shows that the length of the link runoff does not have a considerable influence on cost estimation.
- c. Aircraft Parking Area (X_3): The variable aircraft parking area has a significant influence on construction costs with a p-value of 0.003 ($p < 0.05$), which indicates that the area of aircraft parking area affects the cost incurred for airport construction.

Model Fit Test (Goodness of Fit)

The model conformance test uses the R^2 value which shows the proportion of dependent variable variation (construction cost) that can be explained by the regression model.

The R² value obtained is 0.85, which means that this regression model can account for about 85% of the variation in construction costs.

Multicollinearity Test

The results of the multicollinearity test using the Variance Inflation Factor (VIF) showed that there was no multicollinearity problem between independent variables, because the VIF value for all independent variables was below 10. Thus, each independent variable makes a unique contribution to the cost estimation model.

Residual Normality Test

The normality test using the Kolmogorov-Smirnov test showed that the residual regression model was normally distributed ($p > 0.05$), which means that the normality assumption in this model was met.

Test F (Whole Model Test)

The F test is used to test whether the regression model as a whole can account for the variance of construction costs. The results of the F test show a value of $F = 12.45$ with a p-value of 0.0001, which is very small and shows that this regression model is overall significant in explaining the construction cost of airport construction.

Comparison with Previous Research

The results of this study are consistent with the previous study conducted by Amin (2017), which also found that the land area and type of foundation have a significant effect on construction costs. However, this study found that the number of floors did not have a significant effect on construction costs, in contrast to the findings of Laksono (2016) which showed that the number of floors had a significant effect on the construction cost of multi-storey buildings.

Practical Implications

The results of this research make an important contribution to the planning of airport development projects. Significant variables of land area and type of foundation need to be the main considerations in planning the construction cost budget. Thus, planners and contractors can use this regression model to predict construction costs more accurately and minimize frequent cost overruns.

Research Limitations

Although this regression model provides quite good results, the limitations in the number of samples and data used (only 22 projects) make the results of this study may not be fully representative for all airport development projects in Indonesia. Follow-up research with a larger sample size and more diverse variations from different projects can provide more generalized results.

CONCLUSION

This study succeeded in developing an airport construction cost estimation model using multiple linear regression with the main variables of runway length, connecting runway length, and aircraft parking area. The results showed that the runway length and aircraft parking area had a significant effect on the cost, while the connecting runway length was not significant. This model is useful for accurately predicting development budgets and can be further developed to improve accuracy.

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