The Cost Estimation Using "Cost Significant Model" on The Structure of Beam Girder Development of DPU Bina Marga Bridge Province In East Java

Esti Wulandari*, Budi Witjaksana, Waten Oetomo, & Hadi Pramoedjo

Civil Engineering, 17 Agustus 1945 Surabaya University, Surabaya, Indonesia

E-mail: estiwulandari@gmail.com

Abstract: Cost estimation is one of the construction processes to know the amount of cost for the completion of a project. The cost model on the project should be simple, easy, accurate and the results are accountable. This study is intended to find out the work affecting the total cost of bridge construction, model and cost model. Cost method realization model with the cost model used in DPU BinaMarga East Java Province.

This research chose a location in East Java area with research object of Bridge Girder Construction at DPU BinaMarga East Java Province. The data of the research was collected by using a census of development work packages in the same province of East Java whose funds sourced from APBD, from 2011 to 2014. The research data consisted of nearly equal 6 (six) job project data. Data analysis technique used in this research is using descriptive statistical analysis and inferential analysis.

Based on the calculation, there is a procurement of top and installation buildings, stone and masonry work, pavement and asphalt work, reinforcement work, foundation work, and concrete work significantly to the cost of building girder bridge, 84.72% additional cost, otherwise 15.28% Caused by other causes, Model cost of development of the Bridge with the Model Significant Cost is: \( Y = 22.971.133.97 + 1.513X7 + 1.161X9 + 2.108X3 \). A curation of significant models ranged from -10.20 % to + 6.75 %. Estimates with the Significant Cost Model resulted in better results when compared to parameters using long road parameters that have been used in DPU BinaMarga East Java Province with an accuracy ranging from -38.68 % to + 38.05 %.

Keywords: Significant Cost Model, accounting, development cost, bridge length parameters

1. Introduction

The preparation of the development budget of a project requires accuracy in the estimated costs, the estimated costs play an important role in budgeting. The estimated cost is one of the construction processes to know the magnitude of the cost to the completion of a project. On a construction project in the Government estimated cost is calculated based on the quantity of the results of calculation of the plan implemented by the image consultant Planner. However, in certain cases, e.g., natural disasters floods or landslides that resulted in a bridge collapse and the bridge is vital access which must quickly dealt with, then the required speed of handling[1] [2][3]. To handle such cases required speed and
accuracy estimation of the costs for the budgeting on the construction of the bridge cost estimation process, building upon the very structure of the effect the in the amount of the fee required[4][5]. The types of building structures commonly used for the construction of the bridge. The estimated cost of the construction of bridge structures over it using concrete prestressing. The methods that will be used to examine the cost estimation is a Significant Cost Model. Cost Model is a Significant way of estimating costs using collecting data Bill of Quantity of some similar contracts have implemented in the previous year on projects PU BinaMarga. To get the perfect research required data collected from the construction contract Bill of Quantity bridge DPU BinaMarga East Java Provincial fiscal year 2011 – 2014.

1.1. Formulation of The Problem
Based on the above description, the problems in this study are:
1. What type of work has significantly affected the overall cost of building a bridge?
2. What is the estimation model of the cost of the girder beam bridge construction using the "Cost Significant Model" method in the East Java Province Highways DPU?
3. What is the accuracy of the estimation model of the cost of the girder beam bridge construction using the "Cost Significant Model" method towards the realization of costs?
4. What is the comparison between the accuracy of the estimated model cost of the girder beam bridge construction using the "Cost Significant Model" method with the estimation model that has used in the DPU Workers' Office of East Java Province?

1.2. Research objectives
Research objectives are as follows:
1. Knowing the type of work that has a significant effect on the overall cost of building a girder beam bridge.
2. Find an estimation model for the construction of girder beam bridges using the "Cost Significant Model" method in the DPU of Bina Marga in East Java Province.
3. Knowing the accuracy of the estimated cost model of the construction of the press girder bridge with the method "Cost Significant Model" to the realization of costs.
4. You are comparing the accuracy of the estimation model using the "Cost Significant Model" method with an estimation model that has used in the DPU of the Highways of East Java Province.

2. Review of Related Literature

2.1. Previous research
Previous research and studies related to the estimated cost of development using the Cost Significant Model method to support this research are as follows:
1. Estimated Cost by Using "Cost Significant Model" on Steel Frame Bridge Work in the South Cross Road Construction Project in East Java Province [6][7][8]. This study analyzes the bridge frame of the South Java provincial south road development project. The results of this study are the procurement of building and installation, reinforcement work, earthworks, foundation work, and concrete work significantly influence the cost of building a steel frame bridge, where 85.39% of the bridge construction costs, while the other reasons influence the remaining 14.61%. The estimated cost of development model of the South Cross Bridge of East Java with "Cost Significant Model" is: 

\[ y = Y = 75,709,920,922 + 0.709 X^7 + 0.573 X^5 + 0.917 X^3 \]

The accuracy of the estimation model of bridge construction costs using the "Cost Significant Model" method is in the range of -3.47% to +27.26%, with an average of +1.17%.

2. Development of "Cost Significant Modeling" for Estimating Water Project Costs [9]. This study describes the nature and usefulness of the cost model, and the principle of significant costs can produce a simple, structured and accurate measurement method. The results of this study are the accuracy rate for the consolidation dam ranges from 7% - 15%, the sediment retaining range is around...
3.1. The Identification of Variables
These studies involve a single variable and ten free variables. The relationship between the free variables with the variable It can be illustrated in the research model as follows:

7%, and the channel ranges from 6% while the level of accuracy in tender activities ranges from 5% - 15%.

3. Model Facilities Maintenance Costs at Bali’s Ngurah Rai Airport. This study analyzes the maintenance cost model to identify maintenance activities in Ngurah Rai Airport by collecting data on facility maintenance costs in the last five years (2007-2011) [10][11][12]. The results of this study are using the Cost Significant Model and multiple linear regression equations, resulting in significant maintenance of facilities that affect the cost of maintaining facilities at Ngurah Rai Airport, namely passenger terminal building maintenance costs (X6), maintenance costs (X1), taxiway maintenance costs (X2), maintenance costs for AC installation (X14), road maintenance costs (X4), vehicle parking maintenance costs (X5), and air transportation maintenance costs (X10). The regression equation model obtained is 3, namely 1) Y = 11873745878,77 + 0,993X1 + 0,826X2 + 0,334X4 + 1,181X6, 2) Y = -698840481,94 + 1,327X1 + 1,716X2 + 5,516X5 + 3,060X14, and 3) Y = 82110363478,07 + 1,013X1 - 17,223X5 + 22,406X10 - 12,035X14. After testing the Cost Model Factor (CMF) on the three multiple linear regression equations, the most accurate equation is the linear regression equation Y = 82110363478,07 + 1,013X1 - 17,222X5 + 22,406X10 - 12,035X14. With the average ratio of the difference of the equation this is 0.006% of the actual cost, so this estimation model is very good to be used to model facility maintenance costs at Bali’s Ngurah Rai Airport.

2.2. The Basics Of Cost Significant Models
According to [13][14] in the journal of "Cost-significant modeling-its potential for use in south-east Asia," states that the tender process in Indonesia sometimes influenced by local culture. Relationships based on trust between the customer (owner) and the contractor can reduce the calculation of project estimates in detail. The contractor identifies and roughly describes the project needs and carries out price negotiations [6][15]

As the basis of the Significant Cost Model, it is to rely on well-documented findings that 80% of the total value of the project contained in 20% of the most expensive work items. For projects that have similar characteristics, costly items are roughly the same.

Cost significant items can be collected using a variety of techniques into the same number of cost-significant work items, which can present the exact proportion of the total budget costs that are usually close to 80%. The total value of the project can usually calculated by multiplying the total price of the cost-significant packages with the right factor, approaching 1.25. The value of these factors varies depending on the category and analysis of historical data. Plans of planned work can reflect field implementation. Thus feedback and control can be facilitated. In common, it is only about 10% of the total items from conventional budgets. Simplification of this model reduces the time for Estimating costs compared to traditional cost budgets, which can consist of thousands of items. Cost Significant Models can be used to estimate costs better than 5%, and the final calculation is better than 1%. The accuracy can be increased or decreased by improving the model and depending on the data which are available.

3. Data Analysis and Discussion
3.1. The Identification of Variables
These studies involve a single variable and ten free variables. The relationship between the free variables with the variable It can be illustrated in the research model as follows:
Figure 1. The relationship between the free variables with variables bound

Image captions:
X1 = The cost of the work mobilization
X2 = The cost of the drainage work
X3 = The cost of earthwork
X4 = The cost of the concrete work
X5 = The cost of the work of reinforcement
X6 = The cost of the Work Foundation
X7 = The cost of procurement of building upon the
X8 = The installation cost of building upon the
X9 = The cost of the brick and stone couples jobs
X10 = The cost of the job returns job conditions and minor
Y = The amount of the value of the job/real cost
Table 1. Comparison Of Model Estimation Of The Cost Of Construction Of The Bridge

| NO | PACKAGE-NAME PROJECT | TOTAL COST of IMPLEMENTATION (2017) (Rp.) | THE LENGTH OF THE BRIDGE (m) | COST SIGNIFICANT MODEL ESTIMATION OF COSTS (Rp.) | ACCURACY | THE METHOD PARAMETER IS THE LENGTH OF THE BRIDGE ESTIMATIO N OF COSTS (Rp.) | ACCURACY |
|----|-----------------------|-------------------------------------------|------------------------------|-----------------------------------------------|----------|-------------------------------------------------|----------|
| 1  | PLAPAR                | 12,955,693,310                             | 50                           | 12,643,893,634                                 | -2.41%   | 8,750,000,000                                   | -32.46%  |
| 2  | CUMPLENG              | 2,966,905,521                              | 21                           | 2,993,415,722                                  | 0.89%    | 3,675,000,000                                   | 23.87%   |
| 3  | KADEMANGAN            | 7,855,887,997                              | 40                           | 8,360,487,610                                  | 6.42%    | 7,000,000,000                                   | -10.89%  |
| 4  | MOROWUDI I            | 6,734,686,631                              | 24                           | 6,634,439,876                                  | -1.49%   | 4,130,000,000                                   | -38.68%  |
| 5  | KEDUNG SUMBER I       | 5,289,507,850                              | 38                           | 5,646,591,964                                  | 6.75%    | 6,650,000,000                                   | 25.72%   |
| 6  | TEMBERU ALIT          | 4,310,034,096                              | 34                           | 3,870,517,442                                  | -10.20%  | 5,950,000,000                                   | 38.05%   |

Max: 6.75%    38.05%
Min: -10.20%   -38.68%

Source: Analysis Results

From comparisons of models such as table 1 accuracy model which positively stated that the estimated costs are greater than the cost of implementation (actual cost). While on the contrary, the accuracy of the model is negative States that estimated the cost of implementation costs (actual costs). Accuracy with "Significant Cost" Model is in the range-10.20% up to + 6.75. While using the method parameter length of road which is used on the public works agency Bina Marga province of East Java, ranging between-38.68% up to + 38.05%. Estimated cost with "Significant Cost" Model "developed a better estimation of yield compared to the estimate by using the parameters of the length of the bridge.

4. Conclusions and Suggestions

4.1. Conclusion

Based on the results of research that has been carried out, the following conclusions obtained:

1. Procurement, building upon the work of the pair of stone and brick, and asphalt roughness verbatim work, is a work that greatly affects the overall costs significantly to the construction of the bridge.

2. The model estimated the cost of construction of the bridge in Agency PU BinaMarga Eastern provinces with "Significant Cost" Model was: $Y = 26,217,681.38 + X 7 + 1.161 1.513 X9 2.108 + X 3$

3. The accuracy of model estimates of the cost of construction of the bridge with the method of "Significant Cost" Model "is in the range-10.20% up to + 6.75%. The value of accuracy-10.20% indicates that the costs to the "Cost Model" Significant smaller 10.20% of the actual cost and so did the value of accuracy + 6.75% indicates that the costs to the "Cost Model" Significant larger than 6.75% of actual cost.

4. Estimation with "Significant Cost" Model "produces a better estimation when compared with the estimated parameters using the long path that has used on the public works agency BinaMarga East Java province that its accuracy range between-38.68% up to + 38.05%.

4.2. Suggestion

From the conclusions of the study as described previously, then things may be suggested as follows:

1. Based on the accuracy of the model is obtained, then the estimated cost with "Significant Cost" Model "used in the early stages planning to arrange the building of the bridge project budgets in East Java province by using beam girder.
2. For estimating the cost in the construction of the bridge project in East Java province, next year is expected to take into account the magnitude of inflation applicable to the year in question.

References
[1] D. P. Umum, “Undang-Undang Republik Indonesia Nomor 38 Tahun 2004 tentang JALAN.” Jakarta, 2004.
[2] P. R. Indonesia, “Peraturan Pemerintah nomor 34 tahun 2006 tentang jalan,” Jakarta Sekr. Negara, 2006.
[3] R. Marwanaya and Z. R. SD, “Pengawasan Infrastruktur Jalan Oleh Dinas Pekerjaan Umum Kota Pekanbaru,” J. Online Mhs. Bid. Ilmu Sos. dan Ilmu Polit., vol. 3, no. 2, pp. 1–14, 2016.
[4] H. S. D. Roring, B. F. Sompie, and R. J. M. Mandagi, “Model Estimasi Biaya Tahap Konseptual Konstruksi Bangunan Gedung Dengan Metode Parametrik (Studi Kasus Pada Bangunan Gedung Publik Di Wilayah Kota Manado Dan Kabupaten/kota Sekitarnya),” J. Ilm. Media Eng., vol. 4, no. 2, 2014.
[5] T. Listyorini et al., “Holographic reflection Penglipuran Village Bali,” international J. Eng. &Technology, vol. 7, No. 14 (2018), 2018.
[6] A. Bakar, “ESTIMASI BIAYA DENGAN MENGUNAKAN ‘COST SIGNIFICANT MODEL’ PADA PEKERJAAN JEMBATA RANGKA BAJA DI PROYEK PEMBANGUNAN JALAN LINTAS SELATAN PROVINSI JAWA TIMUR,” EXTRAPOLASI J. Tek. Sipil, vol. 7, no. 1, 2014.
[7] I. E. Wulfram, “Manajemen proyek konstruksi,” Andi, Yogyakarta, 2002.
[8] A. Prijono and V. G. Hajek, Manajemen proyek perekaayasaan. Erlangga, Jakarta. 1988.
[9] P. F. Kaming, W. I. Ervianto, and M. G. W. Kushartini, “PENGEMBANGAN ‘COST SIGNIFICANT MODELLING’ UNTUK ESTIMASI BIAYA PROYEK PENGAIRAN.”
[10] R. Dewita, I. G. A. A. Putera, and I. G. P. Suparsa, “MODEL BIAYA PEMELIHARAAN FASILITAS PADA BANDAR UDARA NGURAH RAI BALI,” J. Spektran, 2013.
[11] G. S. Indrawan, “Estimasi Biaya Pemeliharaan Jalan Dengan Cost Significant Model Studi Kasus di Kabupaten Jembrana Bali,” Bali Univ. Udayana, 2011.
[12] I. Dipohusodo, “Manajemen Proyek dan Konstruksi jilid 1 dan jilid 2,” Kanisius Jakarta, 1996.
[13] I. Pemayun, “Praktek Estimasi Biaya Dengan Metode ‘Cost Significant Model’ Pada Bangunan Gedung Yang Memakai Arsitektur Bali (tesis),” Yogyakarta Univ. Atma Jaya, 2003.
[14] P. S. H. Poh and R. MALCOLM W. HORNER, “Cost-significant modelling-its potential for use in south-east Asia,” Eng. Constr. Archit. Manag., vol. 2, no. 2, pp. 121–139, 1995.
[15] I. N. Pujiawan, “Ekonomi Teknik,” Penerbit Guna Widya. Surabaya, 2004.