Winning ratio improvement of tender in hospital building construction project by definitive technique based on java utilization

Albert Eddy Husin[1], Paksi Dwiyanto Wibowo[2]
[1,2](Master Program of Civil Engineering, Mercu Buana University, Jakarta, Indonesia
Email: albert_eddy@mercubuana.ac.id)

ABSTRACT
The need of the hospital in Indonesia has indicated by 1.16 bed per 1.000 people ratio less than ASEAN Countries 2.5 bed per 1.000 people. The Hospital requires in Indonesia has increased by 11.57% in 2017. It is directly proportional construction activity especially tender. To win a project with high profit and low bid price has become an obstacle to establishing the contractor bid price, which triggered the use of Definitive Technique based on Java and Mark Up analysis in this research. Statistical analysis by using Relative Importance Index (RII) was done in order to acquire the 16 most important factors in this research which are: competitive bidding strategy, experience of similar project, need of work, number and identify competitors, history competitors tender, design complexity and construction, drawing and specifications completeness, winning probability, expected profit, contractor experience in building hospital, experience and competence of the estimator, project location, project duration, accuracy of the cost estimation, qualify and bid price. The result of the case study showed the Friedman method as markup value used to outbid all competitors by 18%, showed with 11.4% expectation profit and 62.9% winning probability. The Definitive Technique result showed the proportion real cost value of hospital tender: architectural work (41.48%), structure work (32.32%), mechanical work (13.05%), electrical work (9.47%), change order work (2.52%) and preliminary work (1.17%).

Keywords *- Definitive Technique, Hospital Project Tender, Java, Mark Up*

I. INTRODUCTION
Delay of schedule The use of Hospital classified by two-term as public health building and/or infrastructure which contribute to Global Competitiveness Index [1]. Based on the Global Competitiveness Index (2017-2018), the vital role of the hospital indicated by the sector's contribution to the four pillars that form the basis of a country's factor-driven competitiveness: 1) institution, 2) infrastructure, 3) macroeconomic environmental and 4) health and primary educational [2]. Although an ideal governance structure should improve the production efficiency and, at the same time, economize on the relevant transaction costs, different governance mechanisms often present different trade-offs between benefits and costs [3]. The need of a hospital in Indonesia has indicated by 1.16 bed per 1.000 people ratio less than ASEAN Countries 2.5 bed per 1.000 people [4]. The number of hospitals in Indonesia growth in 2015 grew by 7.98%, in 2016 it grew by 3.40% and in 2017 grew by 11.57% [5]. It means the public health expenditure has been increased to reach the rate of hospital bed per 1.000 people ratio.

In Indonesia the hospital category has classified by 4 type based on facility and capability services there are type A, B, C and D. There are 71 units type A, 397 units type B, 1.340 units type C, 737 units type D and 231 units that even yet classified, that recorded at the end of 2017. In this research, the object of a hospital by using category hospital type C. The percentage of the hospital category in Indonesia has shown in Figure 1.

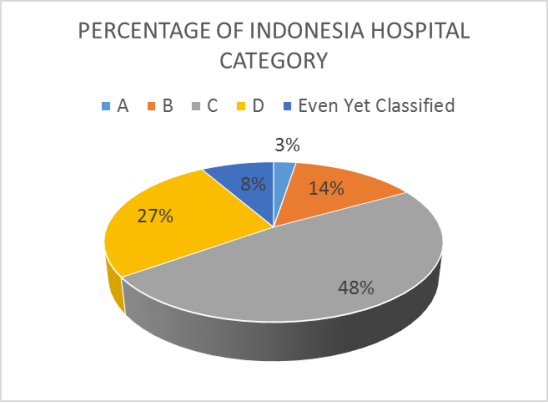

Figure 1. Percentage of Indonesia hospital category
Source: (Kemenkes RI, 2018)

To win a project with high profit and low bid price has become an obstacle to establishing the contractor bid price. Reliable prediction of final tender sums (contract sums) of building projects from the cost plans has posed

challenges for construction [6]. In this case of the hospital tender, criteria acceptance of tender price determined by the rate of revenue (ROR) from the contractor side which means the profit that should to received by the contractor have to higher 9% [7]. A creative and innovative effort is needed in planning so that it can provide significant added value to the project [8]. Competitive bidding is the major mechanism for allocation of construction projects and consequently price determination of the construction services [9]. The tender strategy is different for each contractor. The goal is to win the tender and get a new project. Determination of bid price based on several aspects like the amount of expected profit and probability of winning the tender. There is kind of method the bid model provides an approach to evaluating closed-bid competitive situations among known competitors in the determination of the probability of placing a winning bid, that is Friedman Model. This model has introduced since 1956 [10]. Therefore model Friedman used to analyze of determination the markup value, expected profit and probability of winning the tender.

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Due to the above explanation regarding the competitive bid price determined by estimation method that used to arrange the amount of the tender. In this research, estimation method has selected by using Definitive Technique. This method has the rate of work definition between 50%-100% and it classified as the top level of cost estimation method [11]. The other literature mentioned that definitive technique has the highest accuration of estimation which means -5% to 15% [12]. Therefore these kinds of cost estimation have used to determine a tender price. At the end of the analysis, all of the aspect to arrange the bid price has been obtained like the amount of work and mark up value and then it will bring into the application based on java programming to establish bid price and detail cost estimation.

II. METHODS

This research involved a case study of a hospital tender project in Tangerang. The goal of this research is to acquire optimum markup indicated by high expected profit and probability of winning tender of the hospital project, to determine competitive bid price and to know detail cost estimation by using markup Friedman method and definitive technique. Figure 2 shows the flow of the overall research framework consisting of the following steps:

- Identify key success factor regarding the application of definitive technique and mark up Friedman method, with the case study hospital tender project.
- Analysis markup by using Friedman method to acquire the probability of winning a tender to against the competitor and high expected profit.
- Analysis cost estimation of hospital tender project by using Definitive Technique to acquire detail cost model of hospital tender price.

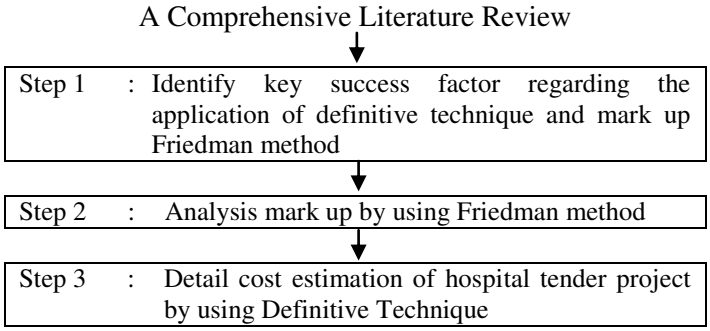

Figure 2. The Flow of overall research framework

2.1. Mark up Friedman

The Friedman method is one of the mathematical modeling methods in price quotes made in 1956. This model produces optimal prices with optimum benefits. The output of this method is the markup value, the

probability of profit and the probability of winning the tender. The model relies on essentially the same information regarding probabilities of submitting the winning bid with optimum profit [10]. Literature review shows that markup Friedman can calculate by Equation 1 below [13]:

$$P_{Win}(r) = \prod P_i(r) \quad \text{Eq. 1}$$

Where:
$P_{win}(r)$ = Probability of win against all competitor
$P_i(r)$ = Probability of win against i competitor

Then the expected profit can acquire by using Equation 2:

$$E(P) = \text{Mark Up} \times P_{win} \quad \text{Eq. 2}$$

Where:
$E(P)$ = Expected Profit
P_{win} = Probability of winning

2.2 Definitive Technique

In this research cost estimation establish by using definitive technique method. According to research results [12] states that the definitive technique estimation method is a more detailed estimation method with an accuracy rate of -5% to + 15%. According to [14] there is a level of accuracy and duration of definitive estimate estimation, having a duration of 10-15 people/day with an accuracy rate of -5% s.d 10%. Therefore, this estimation method is used as the basis for preparing the budget for the tender for hospital projects. Definitive Technique will be running an application based on java programming that has an Indonesia copyright.

III. RESULTS AND DISCUSSION

3.1 Mark Up Friedman.
Analysis markup in this case using 30 number of similar project to prepare competition with 2 contractors competitor. Analysis probability of winning tender with probabilistic analysis by using multinormal distribution the step analysis explained below:

a. Determine history tender with the competitor and find out average, mean and deviation to analysis probability of winning the tender. It showed in Table 1 and the result of probability winning and expected profit showed in Table 2.

Table 1. Determine history tender with the competitor

No	Year	Real Cost PT. A (Object of The	Bid Price PT. A (Object of The Contractor)	Bid Price		Ratio Bid Price toward Real Cost	
				PT. C1	PT. C2	PT. C1	PT. C2
1	2015	20,777,155,144	25,509,360,000	28,477,083,000	27,244,861,000	1.371	1.311
2	2015	8,576,318,357	10,724,000,000	12,912,983,000	12,126,360,000	1.506	1.414
3	2015	13,626,935,897	16,885,000,000	19,043,642,000	20,273,135,000	1.397	1.488
4	2015	56,701,166,528	68,973,000,000	73,144,539,000	75,844,979,000	1.290	1.338
5	2015	16,032,213,176	20,047,000,000	23,152,320,000	24,279,421,000	1.444	1.514
6	2015	9,586,564,149	11,770,000,000	13,040,047,000	12,691,751,000	1.360	1.324
7	2015	48,383,743,062	60,500,000,000	66,693,561,000	73,487,545,000	1.378	1.519
8	2015	22,231,557,397	27,798,784,000	33,265,866,000	25,617,574,000	1.496	1.152
9	2015	74,361,049,088	92,982,543,000	81,397,995,000	106,981,198,000	1.095	1.439
10	2015	11,714,667,072	14,648,254,000	13,815,915,000	12,964,028,000	1.179	1.107
11	2015	54,664,057,677	68,353,031,000	63,742,594,000	78,060,156,000	1.166	1.428
12	2015	79,398,971,019	98,382,471,000	111,405,435,000	88,107,346,000	1.403	1.110
13	2015	10,354,464,900	12,947,430,000	12,223,573,000	14,699,385,000	1.181	1.420
14	2015	9,140,928,648	11,430,000,000	10,342,215,000	10,845,327,000	1.131	1.186
15	2015	31,328,923,082	39,174,312,000	34,628,966,000	35,750,536,000	1.105	1.141
16	2015	35,702,417,588	44,643,017,000	48,809,566,000	40,522,475,000	1.367	1.135
17	2016	18,173,671,808	22,518,815,000	24,554,208,000	24,071,039,000	1.351	1.325
18	2016	11,944,802,546	14,936,020,000	16,506,249,000	14,086,089,000	1.382	1.179
19	2016	16,328,109,755	20,416,995,000	23,864,757,000	21,774,774,000	1.462	1.334
20	2016	9,346,900,046	11,475,750,000	13,182,673,000	13,289,093,000	1.410	1.422
21	2016	33,330,912,202	41,300,000,000	50,462,354,000	46,340,791,000	1.514	1.390
22	2016	35,948,321,364	44,950,500,000	43,001,344,000	41,719,368,000	1.196	1.161
23	2016	29,123,872,779	36,417,073,000	35,247,987,000	38,726,630,000	1.210	1.330
24	2016	57,820,014,075	72,299,302,000	64,385,413,000	74,763,910,000	1.114	1.293
25	2016	22,630,977,592	28,298,227,000	26,832,355,000	25,054,003,000	1.186	1.107
26	2016	25,018,360,231	31,283,458,000	32,493,486,000	29,295,129,000	1.299	1.171
27	2017	31,532,653,029	39,429,060,000	34,922,493,000	35,621,885,000	1.108	1.130
28	2017	8,348,537,291	10,439,178,000	11,160,635,000	9,589,306,000	1.337	1.149
29	2017	169,309,600,774	211,708,111,000	194,787,527,000	220,013,700,000	1.150	1.299
30	2017	98,459,352,857	123,115,544,000	118,663,348,000	130,300,135,000	1.205	1.323

Ratio Bid Price Real Cost

	Company A Vs C2.	Company A Vs C1.
Average	1.288	1.293
Deviation	0.133	0.135
Variance	0.018	0.018

Table 2. The Probability of winning and expected profit

R	Probability of Winning			Expected Profit
	PT. C1	PT. C2	PT. C1 & PT. C2	
1.34	0.364	0.348	0.112	0.043
1.36	0.310	0.295	0.078	0.033
1.38	0.259	0.245	0.053	0.024
1.4	0.213	0.200	0.034	0.017
1.42	0.173	0.161	0.021	0.012
1.44	0.137	0.127	0.013	0.008
1.46	0.107	0.099	0.007	0.005
1.48	0.082	0.075	0.004	0.003
1.5	0.062	0.056	0.002	0.002
1.52	0.046	0.041	0.001	0.001
1.54	0.033	0.029	0.001	0.001

R	Probability of Winning			Expected Profit
	PT. C1	PT. C2	PT. C1 & PT. C2	
1.120	0.901	0.896	0.811	0.097
1.140	0.873	0.866	0.758	0.106
1.160	0.839	0.831	0.697	0.112
1.180	0.800	0.791	0.629	0.114
1.200	0.756	0.745	0.556	0.113
1.220	0.707	0.695	0.481	0.108
1.240	0.654	0.640	0.405	0.100
1.260	0.597	0.583	0.333	0.091
1.280	0.539	0.524	0.265	0.079
1.300	0.480	0.464	0.205	0.067
1.320	0.421	0.405	0.154	0.055

b. Relationship Mark Up and Expected Profit with graphic showed in Figure 3.

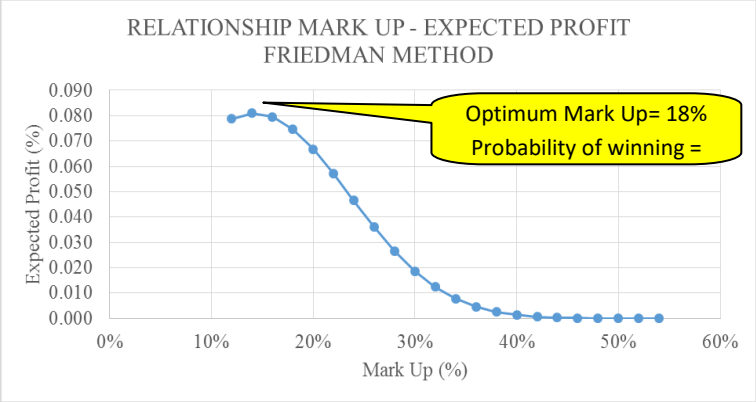

Figure 3. Relationship Mark Up and Expected Profit

3.2. Definitive Technique

The result of definitive technique for the proportion real cost in each item of work, resources project, and hospital project showed in Table 3.

Table 3. Proportion real cost hospital project tender

Work	Material	Labor	Equipment	Sub-Contractor	Total Price
Preliminary	283,971,000	175,420,000	-	83,524,309	**539,700,000**
Structure	8,203,140,867	1,708,357,252	336,864,208	4,777,490,841	**14,875,574,920**
Architecture	7,652,118,238	2,718,448,509	96,907,686	8,817,668,173	**19,264,722,957**
Mechanical	-	-	-	6,069,047,379	**6,176,274,117**
Electrical	-	-	-	4,403,117,848	**4,480,911,270**
Variation Order	61,093,699	398,696,180	276,571,486	434,614,257	**1,159,868,668**
Total Price (Idr)	**16,200,323,804**	**5,000,921,942**	**710,343,380**	**24,585,462,806**	**46,497,051,932**
Area	8,350	m2			
GFA (IDR)	**1,940,159**	**598,913**	**85,071**	**2,944,367**	**5,568,509**

*GFA= Gross Floor Area

The proportion of real cost hospital of Work Item and Resources project in percentage showed in Figure 4 and Figure 5.

Figure 4. Proportion real cost of work

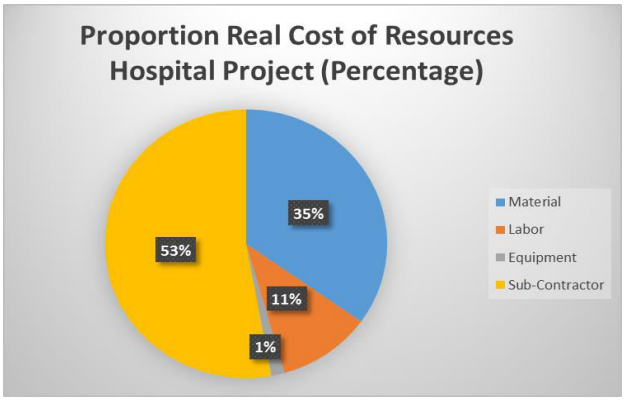

Figure 5. Proportion real cost of resources

The real cost of GPA hospital of Work Item and Resources project in percentage showed in Figure 6 and Figure 7.

Figure 6. GPA item of work

Figure 7. GFA of resources

IV. EVALUATION RESULT

In this part of the research show that improvement of expected profit and winning ratio against the competitor showed in Table 4.

Table 4. Evaluation mark up Friedman

FINAL EVALUATION MARK UP FRIEDMAN TOWARD HOSPITAL PROJECT TENDER				
COMPONENT	REAL COST	BEFORE Winner Bid Price	AFTER Optimum Bid Price	IMPROVEMENT
Price (IDR)	46,497,051,931	55,416,900,000	54,308,600,000	-
Mark up (%)	-	20%	18%	-
Expected Profit (%)	-	11.3%	11.4%	+ 0.1%
Winning Ratio (%)	-	55.6%	62,9%	+ 6,3%

V. CONCLUSION

a. The 16 most important factors in this research which are: competitive bidding strategy, experience of similar project, need of work, number and identify competitors, history competitors tender, design complexity and construction, drawing and specifications completeness, winning probability, expected profit, contractor experience in building hospital, experience and competence of the estimator, project location, project duration, accuracy of the cost estimation, qualify and bid price.
b. The result of the case study showed the Friedman method as markup value used to outbid all competitors by 18%, showed with 11.4% expectation profit and 62.9% winning probability.
c. The Definitive Technique result showed the proportion real cost value of hospital tender: architectural work (41.48%), structure work (32,32%), mechanical work (13.05%), electrical work (9.47%), change order work (2.52%) and preliminary work (1.17%).conclusion

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