Optimization of Rescheduling and Economy Analysis of the Implementation of Kwitang Office Park Building Constructio n Project in Jakarta

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Optimization of Rescheduling and Economy Analysis of the Implementation of Kwitang Office Park Building Construction Project in Jakarta

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Abstract

This study intends to analyze the fastest duration on finishing the implementation of Kwitang Office Park due to the most efficient cost, cheapest material but the quality is the same as the initial design, and the feasibility of infestation on the finishing of implementation. The methodology uses the descriptive research methods such as Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT). Result shows that the optimal time required to complete the rest of construction volume is 90 days for preparatory work, 220 days for structural work, 232 days for architectural work, and 398 days for MEP work, while the cost required to accelerate the completion of remaining construction volume is Rp. 315, 890, 000, - for preparatory work, Rp. 11,387,770,000 , - for structural work, Rp. 3,316,489,000, - for architectural work, and Rp. 7,295,022,000, - for MEP work.

Keywords: optimal, acceleration, CPM, PERT

Introduction

Kwitang Office Park is as an office building which is built in Jakarta city. This office is located in Prajurit KKO Usman Harun Street (or Prapatan street) No

14-16, Senen village-Senen District-Center Jakarta city. The building has the main function as offices building where is the rooms are intended to be rented for company or user in the certain period. Jakarta has the good progress for economic development due to the many business men and as the center of country government so the development of Kwitang Office Park is felt to have the objective that will produce the profit. However, the crisis of global economic in all over the world causes many companies experience the decreasing of business. It is due to many factors such as international one which is related to the tired world economic, the increasing of raw oil price, jammed credit, softening the value of dollar change, the increasing of interest, and the happening of inflation in some countries. Besides the global factor that is more and more increasing, there is predicted the effect that is adding the ease such as how big the retribution load which is paid by the business man himself. The crisis of economic is very felt in Indonesia; it is included in many aspects of economic side. If the business world is weakening, it will create idleness and poverty. However, it becomes as the heaviest throat [1].

Global economic crisis also affects the development process of Kwitang office Park. The project has been implemented during 2 years with the level of building has reached of 60% (aspect of structure for the whole developed building) which has to experience the situation of temporary stopping. Project management on the development of Kwitang Office Park is included on project management by commercial environment which intends to produce goods and service product-, However this product has the objective to give satisfactory to the user or internal interest of the organization itself. Motivation and success are as the base on the commercial project for reaching the objective of profit oriented. Application of project management science on project implementation is as the effort to reach project optimization by determining the boundary such as volume of cost (budget) that is allocated, time schedule, and quality that has to be fulfilled. The boundaries are very inter-related one to another so if one of the boundary has been out of date, it will give impact to another boundary.

Based on the background which is described as above, this study will foccuss on economy. This study intens to obtain wise decision making as the following up on the development implementation of Kwitang Office Park until finishing the project by using new project managment and to apply science on available data processing. Result is hoped to produce the decision making which has the optimum profit.

Material and Method

Location of study is on the building project of Kwitang Office Park which is located in jl. Prajurit KKO Usman Harum (or jl. Prapatan) No 14-16, Senen Village-Senen District- Center Jakarta City. This project has been implemented during 2 years with the progress of development has reached 60% (aspect of structure). During the development, the cost has reached Rp. 31,960,827,000.- and the whole cost of development is Rp. 62,085,115,000.-. The implementation of

development project management is carried out by each of technical, implementor, and designer management staff. Therefore, the data can be taken from every staff on project analysis level as well as management level. Location of study is as in Figure 1 below.

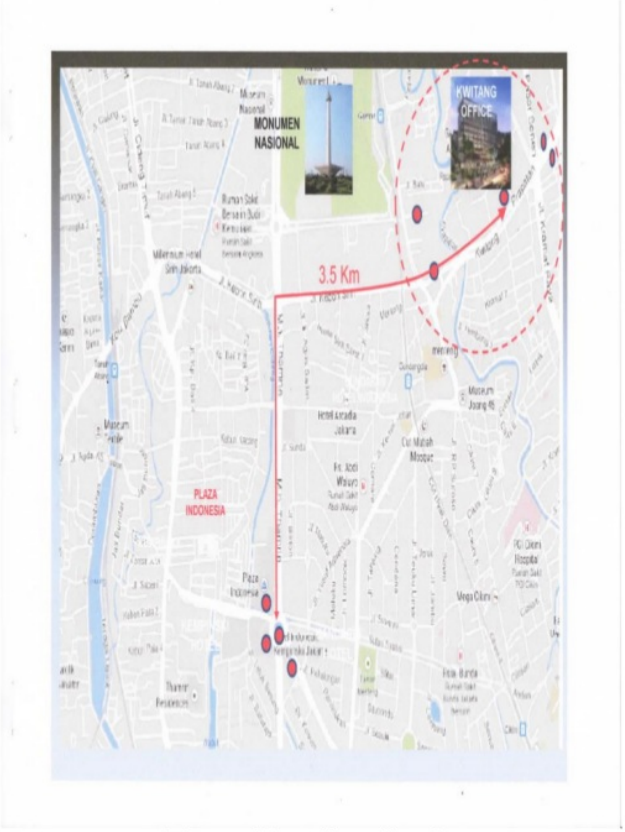

Figure 1 Location of study

Scheme of data processing

Based on the data that has been collected, there is carried out the analysis processing with the steps sa follow:

1. Based on the previous development implementation data, it will obtain the working part data that has been finished and in what working part that has not been finisned and it can also be known the used budget as the financial analysis.
2. Based on the deelopment design data, there is obtained the design budget for unfinishing working part as the base of development cost budget and material base which will be used.

3. Based on the budget of working cost that has not been implemented, there will be re-managed with the objective for producing the profit. For building material which is remained on design data, there will be analyzed by using Operation Research. However, the selection of material will be compared with the other material that is the same or different one. It intends to obtain well quality of material and it is cheaper or it can mentioned as the process of downgrade on material.
4. Based on the processing of material data, it can be analyzed the cost budget plan (RAB) on the projects that will be implemented.
5. Based on the analysis of cost budget plan, the scheduling of project can be implemented. by applying the project management science and it will produce the fastest duration of project schedule to be implemented. Then it can produce the fastest profit.
6. Data of economic aspect are as follow:

Initial administration data of project ownering (land, allowance, design cost); Budget data which has been used on the previous work; Budget cost plan of project implementation which will be implemented; Data of operational cost estimation when the project is operating and cost due to the income tax.; Data of building life time estimation ; Marketing data of office rent value at surrounded of development project as the input data; Data of interest bank due to the asset credit as the funding of project implementation.

7. The data as above are as the base for implementing as follow:

Project feasibility study (payback period, NPV, IRR, B/C, ARR); Investation asset analysis study (MARR); Analysis study of bank credit interest for the investor; Analysis study of buiding asset depressiation; Analysis study of inflation; Result of data analysis through analysis study about it has the possibility to be going to happen the optional alternatives. Therefore, by applyng decision analysis, it can produce the wise decision due to continue the development project which will make the profit.

Project scheduling

Generally, project scheduling is carried out by the consultant of design and then it is coordinated with the contractor and owner and it is due to the condition which has been agreed in the contract. Therefore, time scheduling every activity of project is necessary to be regulated efficiently and as optimized as possible so the scheduling is not late. The contractor has to manage the project scheduling due to the characteristic of construction project that has been planned and the field condition when the implementation time. It is hoped to make easy to be monitored anytime [2].. The methods of project scheduling are described as follow.

Bar Chart

Bar chart is introduced first by Henry L. Gantt in 1977 during the first world war. Therefore, bar chart is often said as Gantt Chart, it is due to the name of founder. Before being found this method, there has not been the systematic and

analytic procedure in the aspect of project design and control [3]. Gantt create this technique for observing the estimation of duty versus actual, so by sight seeing, a project leader can see the progress of project implementation. In bar chart, the activity is illustrated by horizontal block. The length of block presents the time period in the selected scale. Bar chart includes y-axis that presents the activity or working packet of project scope and it is illustrated as block, but x-axis presents time unit in day, week, or month as the duration. The starting and ending time of each work is left and right top of its block [2].

Method of Network Diagram

According to Husen [3], method of network diagram was introduced in the year of about 1950 by the companies of Du Pont and Rand Corporation for developing the management control system. This method intends to design and control an amount of activities that have complex dependent relation in design engineering, construction, and maintenance. This method is relatively more difficult but relation among the activities are clear and can see the critical activity, There were some methods of working network analysis which can be used in project time scheduling as follow [4]

1. Critical Path Method (CPM)

Activity on arrow or CPM (Critical Path Method) includes arrow and circle or four-sided. Arrow illustrates the activity. However, circle or four-sided illustrates the event. Event in the beginning of arrwo is mentioned “T” but in the end is “J”. [3]

Every activity on arrow is as a group of the whole activities so that the event “J” from the previous activity is also as the event “T” for the next activity and it presents as in Figure 2 below.

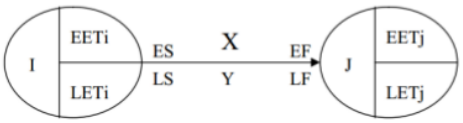

Figure 2 Illustration of AOA

Note:
i,j = number of event
X = name of activity
EET = Earliest Event Time
LET = Latest Event Time
Y = duration of activity
ES = Earliest Start Time
EF = Earliest Finish Time
LS = Latest Start Time
LF = Latest Finish Time

2. Project Evaluation and Review Technique (PERT)

The method of Project Evaluation and Review Technique (PERT) is as a design method by the networking that is related with the certain consideration. As Critical Path Method (CPM), this method needs some parameters and one of them is the activity. Determination of activity duration on CPM is based on the fixed duration. It means that it is enough to carry out the estimation of one activity duration. The characteristic of project causes the activity duration is as an unfixed thing because activity duration is effected by some various conditions. The method of PERT gives assumption on the activity duration as a probabilistic thing because of the variety of construction activity. Globally, the method of PERT and CPM are almost the same on managing the network. The difference is on the determination of activity duration and critical path of duration. The method of PERT is as follow [5]:

a. Determination of activity and the duration use three assumption of activity durations such as optimistic time (to), pessimistic time (tp), and most likely time (tm).

b. Determination on the correlation of time and the continuous distribution, and expected time (te), deviation standard (se), and variant (ve).

c. Expected time (te) is determined as the activity duration and then there is found the critical path as on the CPM.

d. To determine the project duration and critical path.

Determination of To, tp, and tm is as the initial step of PERT because the three assumptions of time determine the tc. The three durations are assumed as the function or generalization of the beta distribution by the variable of activity duration which is moaned that the PERT duration is as the statistical data which is not out of the distribution area. . The beta distribution function is assumed as the base for determining the duration (te), deviation standard (se), and variant (ve) of PERT as follow:

$$te = (to + 4m + tp)/6$$

$$se = (tp-to)/6$$

$$ve = \{(tp-to)/6\}^2$$

Note:

te: Expected time	tp: pessimistic time
to: optimistic time	se: deviation standard
m: most likely	ve: Variation

The formula indicates that the activity duration is assumed as the continuous probability distribution such as beta distribution. The meaning of se and ve are as the variability level indicator of obtained te. Te is as the project duration and it is as the number of critical path te; ve is as the number of critical path ve; and se is as the variability illustration of te. The analysis is possible as two or more the critical path so that te is selected of the critical path with the maximum ve.

Process of decision making on engineering economy

Principally, the process of decision making on engineering economy cannot also be separated from the process of determination on the alternatives and the best selection of alternative.[6]. The decision making is happened because of:

1. Every infestation can be carried out more than one manner so there must have the process of selection.
2. The available resource for doing an infestation is always limited so not all of the alternatives can be carried out but it has to be selected which can make profit.

The principals of engineering economy are as follow:

1. Every alternative has to be defined in physical terminology
2. Physical prediction of every alternative has to be translated in monetary analysis
3. Monetary analysis uses plural interest mathematic on available interest condition
4. The selection of some alternatives is determined by the comparison on monetary unit and the other factor that has not been measured with monetary unit.

Result and Discussion

Analysis of CPM

After obtaining the duration and cost of each activity, the next step is to determine the crash time (tc) and crash cash (cc). In this study, there is carried out the interview to the contractor who handles the project. The results of interviews are as follow:

Preparation of work

Based on the analysis by using Win QSB software, it is obtained the result as in Table 1 about the critical path of work preparation.

Table 1 CPM critical path of work preparation

07-20-2016	Critical Path 1
1	A
2	C
Completion Time	91

Source: analysis result

Based on the result of crashing analysis, it can be known that the suggested time, additional cost, normal cost, and the suggested cost as in Table 2 and 3 below.

Table 2 CPM Activity Critically Analysis Crash Time of work preparation

07-20-2016 07:12:47	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	Yes	20	0	20	0	20	0
2	B	no	20	20	40	45	65	25
3	C	Yes	45	20	65	20	65	0
	Project	Completion	Time	=	65	DAYs		
	Total	Cost of	Project	=	$380,890,000	(Cost on	CP =	$315,890,000)
	Number of	Critical	Path(s)	=	1			

Source: analysis result

Table 3 CPM Critical Path Crash Time of work preparation

07-20-2016	Critical Path 1
1	A
2	C
Completion Time	65

Source: analysis result

Based on the analysis by win QSB software, it is obtained the Earliest Start (ES), Earliest Finish (EF), Latest Start (LS), and Latest Finish (LF). The slack value is obtained from the reduction of LS and ES. The finishing time of 91 days by the project cost of Rp. 315,000,000.-; the cost on critical path is Rp. 270,000,000.- with one critical path, and it is produced from normal by indicating the normal time, acceleration time, suggested time, additional cost, normal cost, and suggested cost.

Based on the analysis by software, it is obtained that the critical path is A-C because this path is as the best path for the study of operation from the beginning to the end. The normal cost is Rp. 380,890,000.- with the finishing time of 91 days. The cost of project acceleration is Rp. 315,890,000.- with the finishing time of 65 days. There is cost difference because for accelerating the working time of a project there has to be carried out the additional employer which needs additional cost.

Structure work

Based on the analysis by using Win QSB software, it is obtained the result as in Table 4 about the critical path of structure work.

Table 4 CPM Critical Path of structure work

07-20-2016	Critical Path 1
1	G
2	H
3	I
4	J
5	K
6	L
7	M
8	N
9	O
10	P
11	Q
Completion Time	218

Source: analysis result

Based on the result of crashing analysis, it can be known that the suggested time, additional cost, normal cost, and the suggested cost as in Table 5 and 6 below.

Table 5 CPM Activity Critically Analysis Crash Time of structure work

07-20-2016 08:24:20	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	no	16	0	16	104	120	104
2	B	no	28	0	28	92	120	92
3	C	no	14	0	14	106	120	106
4	D	no	38	0	38	82	120	82
5	E	no	10	0	10	110	120	110
6	F	no	10	0	10	110	120	110
7	G	Yes	18	14	32	14	32	0
8	H	Yes	14	0	14	0	14	0
9	I	Yes	10	32	42	32	42	0
10	J	Yes	10	42	52	42	52	0
11	K	Yes	10	52	62	52	62	0
12	L	Yes	10	62	72	62	72	0
13	M	Yes	10	72	82	72	82	0
14	N	Yes	10	82	92	82	92	0
15	O	Yes	10	92	102	92	102	0
16	P	Yes	10	102	112	102	112	0
17	Q	Yes	8	112	120	112	120	0
18	R	no	70	0	70	50	120	50
19	S	no	14	0	14	106	120	106
	Project	Completion	Time	=	120	days		
	Total	Cost of	Project	=	$18,641,090,000	(Cost on	CP =	$11,387,770,000)
	Number of	Critical	Path(s)	=	1			

Source: analysis result

Table 6 CPM Critical Path Crash Time of structure work

07-20-2016	Critical Path 1
1	H
2	G
3	I
4	J
5	K
6	L
7	M
8	N
9	O
10	P
11	Q
Completion Time	120

Source: analysis result

Based on the analysis by win QSB software, it is obtained the Earliest Start (ES), Earliest Finish (EF), Latest Start (LS), and Latest Finish (LF). The slack value is obtained from the reduction of LS and ES. The finishing time is 218 days with the project cost of Rp. 14,728,110,000.-; the cost on the critical path is Rp. 8,715,776,000.- with 11 critical paths; and it is produced from the normal time. The crashing analysis table indicates the same critical path due to the normal time, acceleration time, suggested time, additional cost, normal cost, and suggested cost.

Based on the analysis by software, it is obtained that the critical path is H-G-I-J-K-L-M-N-O-P-Q because this path is as the best path for study which is carried out from the beginning operation to the end. The normal cost is Rp. 18,641,090,000.- by the finishing time is 120 days. The acceleration cost is Rp. 11,367,770,000.- with the finishing time is 120 days. There is cost difference because for accelerating time for project work there has to be carried out the additional employer which needs additional cost.

Architecture work

Based on the analysis by using Win QSB software, it is obtained the result as in Table 7 about the critical path of architecture work.

Table 6 CPM Critical Path of architecture work

07-20-2016	Critical Path 1	Critical Path 2
1	A	A
2	C	D
Completion Time	238	238

Source: analysis result

Based on the result of crashing analysis, it can be known that the suggested time, additional cost, normal cost, and the suggested cost as in Table 8 and 9 below.

Table 8 CPM Activity Critically Analysis Crash Time of architecture work

07-20-2016 08:47:40	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	Yes	102	0	102	0	102	0
2	B	no	60	102	162	134	194	32
3	C	Yes	92	102	194	102	194	0
4	D	no	84	102	186	110	194	8
5	E	no	46	0	46	148	194	148
6	F	no	21	0	21	173	194	173
7	G	no	18	0	18	176	194	176
8	H	no	30	0	30	164	194	164
	Project	Completion	Time	=	194	days		
	Total	Cost of	Project	=	$5,689,047,000	(Cost on	CP =	$3,316,489,000)
	Number of	Critical	Path(s)	=	1			

Source: analysis result

Table 9 CPM Critical Path Crash Time of architecture work

07-20-2016	Critical Path 1
1	A
2	C
Completion Time	194

Source: analysis result

Based on the analysis by Win QSB software, it is obtained the Earliest Start (ES), Earliest Finish (EF), Latest Start (LS), and Latest Finish (LF). The slack value is as the reduction of LS and ES. Finishing time is 238 days with the project cost of Rp. 5,093,079,000.-; the cost on critical path is Rp. 3,423,377,000.- with 2 critical paths which is produced from the normal time. Crashing analysis table indicates the same critical path due to the normal time, acceleration time, suggested time, additional cost, normal cost, and suggested cost.

Based on the analysis by software, the critical path is A-C because this path is as the best path for the study which is carried out from the beginning operation to the end. The normal cost is Rp. 5,689,047,000.- with the finishing time of 194 days. The project acceleration cost Rp. 3,316,489,000.- with the finishing time of 194 days. There is cost difference because for accelerating the work time of project there has to be carried out the additional employers which needs additional cost

Work of MEP

Based on the analysis by using Win QSB software, it is obtained the result as in Table 10 about the critical path of MEP work. \

Table 9 CPM Critical Path of MEP Work

07-20-2016	Critical Path 1	Critical Path 2
1	D	D
2	F	J
3	J	
Completion Time	483	483

Source: analysis result

Based on the result of crashing analysis, it can be known that the suggested time, additional cost, normal cost, and the suggested cost as in Table 10 and 11 below.

Table 10 CPM Activity Critically Analysis Crash Time of MEPwork

07-20-2016 09:03:39	Activity Name	On Critical Path	Activity Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)
1	A	no	102	0	102	137	239	137
2	B	no	90	0	90	289	379	289
3	C	no	140	102	242	239	379	137
4	D	Yes	156	0	156	0	156	0
5	E	no	28	156	184	351	379	195
6	F	Yes	121	156	277	156	277	0
7	G	no	34	0	34	345	379	345
8	H	no	52	0	52	327	379	327
9	I	no	30	277	307	349	379	72
10	J	Yes	102	277	379	277	379	0
	Project	Completion	Time	=	379	days		
	Total	Cost of	Project	=	$17,563,340,000	(Cost on	CP =	$7,295,022,000)
	Number of	Critical	Path(s)	=	2			

Source: analysis result

Table 11 CPM Critical Path Crash Time of MEP work

07-20-2016	Critical Path 1	Critical Path 2
1	D	D
2	F	J
3	J	
Completion Time	379	379

Source: analysis result

Based on the analysis by Win QSB software, it is obtained the Earliest Start (ES), Earliest Finish (EF), Latest Start (LS), and Latest Finish (LF). The slack value is as the reduction of LS and ES. Finishing time is 483 days with the project cost of Rp. 16,339,900,000.-; the cost on critical path is Rp. 6,879,188,000.- with 5 critical paths which is produced from the normal time.

Crashing analysis table indicates the same critical path due to the normal time, acceleration time, suggested time, additional cost, normal cost, and suggested cost.

Based on the analysis by software, the critical path is D-F-J because this path is as the best path for the study which is carried out from the beginning operation to the end. The normal cost is Rp. 17,563,340,000.- with the finishing time of 379 days. The project acceleration cost is Rp. 7,295,022,000.- with the finishing time of 379 days. There is cost difference because for accelerating the work time of project there has to be carried out the additional employers which needs additional cost

Analysis of PERT

After obtaining the duration and cost from each activity, then there has to determine the optimistic time (to), realistic time ™, and pessimistic time (tp). In this study, there is carried out the interview to the contractor who handles the project. The results of interviews are as follow:

Preparation of work

Based on the analysis by using Win QSB software, it is obtained the result as in Table 12 and 13 about the activity critically analysis and critical path for work preparation.

Table 12 PERT Activity Critically Analysis of work preparation

07-20-2016 09:15:56	Activity Name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)	Activity Time Distribution	Standard Deviation
1	A	Yes	27.8333	0	27.8333	0	27.8333	0	3-Time estimate	2.5
2	B	no	27.8333	27.8333	55.6667	62.8333	90.6667	35	3-Time estimate	2.5
3	C	Yes	62.8333	27.8333	90.6667	27.8333	90.6667	0	3-Time estimate	2.5
	Project	Completion	Time	=	90.67	days				
	Number of	Critical	Path(s)	=	1					

Source: analysis result

Table 13 PERT Critical Path of work preparation

07-20-2016	Critical Path 1
1	A
2	C
Completion Time	90.67
Std. Dev.	3.54

Source: analysis result

Based on the analysis by software, it is obtain/ed that the critical path is A-C. There is obtained the same deviation standard for each activity. The whole deviation standard is 3.54 and the project finishing time of Kwitang Office Park-Jakarta is 90 days.

Structure work

Based on the analysis by using Win QSB software, it is obtained the result as in Table 14 and 15 about the activity critically analysis and critical path for structure work.

Table 14 PERT Activity Critically Analysis of Structure work

07-20-2016 09:25:31	Activity Name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)	Activity Time Distribution	Standard Deviation
1	A	no	21	0	21	199.3333	220.3333	199.3333	3-Time estimate	1.6667
2	B	no	34	0	34	186.3333	220.3333	186.3333	3-Time estimate	2
3	C	no	21.3333	0	21.3333	199.0000	220.3333	199.0000	3-Time estimate	2.6667
4	D	no	59.6667	0	59.6667	160.6667	220.3333	160.6667	3-Time estimate	5
5	E	no	18	0	18	202.3333	220.3333	202.3333	3-Time estimate	2.6667
6	F	Yes	13.6667	0	13.6667	0	13.6667	0	3-Time estimate	1
7	G	Yes	27.5	13.6667	41.1667	13.6667	41.1667	0	3-Time estimate	2.8333
8	H	no	26.8333	0	26.8333	193.5000	220.3333	193.5000	3-Time estimate	3.5
9	I	Yes	17.6667	41.1667	58.8333	41.1667	58.8333	0	3-Time estimate	2.3333
10	J	Yes	17.6667	58.8333	76.5	58.8333	76.5	0	3-Time estimate	2.3333
11	K	Yes	17.6667	76.5	94.1667	76.5	94.1667	0	3-Time estimate	2.3333
12	L	Yes	17.6667	94.1667	111.8333	94.1667	111.8333	0	3-Time estimate	2.3333
13	M	Yes	17.6667	111.8333	129.5	111.8333	129.5	0	3-Time estimate	2.3333
14	N	Yes	17.6667	129.5	147.1667	129.5	147.1667	0	3-Time estimate	2.3333
15	O	Yes	17.6667	147.1667	164.8333	147.1667	164.8333	0	3-Time estimate	2.3333
16	P	Yes	17.6667	164.8333	182.5000	164.8333	182.5000	0	3-Time estimate	2.3333
17	Q	Yes	16.8333	182.5000	199.3333	182.5000	199.3333	0	3-Time estimate	2.1667
18	R	no	77.1667	0	77.1667	143.1667	220.3333	143.1667	3-Time estimate	2.5
19	S	Yes	21	199.3333	220.3333	199.3333	220.3333	0	3-Time estimate	2.3333
	Project	Completion	Time	=	220.33	days				
	Number of	Critical	Path(s)	=	1					

Source: analysis result

Table 15 PERT Critical Path of structure work

07-20-2016	Critical Path 1
1	F
2	G
3	I
4	J
5	K
6	L
7	M
8	N
9	O
10	P
11	Q
12	S
Completion Time	220.33
Std. Dev.	7.92

Source: analysis result

Based on the analysis by software, it is obtained that the critical path is F-G-I-J-K-L-M-N-O-P-Q-S. There is obtained the same deviation standard for each activity. The whole deviation standard is 7.92 and the project finishing time of Kwitang Office Park-Jakarta is 220 days

Architecture work

Based on the analysis by using Win QSB software, it is obtained the result as in Table 16 and 17 about the activity critically analysis and critical path for architecture work.

Table 16 PERT Activity Critically Analysis of Architecture work

07-20-2016 09:33:03	Activity Name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)	Activity Time Distribution	Standard Deviation
1	A	Yes	118.3333	0	118.3333	0	118.3333	0	3-Time estimate	5
2	B	no	75	118.3333	193.3333	157.3333	232.3333	39	3-Time estimate	3.6667
3	C	no	116.3333	0	116.3333	116	232.3333	116	3-Time estimate	6.3333
4	D	Yes	114	118.3333	232.3333	118.3333	232.3333	0	3-Time estimate	6.6667
5	E	no	56	0	56	176.3333	232.3333	176.3333	3-Time estimate	3.3333
6	F	no	29.5	0	29.5	202.8333	232.3333	202.8333	3-Time estimate	2.5
7	G	no	25.8333	0	25.8333	206.5000	232.3333	206.5000	3-Time estimate	3.1667
8	H	no	43.3333	118.3333	161.6667	189.0000	232.3333	70.6667	3-Time estimate	3.3333
	Project	Completion	Time	=	232.33	days				
	Number of	Critical	Path(s)	=	1					

Source: analysis result

Table 17 PERT Critical Path of Architecture work

07-20-2016	Critical Path 1
1	A
2	D
Completion Time	232.33
Std. Dev.	8.33

Source: analysis result

Based on the analysis by software, it is obtained that the critical path is A-D. There is obtained the same deviation standard for each activity. The whole deviation standard is 8.33 and the project finishing time of Kwitang Office Park-Jakarta is 232 days

Work of MEP

Based on the analysis by using Win QSB software, it is obtained the result as in Table 18 and 19 about the activity critically analysis and critical path for MEP work:

Table 18 PERT Activity Critically Analysis of MEP Work

07-20-2016 09:54:11	Activity Name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS-ES)	Activity Time Distribution	Standard Deviation
1	A	Yes	119	0	119	0	119.0000	0	3-Time estimate	5.6667
2	B	no	107	0	107	291.8333	398.8333	291.8333	3-Time estimate	5
3	C	no	165.3333	119	284.3333	233.5000	398.8333	114.5000	3-Time estimate	6.6667
4	D	no	190.3333	119	309.3333	164.8334	355.1667	45.8334	3-Time estimate	7.6667
5	E	no	35.3333	0	35.3333	363.5	398.8333	363.5	3-Time estimate	2.6667
6	F	Yes	161.1667	119	280.1667	119.0000	280.1667	0	3-Time estimate	8.8333
7	G	no	52.3333	0	52.3333	346.5	398.8333	346.5	3-Time estimate	4.3333
8	H	no	60	0	60	338.8333	398.8333	338.8333	3-Time estimate	2.6667
9	I	no	43.6667	309.3333	353.0000	355.1667	398.8333	45.8334	3-Time estimate	3.6667
10	J	Yes	118.6667	280.1667	398.8333	280.1667	398.8333	0	3-Time estimate	5.3333
	Project	Completion	Time	=	398.83	days				
	Number of	Critical	Path(s)	=	1					

Source: analysis result

Table 19 PERT Critical Path of MEP work

07-20-2016	Critical Path 1
1	A
2	F
3	J
Completion Time	398.83
Std. Dev.	11.77

Source: analysis result

Based on the analysis by software, it is obtained that the critical path is A-F-J. There is obtained the same deviation standard for each activity. The whole deviation standard is 11.77 and the project finishing time of Kwitang Office Park-Jakarta is 398 days

Conclusion

Based on the analysis by using CPM-PERT method, there is concluded as follow:

1. Result of PERT analysis indicates that duration of work is optimal

a. Preparation work has the critical path of A-C and duration of project finishing is 90 days.

b. Structure work has the critical path of F-G-I-J-K-L-M-N-O-P-Q-S and duration of project finishing is 220 days.

c. Architecture work has the critical path of A-D and duration of project finishing is 232 days.

d. MEP work has the critical path of A-F-J and duration of project finishing is 398 days.

2. Result of CPM analysis indicates that the project cost is optimal

a. Preparation work has the critical path of A-C and the acceleration project cost is Rp. 315,890,000.-

b. Structure work has the critical path of H-G-I-J-K-L-M-N-O-P-Q and the acceleration project cost is Rp. 11,387,770,000.-
c. Architecture work has the critical path of A-D and the acceleration project cost is Rp. 3,316,489,000.-
d. MEP work has the critical path of A-F-J and the acceleration project cost is Rp. 7,295,022,000.-

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