

DOI: <https://doi.org/10.31933/dijemss.v3i2>

Received: 15 October 2021, Revised: 25 November 2021, Publish: 25 December 2021



## OPTIMIZATION OF PROJECT COLOCATION AT PT. XYZ USING PERT AND CPM METHODS BASED ON POM-QM FOR WINDOWS APPLICATION

Eko Purnama<sup>1</sup>, Sugiyono Sugiyono<sup>2</sup>, Ahmad Badawi Saluy<sup>3</sup>

<sup>1</sup>Universitas Mercu Buana, Jakarta, Indonesia, [ekopurnama@gmail.com](mailto:ekopurnama@gmail.com)

<sup>2</sup>Universitas Mercu Buana, Jakarta, Indonesia, [sugiyono.madelan@gmail.com](mailto:sugiyono.madelan@gmail.com)

<sup>3</sup>Universitas Mercu Buana, Jakarta, Indonesia, [ahmad.badawi@mercubuana.ac.id](mailto:ahmad.badawi@mercubuana.ac.id)

\*Corresponding author: First Author

**Abstract:** The development of cellular technology continues to increase, so that currently there will be fifth generation (5G) technology. Therefore, the need for telecommunications towers and competition among contractors will increase. The optimization of the colocation project at PT. XYZ has been carried out using the case of the Mekarsari Banjar site, West Java Province using the CPM-PERT method with the POM-QM for Windows application. PERT and CPM methods are methods used to manage project completion time more efficiently and effectively. The result of the research shows that the real project processing time at PT. XYZ on this site for 19 days with a normal fee of Rp. 32,811,000,-. In accelerated conditions, the colocation project can be carried out for 10 days with a Z value = 3.77 with a probability of 99.992% with a total cost of Rp. 34,181,000,- with project effectiveness is around 47.36%.

**Keywords:** 5G, Project colocation, Site, PERT-CPM, POM-QM for Windows

### INTRODUCTION

Telecommunication equipment is currently needed not only for voice communication but data communication which includes images and videos which is known as multimedia communication. Telecommunication service technology is always developing, namely the first generation broadband known as 1G with the Nordic Mobile Telephone (NMT) technology standard based on analog (Fauzi, Harly and Hs, no date).

Furthermore, the second generation (2G) which is digital based, 2.5G which has increased in bandwidth capacity and has now reached the fourth generation (4G).

4G telecommunication technology (Astuti, Dewi and Wirastuti, 2013) is currently developing very rapidly in Indonesia. 4G is the development of 3G telecommunication technology. The advantage of this 4G technology is that the flow of voice, data and multimedia can move very fast and can go up anywhere and anytime (Iswahyudi, 2015). In addition, 4G technology has higher data than the previous generation (Fauzi, Harly and Hs, no date). The well-known carrier of 4G technology that greatly benefits both operators and users, namely the LTE (Long Term Evolution) type with access speeds of up to 10 times compared to 3.5G, which is up to 100 Mbps (Maria and Irtawaty, 2018). However, there are still challenges in the demand for data access speed with the reliability of the 4G (Admaja, 2015) dan (Gemiharto, 2015) network service.

The development of cellular technology continues to develop, so that currently there will be a fifth generation technology (5G) (Admaja, 2018). The 5G technology is different from the previous technology (Yuniarto, 2019). According to the world's telecommunications regulatory body, namely the International Telecommunication Union (ITU). This vision of 5G is not only a fourth generation (4G) evolution in terms of speed (Enhanced Mobile Broadband/ eMBB and latency (Ultra Reliable Low Latency / URLLC) but also increases the number of connected devices in one area (Massive Machine Type Communications/ MMTC) (PuslitbangSDP3I, 2016). In 2020, the telecommunications world in Indonesia is busy preparing for 5G service technology (fifth generation). Internet speed with this 5G technology can reach 4 Gigabits per second, equivalent to 500 Megabytes per second, which can download 50 GB in 2 minutes. 5G technology is an evolutionary technology from 4G, namely new technology from radio systems (Putra, no date) and network architecture by presenting broadband connectivity, ultra-robust, extreme low latency and massive networks for humans, Internet of Things (IoT) and large scale Machine to Machine (M2M) communications (Zulpratita, 2018).

Preparation for the 5G network services includes radio equipment and the necessary supporting infrastructure. This phenomenon is a fresh opportunity for contractor companies engaged in the construction and installation of BTS (Base Transmition Stationary) radio equipment and their infrastructure. One company that is definitely involved in the expansion of this service network is a tower provider company. Infrastructure development by tower providers is the topic of this research. Likewise in the telecommunications world, this research focuses on infrastructure development projects that support BTS radios, which are commonly called colocation projects.

A project that can be completed on time, with good quality, and get the desired profit margin, is of course the target of a company. In addition to increasing company productivity, it will also strengthen partners' trust in cooperating on a project.

There is no time standard, no cost standard, no reference for the ideal number of workers for the completion of a project, making the colocation project contractor company unstable in terms of productivity. The author, as the supervisor of this company, often finds this out.

This instability does not mean that the company's overall performance or target achievement is not good. However, there are jobs that have been completed before being targeted, but there are also jobs that are not completed even though the targeted time has passed. This colocation project is classified as a small-scale project, but once down it can be up to 80 sites. So that the contractor company, in this study focused on PT. XYZ, have to prepare many teams in the field. The performance and character of the team are different, often resulting in different quality, quantity and project time achievements. This will certainly affect the performance of PT. XYZ towards clients or customers.

In this paper, the authors try to assist this company in determining the time, effort, and cost effectively in running a colocation project. With the research title "Optimization of Project Colocation at PT. XYZ Using PERT and CPM Methods Based on POM-QM Application for Windows". Texts font is Times new Roman, 11 pt size and justify the alignment. Auto spacing between paragraph and not indent.

## **REVIEW OF LITERATURE**

### **Telecommunication Infrastructure**

Infrastructure is a key condition for service provision and the same is true for the telecommunications industry. Telecommunication infrastructure has an important role in the national economy. The development of telecommunication technology is increasing rapidly so that the demand for telecommunication services is also increasing (Amalin and Handayeni, 2017).

Telecommunication companies generally have their own arrangements to fulfill infrastructure, because investment in the telecommunications sector or sector requires a very large investment or capital. Therefore, a new business model for infrastructure in the telecommunications industry has emerged, which is often known as sharing infrastructure.

The telecommunications industry follows the trend of sharing infrastructure as a business process so that it keeps their investment low and competes for economies of scale. There are mainly three types of shared infrastructure possible and used around the world. Passive Infrastructure Sharing It is a shared non-electronic infrastructure at a cell site. Passive infrastructure is becoming popular in the world telecommunications industry. This sharing includes towers or towers, BTS shelters, power supply, generators, batteries, air conditioners (AC), fire engines. Active sharing infrastructure Is an electronic sharing infrastructure. These include: Spectrum, Switches, Antennas,

Transceivers, Microwave equipment. The spectrum-sharing concept is based on a rental model and is often called spectrum trading. An operator can lease part of the spectrum to another operator on commercial terms.

The third type is a self-supporting tower (Self Supporting Tower) which is a free-standing tower and can be built with three or four legs with a lattice frame design. This tower has a larger footprint than the monopole, but still takes up a much smaller area than the guyed mast tower. These towers are generally the strongest as they can support the greatest loads which include much wind and ice.

BTS (Base Transceivers Station) is a telecommunications infrastructure product that is experiencing growth in line with the increasing demand for wireless and cellular technology (Windharto and Setiawan, 2009). BTS emits electromagnetic waves emitted by sectoral antennas with low frequencies ranging from 900 to 1800 Mhz, which will then be captured by the cellphone antennas on each cellphone subscriber.

A communication tower is basically a tower made of a triangular or square cross section lattice with one or more antennas attached to the top. Tower heights usually vary in the range of 50 - 250m. This tower or tower can only be built on site if it has an excellent engineering design, because the load is applied not only from the mass itself (dead load), but includes live loads, wind loads and earthquakes if any (Sumbiar, 2011).

There are three types of towers, namely monopole, which is a free-standing tower and is most often used in cellular and personal communication (PCS) service applications. These towers are usually constructed from sections of steel of different diameters that are either cylindrical or multi-sided. Because the construction requires a high cost to produce but easy to erect. And plus, monopoles are mainly used in urban environments where there is limited space available for tower footprints.

### **Colocation Project**

Colocation is there are two or more cellular operators in one site. In Indonesia, a colocation project is a BTS radio infrastructure development project at an existing site or a tower where other operators have previously existed.

The collocation process is an important phase in the life cycle of the telecommunications industry. It has the capacity to reduce average costs per site by more than 50% with cost savings of up to 30% for individual operators. As the market matures, diminishing revenue growth reduces and operators must look for innovative ways of increasing their income while reducing both CAPEX and OPEX (Francis E. Idachaba, 2010).

The collocation process will require a stable and corporate regulatory framework so that smaller operators or rental operators or rental space are not treated unfairly by owner operators in a collocated environment. shared infrastructure can be handed over to a third party while both operators monitor shared resources and control their respective shelters.

There are two types of telecommunication tower infrastructure built, namely the rooftop tower type which is built on top of a building and the Greenfield tower type which is built directly on the ground. As a tower rental service provider, tower provider has several tenants or tenants for selurer operators such as Telkomsel, Excelcomindo (XL), Indosat, HCPT (Tree), FM (internux) Smart Fren and others.

### **PERT-CPM Method**

Over the years, two approaches that have proven useful for planning, scheduling and controlling construction projects are the Critical Pathway Method (CPM) and the Project Evaluation / Program Evaluation Review Technique (PERT). This technique allows the project manager to evaluate the start and end times at which activities can start and finish, calculate slack, define critical activities, and evaluate the impact of changes in duration, logical relationships and costs on the overall project duration. Both CPM and PERT are network-based techniques (Aja, 2017) and therefore assist in programming and monitoring the progress of the stages involved so that the project is completed within the deadline. In doing this, it determines the important parts of the project which if delayed beyond normal time will increase the overall project completion time.

Although PERT and CPM differ to some extent in terminology and in network building, the objectives remain the same. Furthermore, the analyzes used in these two techniques are very similar. The main difference is that, in the CPM activity time is assumed to be proportional to the amount of resources allocated to them, and by changing the level of resources, activity time and project completion time can vary. CPM thus assumes previous experience with similar projects from which a relationship between resources and work time is available (Elisabeth Riska Anggraeni *et al.*, 2017).

### **METHODOLOGY**

The research was conducted in one of the contracting companies, namely PT. XYZ, located in Bandung, Indonesia. The research duration is approximately 6 months, starting from June to November 2020. Meanwhile, the project location which is the location for field data collection is the Mekarsari Banjar site located in West Java, Indonesia.

The data analysis technique in this study used PERT and CPM methods based on POM-QM for Windows. POM-QM for WINDOWS used in this study is QM for WINDOWS version 5.

CPM is a time-oriented method that leads to the determination of the schedule and the estimate or time estimate is deterministic. The CPM method is used to estimate the time in a series of collocation project activities. In addition, this method can also calculate costs according to the scheduled time. The steps for processing data using the CPM method are: a. Construction process data and processing time Construction process data and processing time that have been determined by this company are needed for making Network Diagrams. b. Data on raw material prices. This data is very useful for determining project costs that will be incurred both at the initial and acceleration time.

The output that will be obtained from the data collection above using the CPM method is a Network Diagram. Network diagram is a network method that identifies critically about the initial schedule and planning.

The PERT method is a time-oriented method that leads to the determination of a schedule where the time is probable (probabilistic). Data processing with the PERT method uses the concept of probability or probability. The PERT method can be divided into three types of time duration, namely optimistic time (a), pessimistic time (b) and normal or most likely time (m). The data to be used in the PERT method is the result of making a network diagram that has a critical path according to the CPM method.

## RESULTS

Broadly speaking, the collocation project stages are divided into 3 stages, namely the preparation stage, the civil works stage, and the mechanical electrical (ME) work stage. The preparation stage consists of survey work, preparation of Healthy Safety and Environment (HSE) tools and briefings, as well as preparation of civil and mechanical electrical materials. The civil works stage consists of several activities, namely bowplank work, excavation, river stone installation, ironwork, formwork, casting, plastering and hammering, to finishing. Meanwhile, Mecanical Electrical's work consists of installing KWH poles and panels as well as ACPDB poles and panels, tray installation work, both horizontal and vertical trays. Other activities in the mechanical electrical section include mounting work, grounding system work, and connecting PLN. The systematic order of the types of activities in this collocation project can be seen in Table 1.

**Table 1 Type of Activities and Duration of Activities**

No	Type of Activity	Symbol	Time (Days)
1	Survey	A	2
2	Preparation of HSE tools and briefings	B	1
3	Material preparation	C	1
4	Bowplank	D	1
5	Excavation	E	1
6	Stone installation	F	1
7	Reinforcing	G	1
8	Formwork	H	1
9	Casting	I	1
10	Plaster	J	1
11	Dyeing and painting	K	1
12	Install the pole and KWH Panel and install the pole and ACPDB panel	L	1
13	Install the cable leader tray	M	1
14	Install Mounting	N	2
15	Install the grounding system (Grounding system)	O	1
16	Connecting PLN	P	1
17	Finishing	Q	1

**Data Description of Activities and Project Colocation Costs**

For this colocation project financing is also divided into three divisions, namely material costs, wages, and new PLN connection costs. In this study, for material costs, the authors took the actual price of materials multiplied by the need for completion of a project, while the cost of work-staged wages was classified based on the daily wage multiplied by the number of workers. Meanwhile, PLN's new connection fee is based on the AKLI price. Details of material prices, wages and new PLN connection costs can be seen in Table 2.

**Table 2 Description of activities and activity costs**

No	Type of Activity	Symbol	Cost (Rp)
1	Survey	A	500,000
2	Preparation of HSE tools and briefings	B	0
3	Material preparation	C	1,758,1000
4	Bowplank	D	120,000
5	Excavation	E	210,000
6	Stone installation	F	210,000



7	Reinforcing	G	210,000
8	Formwork	H	210,000
9	Casting	I	300,000
10	Plaster	J	300,000
11	Dyeing and painting	K	120,000
12	Install the pole and KWH Panel and install the pole and ACPDB panel	L	210,000
13	Install the cable leader tray	M	210,000
14	Install Mounting	N	300,000
15	Install the grounding system (Grounding system)	O	210,000
16	Connecting PLN	P	12,000,000
17	Finishing	Q	120,000

### Data processing with the Critical Path Method

In this study the data were taken from a colocation project, namely the Mekarsari Banjar site. Data analysis in this project uses two conditions, namely condition 1 and condition 2. In analyzing the scheduling problem for this colocation project, we use initial condition 1 (Table 1) and condition acceleration 1. Calculation of forward and backward in initial condition 1 with the POM-QM For application. Windows can be seen in Table 3.

**Table 3 Calculation of forward and backward and total float (slack) in initial conditions 1**

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack
Project	19					
A	2	0	2	0	2	0
B	1	2	3	2	3	0
C	1	3	4	3	4	0
D	1	4	5	4	5	0
E	1	5	6	5	6	0
F	1	6	7	6	7	0
G	1	7	8	7	8	0
H	1	8	9	8	9	0

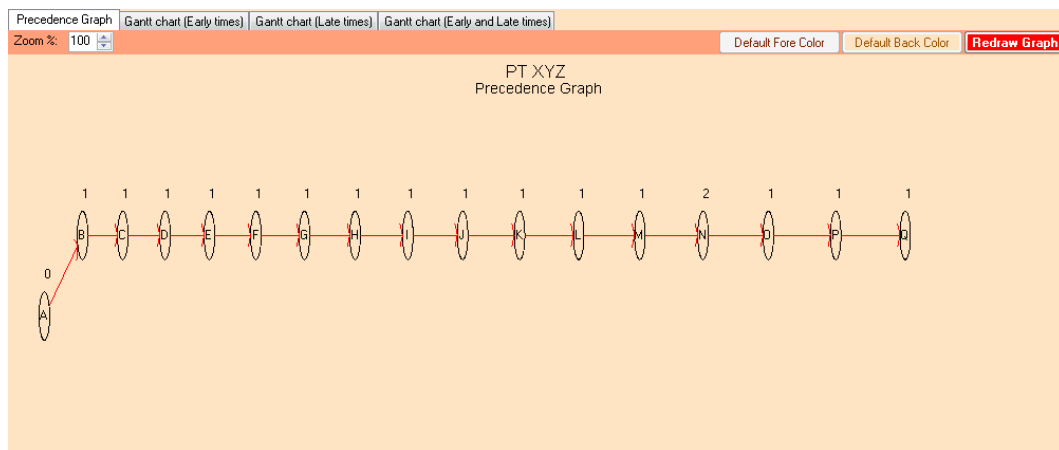


I	1	9	10	9	10	0
J	1	10	11	10	11	0
K	1	11	12	11	12	0
L	1	12	13	12	13	0
M	1	13	14	13	14	0
N	2	14	16	14	16	0
O	1	16	17	16	17	0
P	1	17	18	17	18	0
Q	1	18	19	18	19	0

The forward and backward calculations as well as the total float or slack in the initial conditions 1 as shown in Table 3 have 17 critical activities. The project completion time in initial condition 1 is around 19 days. This means that all of these collocation project activity flows cannot be delayed. The total value of the float or slack is zero (TF = 0). All of these activities are critical because if there is a delay in one of the activities, the whole project will be delayed. In this collocation project, every activity is interdependent between other activities.

**Network Diagram**

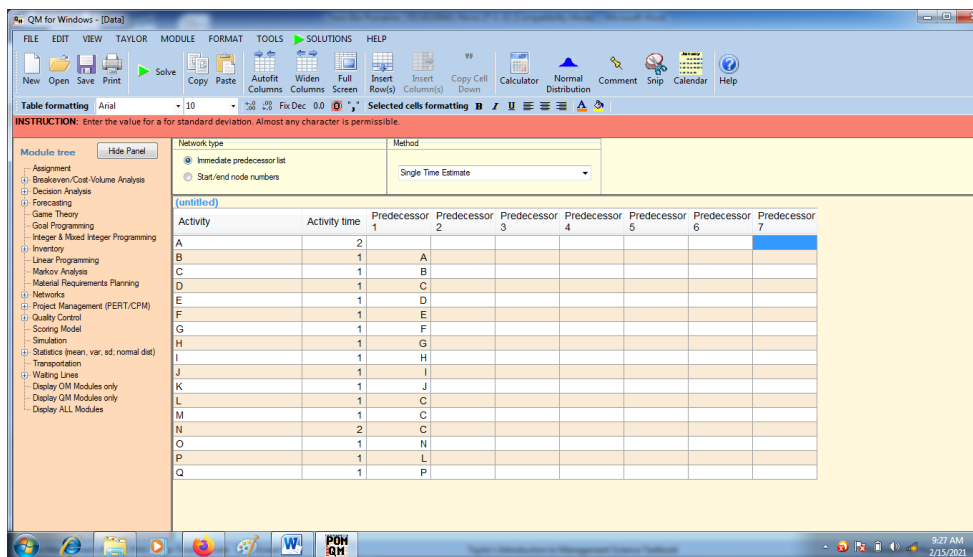
Network diagrams are prepared based on initial condition data in Table 1 using POM and QM applications for Windows V5 with the results shown in Figures 1. In the POM and QM applications for Windows V5, select or click the Solutions menu, select Chart. Chart results can be a precedence chart. In the solutions menu you can also select the Gantt chart for the initial conditions (Early times) and the final conditions (Late times) and the Gantt chart for the initial and late conditions (Early and Late times).



**Figure 1. Network diagram of initial conditions 1**

Activities in this colocation project are not branched, this is because the activities are related to one another as evidenced by the zero slack or total float value (all activities cannot be postponed) (Figure 1). Analysis of the colocation project scheduling in the initial conditions of the network diagram in Figure 1, the time needed to complete the colocation project is 19 days (Table 3).

**Predecessor Initial condition 2**



The forward and backward calculations and the total float or slack in the initial condition 2 can be seen in Table 4. In Table 4 it can be seen that there are eleven (11) activities that are on the critical path. Whereas in this condition there are 6 activities that are not on the critical path with the float value not equal to zero (0).

**Table 4 Calculation of forward and backward and total float (slack) in initial conditions 2**

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack
Project	12					
A	2	0	2	0	2	0
B	1	2	3	2	3	0
C	1	3	4	3	4	0
D	1	4	5	4	5	0

E	1	5	6	5	6	0
F	1	6	7	6	7	0
G	1	7	8	7	8	0
H	1	8	9	8	9	0
I	1	9	10	9	10	0
J	1	10	11	10	11	0
K	1	11	12	11	12	0
L	1	4	5	9	10	5
M	1	4	5	11	12	7
N	2	4	6	9	11	5
O	1	6	7	11	12	5
P	1	5	6	10	11	5
Q	1	6	7	11	12	5

Network diagrammed initial conditions in condition 2 can be seen in Figure 2. From the figure, it can be seen that there are eleven activities that are on the critical path.

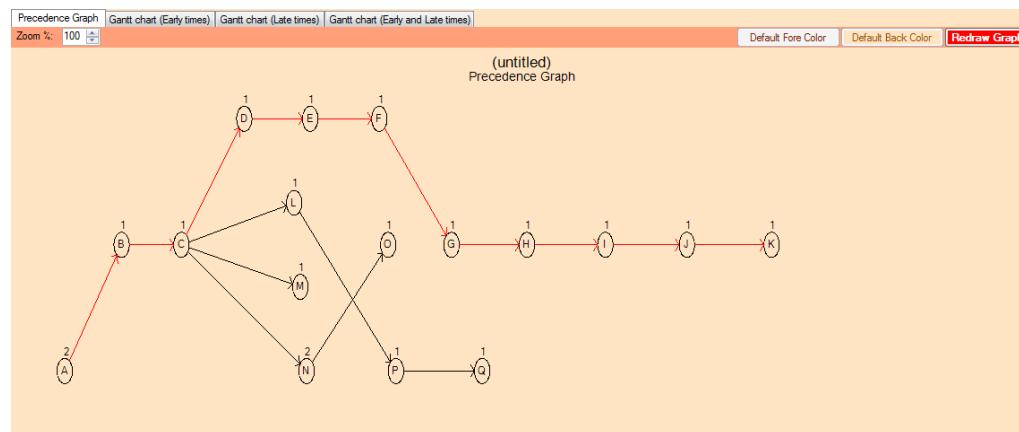


Figure 2 Network Diagram Initial Conditions 2

### Scheduling project collocation acceleration conditions 1

Collocation project schedules are arranged in the presence of activities that should be done quickly, because the processing time is rather long. These activities are critical activities and the paths they cross are known as critical paths. Manually the critical path calculation is determined using forward computation and backward calculation. This forward and backward calculation is used to determine the critical path with a total float

of zero (0). This float value can also determine what activities or activities can be snoozed. In this accelerated condition, there are 15 activities that can be accelerated as shown in Table 5 below:

**Table 5 Work acceleration of collocation project activities**

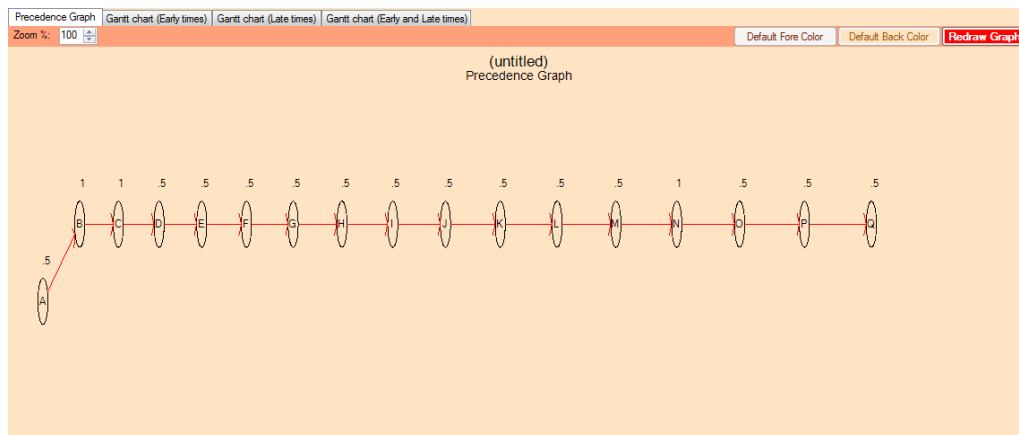
No	Type of Activity	Symbol	Normal Time (Days)	Time Acceleration (Days)
1	Survey	A	2	0.5
2	Preparation of HSE tools and briefings	B	1	1
3	Material preparation	C	1	1
4	Bowplank	D	1	0.5
5	Excavation	E	1	0.5
6	Stone installation	F	1	0.5
7	Reinforcing	G	1	0.5
8	Formwork	H	1	0.5
9	Casting	I	1	0.5
10	Plaster	J	1	0.5
11	Dyeing and painting	K	1	0.5
12	Install the pole and KWH Panel and install the pole and ACPDB panel	L	1	0.5
13	Install the cable leader tray	M	1	0.5
14	Install Mounting	N	2	1
15	Install the grounding system (Grounding system)	O	1	0.5
16	Connecting PLN	P	1	0.5
17	Finishing	Q	1	0.5

Forward and backward calculations as well as the total float at acceleration 1 conditions can be seen in Table 6. The table shows that all activities are on a critical path with zero slack value (0). The amount of time needed is 10 days which is on the critical path.

**Table 6 Calculation of forward and backward and total float in acceleration conditions 1**

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack
Project	10					
A	0.5	0	0.5	0	0.5	0
B	1	0.5	1.5	0.5	1.5	0
C	1	1.5	2.5	1.5	2.5	0
D	0.5	2.5	3	2.5	3	0

E	0.5	3	3.5	3	3.5	0
F	0.5	3.5	4	3.5	4	0
G	0.5	4	4.5	4	4.5	0
H	0.5	4.5	5	4.5	5	0
I	0.5	5	5.5	5	5.5	0
J	0.5	5.5	6	5.5	6	0
K	0.5	6	6.5	6	6.5	0
L	0.5	6.5	7	6.5	7	0
M	0.5	7	7.5	7	7.5	0
N	1	7.5	8.5	7.5	8.5	0
O	0.5	8.5	9	8.5	9	0
P	0.5	9	9.5	9	9.5	0
Q	0.5	9.5	10	9.5	10	0



**Figure 3 Network Diagram of Acceleration Conditions 1**

Making a network (network) diagram for acceleration conditions 1 used data from Table 5, namely the activity description data and the duration of the acceleration activity. Network diagram of acceleration condition 1 can be seen in Figure 3. The time to complete the project is in acceleration condition 1 which is 10 days (all critical).

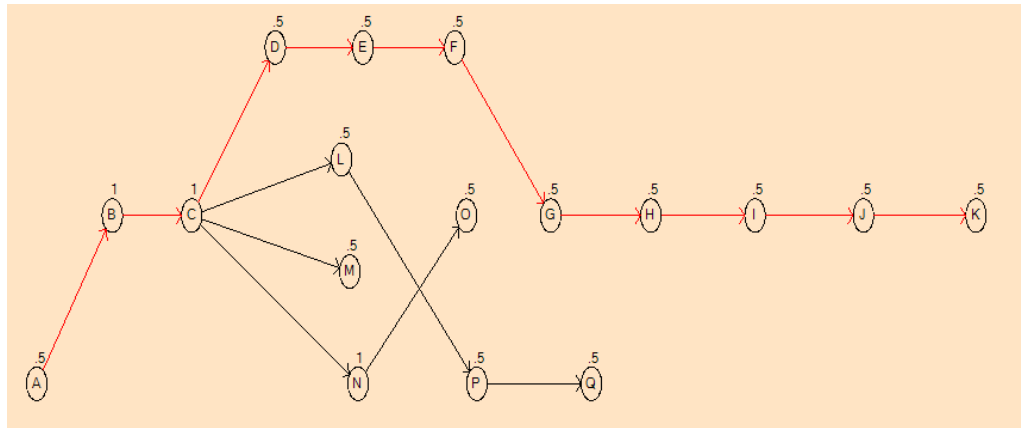
**Project Collocation Scheduling Acceleration Conditions 2**

Forward and backward calculations in acceleration condition 2 using POM QM For Windows in full can be seen in Table 7.

**Table 7 Calculation of forward and backward and total float on acceleration conditions 2**

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack
Project	6.5					
A	0.5	0	0.5	0	0.5	0
B	1	0.5	1.5	0.5	1.5	0
C	1	1.5	2.5	1.5	2.5	0
D	0.5	2.5	3	2.5	3	0
E	0.5	3	3.5	3	3.5	0
F	0.5	3.5	4	3.5	4	0
G	0.5	4	4.5	4	4.5	0
H	0.5	4.5	5	4.5	5	0
I	0.5	5	5.5	5	5.5	0
J	0.5	5.5	6	5.5	6	0
K	0.5	6	6.5	6	6.5	0
L	0.5	2.5	3	5	5.5	2.5
M	0.5	2.5	3	6	6.5	3.5
N	1	2.5	3.5	5	6	2.5
O	0.5	3.5	4	6	6.5	2.5
P	0.5	3	3.5	5.5	6	2.5
Q	0.5	3.5	4	6	6.5	2.5

In the accelerated condition condition 2 there are eleven activities including the critical path or path (Table 7), namely Survey activities (A), Preparation of HSE tools and briefings (B), Material preparation (C), Bop plank (D), Excavation (E), Stone installation (F), ironing (G), Formwork (H), Casting (I), Plaster (J) and Plastering and painting (K). The overall project completion time under accelerated conditions is 10 days (6.5 days critical time). The completion time of this project is 4 days faster than normal projects (14 days). This acceleration is in accordance with field observations, namely by increasing the workforce. Network diagram and Gantt chart acceleration condition 2 can be seen in Figure 4.



**Figure 4 Network Diagram of acceleration conditions 2**

Crashing is the process of shortening the project time and the lowest cost. Activities in this colocation project consist of 17 activities with a normal completion time of 19 days. After the process of accelerating each activity may get a crash time of 10 days. Normal time and crash time, normal cost and crash cost for each activity can be seen in Table 6. The total cost of acceleration is Rp. 1,370,000 (One million three hundred and seventy thousand rupiah). This is consistent with the concept of crashing, which is to shorten the project completion time at a low cost.

**Table 8 Crashing schedule Critical Path Method**

Activity	Normal time	Crash		Normal Cost	Crash Cost	Crash cost/pd	Crash by	Crashing cost
		h	time					
Project	19		10					
A	2	0,5		Rp.500000	Rp.700000	3	1,5	Rp.20000
B	1	1		Rp.0	Rp.0	Rp.0	0	Rp.0
C	1	1		Rp.175810	Rp.175810	Rp.0	0	Rp.0
D	1	0,5		Rp.120000	Rp.210000	Rp.180000	0,5	Rp.90000
E	1	0,5		Rp.210000	Rp.300000	Rp.180000	0,5	Rp.90000
F	1	0,5		Rp.210000	Rp.300000	Rp.180000	0,5	Rp.90000
G	1	0,5		Rp.210000	Rp.300000	Rp.180000	0,5	Rp.90000
H	1	0,5		Rp.210000	Rp.300000	Rp.180000	0,5	Rp.90000
I	1	0,5		Rp.300000	Rp.390000	Rp.180000	0,5	Rp.90000
J	1	0,5		Rp.300000	Rp.390000	Rp.180000	0,5	Rp.90000
K	1	0,5		Rp.120000	Rp.210000	Rp.180000	0,5	Rp.90000



L	1	0,5	Rp.210000	Rp.300000	Rp.180000	0,5	Rp.90000
M	1	0,5	Rp.210000	Rp.300000	Rp.180000	0,5	Rp.90000 Rp.18000
N	2	1	Rp.300000	Rp.480000	Rp.180000	1	0
O	1	0,5	Rp.210000 Rp.120000	Rp.300000 Rp.120000	Rp.180000	0,5	Rp.90000
P	1	0,5	00	00	Rp.0	0,5	Rp.0
Q	1	0,5	Rp.120000	Rp.120000	Rp.0	0,5	Rp.0
<b>TOTA</b>			<b>32.811.000,</b>				<b>1.370.000</b>
<b>L</b>			-				,-

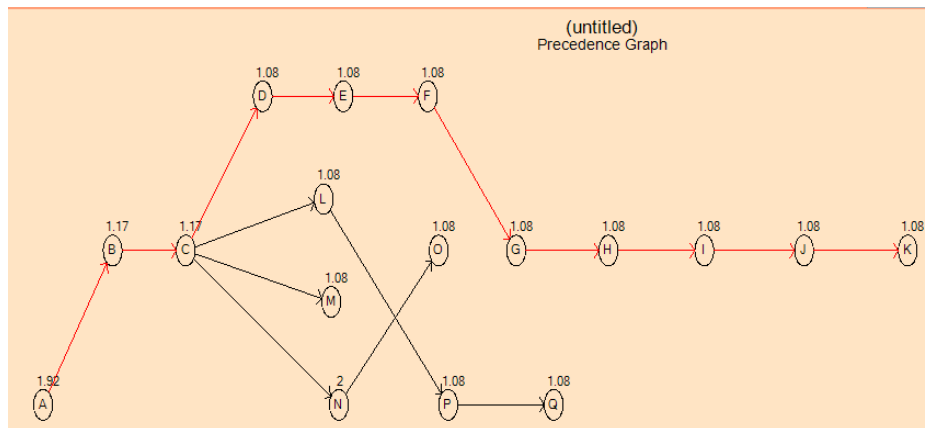
### Data Processing with the PERT Method

Processing data using the PERT method using POM-QM for Windows by selecting the PERT CPM application module file three time estimate which contains optimistic time, pessimistic time and the most likely time. The full calculation results using POM QM for Windows can be seen in Table 8. The standard deviation and variance values for each activity can be seen in Table 9.

**Table 9 List of Activities, optimistic time, most likely time, pessimistic time, standard deviation and variance**

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack	Standard Deviation	Variance
Project	11.75						0.84	0.7
A	1.92	0	1.92	0	1.92	0	0.42	0.17
B	1.17	0	1.17	10.58	11.75	10.58	0.17	0.03
C	1.17	1.92	3.08	1.92	3.08	0	0.17	0.03
D	1.08	3.08	4.17	3.08	4.17	0	0.25	0.06
E	1.08	4.17	5.25	4.17	5.25	0	0.25	0.06
F	1.08	5.25	6.33	5.25	6.33	0	0.25	0.06
G	1.08	6.33	7.42	6.33	7.42	0	0.25	0.06
H	1.08	7.42	8.5	7.42	8.5	0	0.25	0.06
I	1.08	8.5	9.58	8.5	9.58	0	0.25	0.06
J	1.08	9.58	10.67	9.58	10.67	0	0.25	0.06
K	1.08	10.67	11.75	10.67	11.75	0	0.25	0.06
L	1.08	3.08	4.17	8.5	9.58	5.42	0.25	0.06
M	1.08	3.08	4.17	10.67	11.75	7.58	0.25	0.06
N	2	3.08	5.08	8.67	10.67	5.58	0.33	0.11

O	1.08	5.08	6.17	10.67	11.75	5.58	0.25	0.06
P	1.08	4.17	5.25	9.58	10.67	5.42	0.25	0.06
Q	1.08	5.25	6.33	10.67	11.75	5.42	0.25	0.06



**Figure 5 Network Diagram of PERT method**

In Figure 5 can be seen a network diagram of the sequence of activities that can be accelerated using the PERT method. In the graph there are eleven activities on the critical path, namely Surveying (A), Preparation of HSE tools and briefings (B), Material preparation (C), Bop plank (D), Excavation (E), River stone installation (F), Cleansing (G), Formwork (H), Casting (I), Plaster (J) and Reinforcing and painting (K). Activities begin or start at activity A (survey) and end at point Q (finishing). Activity C can be carried out after B is finished, activity B after A is finished, activities D, L, M and N can be carried out after C has finished. Activities E after D, activities F after E, activities G after F, activities H after F finish, activities I after H finish, activities J after I and activities K after J is finished, activities L, M, N after C is finished, activities O after N finished, P activities after L finished, and Q activities after P finished. Activities that are located on the red line are critical paths. So by using PERT it can be determined the order of work and the relationship between work activities that cannot be separated. This attachment can be seen if certain work has not been done, then further work cannot be done.

Table 10 Activity Time Computations

	Optimistic time	Most Likely time	Pessimistic time	Activity time	Standard Deviation	Variance
A	0.5	2	3	1.92	0.42	0.17
B	1	1	2	1.17	0.17	0.03
C	1	1	2	1.17	0.17	0.03
D	0.5	1	2	1.08	0.25	0.06
E	0.5	1	2	1.08	0.25	0.06
F	0.5	1	2	1.08	0.25	0.06
G	0.5	1	2	1.08	0.25	0.06
H	0.5	1	2	1.08	0.25	0.06
I	0.5	1	2	1.08	0.25	0.06
J	0.5	1	2	1.08	0.25	0.06
K	0.5	1	2	1.08	0.25	0.06
L	0.5	1	2	1.08	0.25	0.06
M	0.5	1	2	1.08	0.25	0.06
N	1	2	3	2	0.33	0.11
O	0.5	1	2	1.08	0.25	0.06
P	0.5	1	2	1.08	0.25	0.06
Q	0.5	1	2	1.08	0.25	0.06
Project results Sum of crit act var						0.73
<b>Sum of total variance</b>						<b>1.12</b>
Square root of total					0.85	

The overall variance value is the total of all activity variances from Table 10, namely 1.12. The project standard deviation value is calculated from the root of the total variance, which is 1.0583. The Z value of a colocation project can be calculated using the formula:

$$Z = \frac{T(d) - TE}{S}$$

$Z$  = probability (chance),  $T(d)$  = time limit,  $TE$  = expected completion time,  $S$  = standard deviation of the whole project

$$Z = \frac{T(d) - TE}{S}$$

$$Z = \frac{14 - 10}{1.06}$$

$$Z = 3.77$$

The  $Z$  value of this colocation project is 3.77, based on the normal distribution table, the chance of working on this project in 10 days is 0.99992.  $0.99992 \times 100\% = 99.992\%$  From the  $Z$  value, this collocation project can be done in 10 days with a 99.99% chance.

## CONCLUSION

Based on the results of calculations and analyzes of the data, the optimal time for a colocation project at PT XYZ is 10 (ten) days. The cost of completing the colocation project at the Mekarsari Banjar site as a whole under accelerated conditions is Rp. 34,181,000,- (Thirty-four million one hundred and eighty-one thousand rupiah). The actual condition of PT. XYZ in completing the colocation project is 19 (nineteen) days. The probability of working on a colocation project by PT XYZ is ten days from the target of 14 days with a  $Z$  value = 3.77 with a probability of 99.992%.

## REFERENCES

- Ahmad Fardian Firdaus., Sugiyono Madelan., Ahmad Badawi Saluy.(2021). "Supplier / Partnership Selection System Analysis Based on Analytic Hierarchy Method Process in Oil and Gas Drilling Project (Case Study: PT. KMI)". International Journal of Innovative Science and Research Technology, Vol.6, Issu 3, page. 403 -411.
- Amalia Utami Dewi., Madelan, Sugiyono., Ahmad Badawi saluy.(2021)" Analysis of the Application of Total Quality Management in Lens Products in PT. XYZ" Scholars Bulletin, Scholars Bulletin. Vol.7, Issu,3. Page, 14-20
- Mohammad Fahmi Kurniawan., Sugiyono Madelan., Ahmad Badawi Saluy.(2021)."EFFICIENCY ANALYSIS OF EXCAVATOR NUT INVENTORY USING ECONOMIC ORDER QUANTITY METHOD AT PT. ABCDE BEKASI-JAWA BARAT" Dinasti International Journal of Economics, Finance and Accounting.Vol.2,Issu3.
- Admaja, A. F. S. (2015) 'Kajian Awal 5G Indonesia (5G Indonesia Early Preview)', *Buletin Pos dan Telekomunikasi*, 13(2), p. 97. doi: 10.17933/bpostel.2015.130201.

- Admaja, A. F. S. (2018) 'Pemetaan Riset Teknologi 5G Technology Research Mapping', *Buletin Pos dan Telekomunikasi*, 16(1), p. 27. doi: 10.17933/bpostel.2018.160103.
- Aja, R. O. (2017) 'Application of Project Evaluation , Review Technique and Critical Path Method ( PERT-CPM ) Model in Monitoring Building Construction', *World Applied Sciences Journal*, 35(11), pp. 2401–2413. doi: 10.5829/idosi.wasj.2017.2401.2413.
- Amalin, R. E. and Handayani, K. D. M. E. (2017) 'Kriteria Lokasi Pembangunan Tower BTS (Base Transceiver System) di Kota Kediri', *Jurnal Teknik ITS*, 6(1). doi: 10.12962/j23373539.v6i1.22198.
- Astiti, N. M. E. P., Dewi, I. A. L. and Wirastuti, N. D. (2013) 'Implementasi Teknologi 4G LTE di Indonesia', *Prosiding Conference on Smart-Green Technology in Electrical and Information Systems*, (14-15 November), pp. 14–15.
- Christie H. K. Pasaribu., Sugiyono Madelan., Ahmad Badawi Saluy.(2021)" Single and Multifactor Productivity Analysis of Manual and Automatic Machines at Powder Coating Company PT. TKM in Bekasi" *International Journal of Innovative Science and Research Technology*, International Journal of Innovative Science and Research Technology, Vol.6, Issu,2,Page, 518-524.
- Doddy Agustandi., Sugiyono Madelan., Ahmad Badawi Saluy.(2021)." Quality Control Analysis Using Six Sigma Method to Reduce Post Pin Isolator Rject in Natural Drying Pt Xyz". *International Journal of Innovative Science and Research Technology*.Vol.6.Issu,1.Page1417-1426.
- Elisabeth Riska Anggraeni, D. *et al.* (2017) 'Analysis of Project Planning Using Cpm and Pert', *International Journal of Computer Science and Mobile Computing*, 6(8), pp. 24–25. doi: 10.19113/sdufbed.35437.
- Fauzi, F., Harly, G. S. and Hs, H. (no date) 'Vol.10, No. 2', *Bidang Rekayasa*, 10(2), pp. 281–290.
- Gemiharto, I. (2015) 'Teknologi 4G-LTE dan Tantangan Konvergensi Media Di Indonesia', *Jurnal kajian Komunikasi*, 3(2), pp. 212–220.
- Iswahyudi, C. (2015) 'Teknologi 4G Pada Jaringan Gsm Untuk Kebutuhan Mobile Internet Di Kota Yogyakarta', *Jarkom*, 2(2), pp. 32–43.
- Kemalasari, N., & Saluy, A. B.(2018) The Effect of Human Capital, Structural Capital and Relation Capital on Company Performance. *Saudi Journal of Humanities and Social Sciences (SJHSS)* ISSN 2415-6256, , Vol-3, Iss-5. Page, 642-650
- Maria, U. and Irtawaty, A. S. (2018) 'Optimasi Jaringan 4G LTE ( Long Term Evolution) Pada Kota Balikpapan', *ECOTIPE*, 5.
- Mohammad Fahmi Kurniawan., Sugiyono Madelan., Ahmad Badawi Saluy.(2021)."EFFICIENCY ANALYSIS OF EXCAVATOR NUT INVENTORY USING ECONOMIC ORDER QUANTITY METHOD AT PT. ABCDE BEKASI-

- JAWA BARAT” *Dinasti International Journal of Economics, Finance and Accounting*.Vol.2,Issu3.
- PuslitbangSDP3I, K. (2016) ‘Kajian Lanjutan 5G Indonesia’, *Puslitbang Sumber Daya, Perangkat, dan Penyelenggaraan Pos dan Informatika Badan Penelitian dan Pengembangan Sumber Daya Manusia Kementerian Komunikasi dan Informatika*, pp. 1–2.
- Putra, I. M. S. (no date) ‘Perspektif dan Wawasan Global 5G dan Revolusi Industri Ke-Empat’.
- Saluy, Ahmad Badawi., Masyhudzulkham Djamil., MS Setiawan., and Novawiguna Kemalasari.(2021). Analysis of The Influence of Total Quality Management (TQM) Principles on Service Quality. *Productivity management*, 26(1), GITO Verlag, P. 458-471
- Saluy, A. B. (2018, November). Recruitment and profitability management (case study of primary sector companies listed on Indonesia Stock Exchange 2007-2016). In *IOP Conference Series: Materials Science and Engineering* (Vol. 453, No. 1, p. 012066). IOP Publishing
- Suzulia, M. T., & Saluy, A. B. (2020). THE EFFECT OF CAPITAL STRUCTURE, COMPANY GROWTH, AND INFLATION ON FIRM VALUE WITH PROFITABILITY AS INTERVENING VARIABLE (STUDY ON MANUFACTURING COMPANIES LISTED ON BEI PERIOD 2014-2018). *Dinasti International Journal of Economics, Finance & Accounting*, 1(1), 95-109.
- Saluy, A. B. (2018, November). Recruitment and profitability management (case study of primary sector companies listed on Indonesia Stock Exchange 2007-2016). In *IOP Conference Series: Materials Science and Engineering* (Vol. 453, No. 1, p. 012066). IOP Publishing.
- Saluy, A. B., Musanti, T., & Mulyana, B. (2019). Pengaruh Pelatihan, Motivasi Kerja Dan Kompetensi Terhadap Kinerja Personel Di Makosek Hanudnas I. *Journal Of Management And Business Review*, jilid, 16, 87-109
- Saluy, Ahmad Badawi., **Kemalasari, Novawiguna.**(2018)” The Role of Organizational Culture, Organizational Commitment, and Styles of Transformational Leadership towards Employee Performance” ICBEAS 2018 : International Conference on Business, Economic and Administrative Sciences - International Journal of Industrial and Systems Engineering - Amsterdam, The Netherlands. *International Scholarly and Scientific Research & Innovation* 12(8) 2018
- Sinaga, D., Madelan, S., & Saluy, A. B (2021). Analysis Supply Chain Management Performance Using SCOR Method in Compressor Distributor Company at PT. Pola Petro Development. *International Journal of Innovative Science and Research Technology*, Volume 6, Issue 2, February – 2021,Page 91-102.
- Sumbiar, H. B. (2011) ‘Design of Communication Tower and Its Performance’, in *Disertasi*.

- Saluy, Ahmad Badawi., Sugiyono, Sugiyono.(2018) "The Global Impact on Creative Economy Development for Local Tourism Destination" The 3th International Conference on Management, Economics, and Business (ICMEB), Vol.3. page.185
- Windharto, A. and Setiawan, A. (2009) 'Multi Operator BTS Aesthetic Tower Design for Metropolitan City', *Proceedings of the 1st CIRP Industrial Product-Service Systems (IPS2) Conference, Cranfield University*, (April), pp. 8–15.
- Yuniarto, T. (2019) 'Masa Depan Jaringan 5G dan Perilaku Komunikasi Digital', *Warta ISKI*, 2(01), pp. 1–7. doi: 10.25008/wartaiski.v2i01.22.
- Zulpratita, U. S. (2018) 'Kunci Teknologi 5G', *Jurnal Ilmiah Teknologi Informasi Terapan*, IV(2), pp. 166–173.