Evaluation of the delayed fiber optical installation project on pre-sales division at PT XYZ

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Abstract. This study aims to identify the causes of delays of the project, to know the duration of time of completion and critical paths of the project, and acceleration time as well as the cost of Fiber Optic Installation Project on Pre-Sales division at PT XYZ. The research method used is Mixed Method, and the direct interview is used for data collecting method. Furthermore, The analysis methods that are used in this research are Cause and Effect Diagram Method as an analysis tool to identify the factors that cause delays, especially on the service industry. Critical Path Method (CPM) is used to identify which activities are included in Critical Path, which can shorten its duration by using Crashing Project with POM-QM as an analysis tool. The research resulted there are four factors that cause delays which are System, Skill, Supplier, Surrounding. The project can be completed within eighty-one days. The project can also be completed within seventy-eight days within the consideration of additional hours for an hour per day, and acceleration cost added. From the results of this study, the company will able to find out the causes of delays in the service industry that have an impact on project delays.

1. Introduction

The Critical Path Method (CPM) is a popular quantitative analysis technique that allows managers to plan, plan, monitor, and control large and complex projects. CPM is a deterministic method since it is assumed that the time is known with certainty to determine the project completion time and to identify the critical path [1]. There are several previous studies that use the CPM method in several companies, such as the construction company [2], a small and medium-sized enterprise (SMEs) [3] and biogas plants [4]. However, they did not look for the cause of the project's delay in their research.

Cause-and-effect diagram, also called the Ishikawa diagram or herringbone diagram, is a schematic technique that can be used to find out what potential causes contribute to the problem being studied [5] [6]. The use of cause-and-effect diagrams can be found in several studies, for example in studies by Al Ghaithi et al. [7] on the analysis of delays in the EPC project, Górny [8] on causes of accidents at the Forklift Truck Operator and Doshi et al. [9] on the cause of defective products in the manufacture of car radiators.

PT XYZ is a telecommunications and information services company, in particular, telecommunications services and Internet networks in Indonesia. The problem facing PT XYZ is the delay in installing fiber optic cables by two months, which is a routine job every year. To solve this problem, we need a method that can determine the root cause of the problem and the method, to know
exactly how long the project has been completed, and to determine the critical path so that it will not to new project delays comes.

In the previous study, the application of the CPM method to the biogas plant [4] aimed to make biogas an alternative source of energy due to the energy derived from organic waste. However, the management of a biogas plant major project requires many coordinated activities of varying duration and is very dependent. With the implementation of CPM, four critical lines and 38 weeks project completion time have been achieved, in the hope that this will not be delayed.

In the study of Górny [8], to identify the causes of an accident with the operator of the forklift. He uses the cause and effect diagram with 5 M + E (personnel, methods, machines, materials, management, and environment). His research shows that the cause-and-effect diagrams help to link the causes of the primary factors (labor, methods, machinery, materials, management, and environment). Based on several previous studies, where research on project delays uses only CPM and is still limited to discussing the root causes of project delays using Fishbone analysis. In addition, the use of 4S in Fishbone analysis is still limited in the construction services industry. The state-of-the-art research is a combination of analysis methods, namely the cause-and-effect diagram and the CPM, to overcome project delays. Also, the differences in this research with previous research, due to this research in the telecommunications services industry, use it's cause and effect diagram with the 4S approach, i.e. Environment, suppliers, systems, capabilities [10], which are still rarely used in the service industries. The purpose of this study is to identify the factors that cause delays in fiber installation projects, to determine the duration of the project's completion and critical path, and to determine crash costs and time in accelerating the completion of the fiber installation project PT XYZ.

2. Method
The type of research used in this study is descriptive research. The type of data used is quantitative and qualitative. Sources of data in this study are primary data and secondary data. To support research at PT XYZ, the researcher conducted a series of steps as follows:
1. Data collecting by interviewing PT XYZ internal parties, and using secondary data in the form of workflow data, literature study, and work process time data on previous projects from PT XYZ,
2. After that, the data is processed into Cause and Effect Diagram with category 4S to identify root causes and causes of delay. The 4S category in the service industry [Radziwill, 2017]:
   - Surroundings: external factors that affect the project, that means market needs, demand, and competition.
   - Suppliers: third parties who send supplies and needs.
   - Systems: the method used to provide services.
   - Skills: skills or qualifications of employees and coworkers in the organization.
3. From the results of the Cause and Effect Diagram, then doing Pareto analysis to identify problems based on their importance [Reid & Sanders, 2013]
4. We then create a network to determine the time of the project and the critical path using the Critical Path Method (CPM) using the POM-QM for Windows software.
5. The next step is to calculate the acceleration of the project using the Crashing Project method with the POM-QM For Windows software. Thus, the results of the data processing can be used as a consideration in the evaluation or decision of companies for the future.

3. Results and Discussions
3.1. Analysis of Cause and Effect Diagram
In identifying the root causes of the problem, we categorize the problems divided into 4S categories, namely System, Skill, Supplier, and Surrounding.
After classifying the problem, we use analyzing the data using the Pareto diagram to identify the problem by calculating the highest frequency level of the problem that often occurs to the lowest frequency level, namely very rare problems based on the categories of problems in Cause and Effect as presented in the table below:

**Table 1. Data of Pareto Diagram**

| Problem Categories | Frequences | Percentation |
|--------------------|------------|--------------|
| System             | 7          | 43.75%       |
| Surrounding        | 6          | 37.5%        |
| Supplier           | 2          | 12.5%        |
| Skill              | 1          | 6.25%        |
| Total              | 16         | 100%         |

The next step, based on the data above, we created a Pareto diagram as below.
With the Pareto diagram principle of 20/80, 20% of the total problems are the cause of 80% of project delays. From the Pareto diagram, it can be seen that the System is the biggest factor that can affect the project delay that is equal to 43.75%. The second biggest factor affecting project delays is Surrounding, which is 37.50%. Both of these factors (System and Surrounding) are the main factors causing 81.25% delay.

3.2. Analysis of the Critical Path Method

In a series of fiber optic project installation activities, there are several activities in the process of the process and must be carried out by the regular order. The following is data on the activities of the optical fiber project.

| No | Activity Symbol | Activities          | Preliminary Activity | Required time (days) | Problems                                                   |
|----|-----------------|---------------------|----------------------|----------------------|------------------------------------------------------------|
| 1  | A               | New Sales Order     | -                    | 3                    | Lack of sales preparation to the customer                  |
| 2  | B               | On Desk Survey      | A                    | 3                    | Do not have Tools                                          |
| 3  | C               | Capacity Forecast   | B                    | 3                    | There is no certain Stock List                              |
| 4  | D               | Price Creation      | B, C                 | 2                    | Undetailed Order description                               |
| 5  | E               | MLD Creation        | C                    | 2                    | Uncleared CID making                                      |
| 6  | F               | Price Offering      | D                    | 7                    | Uncertain Price                                            |
| 7  | G               | Offering Letter     | F                    | 4                    | Inflexible Hierarchy                                      |
| 8  | H               | On-Site Survey      | E, G                 | 7                    | Unsuitable Survey results and reality                      |
|    |                 |                     |                      |                      | Hard to follow the Multiple Order and the SM (supplier management) process is complex |
| 9  | I               | Capacity Booking    | H                    | 3                    |                                                              |
| 10 | J               | Equipment Booking   | H                    | 3                    | Unclear procedure and PIC                                  |
| 11 | K               | MLD Revision        | I, J                 | 3                    | Incomplete catalyst Data                                   |
| 12 | L               | Price Revision      | J, K                 | 2                    | Uncertain price                                            |
| 13 | M               | Initiate Procurement| J, L                 | 3                    | Changeable BAU policy                                      |
| 14 | N               | Project Charter     | K, M                 | 2                    | Limited monitoring license                                 |
| 15 | O               | Installation: Excavation | N            | 25                   | Authority License and community issue                      |
| 16 | P               | Installation: Pull and Connect | O        | 12                   | Authority License and community issue                      |
| 17 | Q               | Test and integration| O, P                 | 2                    | Limited monitoring license                                 |

The table above shows the process of a series of activities in a fiber optic installation project in PT XYZ's Pre-Sales division, which will be the basis for processing data to answer the research objectives. Next step, we made the working network as below.
Based on the results of POM-QM data processing for the network diagram above, it can be seen that the activities included in the critical path are the activities of A-B-C-D-F-G-H-I-J-K-L-P-Q. Processing the following numbers is data from the company and the results of processing from POM-QM for windows. Here are the results.

Table 3. Data of Processing Results from POM-QM

| No | Activity | Activity Time (days) | Early Start | Early Finish | Late Start | Late Finish | Slack |
|----|----------|----------------------|-------------|--------------|------------|-------------|-------|
| 1  | A        | 3                    | 0           | 3            | 3          | 0           |       |
| 2  | B        | 3                    | 3           | 6            | 3          | 6           | 0     |
| 3  | C        | 3                    | 6           | 9            | 6          | 9           | 0     |
| 4  | D        | 2                    | 9           | 11           | 9          | 11          | 0     |
| 5  | E        | 2                    | 9           | 11           | 20         | 22          | 11    |
| 6  | F        | 7                    | 11          | 18           | 11         | 18          | 0     |
| 7  | G        | 4                    | 18          | 22           | 18         | 22          | 0     |
| 8  | H        | 7                    | 22          | 29           | 22         | 29          | 0     |
| 9  | I        | 3                    | 29          | 32           | 29         | 32          | 0     |
| 10 | J        | 3                    | 29          | 32           | 29         | 32          | 0     |
| 11 | K        | 3                    | 32          | 35           | 32         | 35          | 0     |
| 12 | L        | 2                    | 35          | 37           | 35         | 37          | 0     |
| 13 | M        | 3                    | 37          | 40           | 37         | 40          | 0     |
| 14 | N        | 2                    | 40          | 42           | 40         | 42          | 0     |
| 15 | O        | 25                   | 42          | 67           | 42         | 67          | 0     |
| 16 | P        | 12                   | 67          | 79           | 67         | 79          | 0     |
| 17 | Q        | 2                    | 79          | 81           | 79         | 81          | 0     |

Based on the results above, it can be seen that the project time can be completed within 81 days which means it is 73 days faster than the project completion time before using the CPM method which is 154 days. It can be seen that the activities of A-B-C-D-F-G-H-I-J-K-L-M-N-O-P-Q are included in critical trajectory activities.
3.3. Crashing Project
The author uses the Crashing Project method to crash the completion of the project using the inverse assumption between time and cost. Accelerated activities are activities that are included in the critical path.

The acceleration in this study was done by adding hours of overtime to workers for 1 hour/day considering the completion of work time after overtime at 6:00 p.m. where lighting is not necessary and optimal worker productivity. According to the Decree of the Minister of Manpower and Transmigration of the Republic of Indonesia Number KEP. 102 / MEN / VI / 2004 article 11 [12] the wage of workers' wages for working hours overtime the first hour is equal to 1.5 (one and a half) times the company's one-hour wages. The following are the results of calculations and acceleration of the Pre-Sales division tables of Fiber Optic installation PT XYZ.

| Activity | Total manpower | Normal time (days) | Crash time (days) | Normal cost (Rp) | Crash cost (Rp) | Crash cost/pd (Rp) | Crash by | Crashing cost (Rp) |
|----------|----------------|--------------------|-------------------|------------------|----------------|------------------|----------|-------------------|
| A        | 1              | 3                  | 3                 | 681.825          | 681.825        | -                | -        | -                 |
| B        | 1              | 3                  | 3                 | 681.825          | 681.825        | -                | -        | -                 |
| C        | 2              | 3                  | 3                 | 1.363.650        | 1.363.650      | -                | -        | -                 |
| D        | 3              | 2                  | 2                 | 1.363.650        | 1.363.650      | -                | -        | -                 |
| E        | 1              | 2                  | 2                 | 454.550          | 454.550        | -                | -        | -                 |
| F        | 1              | 7                  | 7                 | 1.590.925        | 1.590.925      | -                | -        | -                 |
| G        | 1              | 4                  | 4                 | 909.100          | 909.100        | -                | -        | -                 |
| H        | 3              | 7                  | 7                 | 4.772.775        | 4.772.775      | -                | -        | -                 |
| I        | 2              | 3                  | 3                 | 1.363.650        | 1.363.650      | -                | -        | -                 |
| J        | 3              | 3                  | 3                 | 2.045.475        | 2.045.475      | -                | -        | -                 |
| K        | 1              | 3                  | 3                 | 681.825          | 681.825        | -                | -        | -                 |
| L        | 2              | 2                  | 2                 | 909.100          | 909.100        | -                | -        | -                 |
| M        | 3              | 3                  | 3                 | 2.045.475        | 2.045.475      | -                | -        | -                 |
| N        | 2              | 2                  | 2                 | 909.100          | 909.100        | -                | -        | -                 |
| O        | 75             | 25                 | 23                | 426.140.625      | 465.560.250    | 19.709.820       | 2        | 39.419.650        |
| P        | 23             | 12                 | 11                | 62.727.900       | 68.282.170     | 5.554.268        | 1        | 5.554.268         |
| Q        | 5              | 2                  | 2                 | 2.272.750        | 2.272.750      | -                | -        | -                 |
| TOTAL    | 81             | 78                 |                   | 510.914.200      | 555.888.105    |                   |          |                   |

Based on the results of data processing in the table above, accelerated activities are activities that are on the critical path A-B-C-D-F-G-H-I-J-K-L-M-N-O-P-Q but for activities that can be accelerated can be adjusted to the needs in the field. Based on the results of the interviews obtained not all activities can be accelerated, this is because there are work activities that are not able to be accelerated and related to formal policies or rules that apply and are absolute in PT XYZ. In this study, the activities that can be accelerated on the critical path are O and P.

| Activity | Total time acceleration (Days) | Costs Addition (Rp) | Cost Slope (Rp) |
|----------|--------------------------------|---------------------|-----------------|
| O        | 2                              | Rp. 39.419.650      | Rp. 19.709.820 |
| P        | 1                              | Rp. 5.554.270       | Rp. 5.554.270  |
| TOTAL    | 3                              | Rp. 44.973.920      | Rp. 25.264.090 |
Project time after acceleration is normal time - acceleration time is 81 days - 3 days = 78 days with additional costs of Rp. 39,419,650 for O's activities and Rp. 5,554,270 for P's activities so that the total additional cost after acceleration for a maximum of 3 days is Rp. 44,973,920.

4. Conclusion
Based on the results of the analysis and management of data obtained by using the Cause and Effect method, there are 4 factors that cause delays in Fiber Optic installation projects in the Pre-Sales division with the largest percentage of the causes of project delays is the System, where 80% is caused due to unclear operational standards in the distribution of work activities. By using the CPM method, the project can be completed for 81 days, taking into account the activities included in the critical path, namely the activities of A-B-C-D-F-G-H-I-J-K-L-M-P-Q. Finally, by using the crashing project method, the project can do a maximum acceleration for three days by adding hours of work (overtime) 1 hour per day, so that the project can be completed in 78 days with consideration of additional costs. The limitation of the budget data in this research is the total amount of the project budget, so the estimated amount of the budget in our study can be more or less than the actual expenditure. The resource person used to explore the root of the problem is still limited to the head in charge of the division, and the project manager. With consideration of future research, we expect that cost calculation to be more specific so that calculations can be more accurate. The data used to explore the root of causes can be explored more closely to the scope of staff and project workers.

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