Implementation of Project Management to Develop the AHA.002 Project with PERT Method, Gantt Chart and QM for Windows V5 Software at PT. Matahari Megah

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Abstract
In implementing a project, the company requires optimal activity planning for the successful completion of the project on time. Therefore, controlling project time is needed by the company to run smoothly in managing the planning and implementation of operational activities starting from the flow of information, production data, supply chain, or information on goods within the company. The implementation of the AHA.002 project (Multi Nut Runner Fly Wheel MC for AE 1 Machine) also requires activity schedule by utilizing the Project Evaluation and Review Technique (PERT) method is an analysis designed to assist in scheduling and estimating the duration of project activities where the completion time of each activity is probabilistic, namely the most optimistic time, the most likely time, and the most pessimistic time with using precedence diagrams network and QM for Windows V5 software. The duration needed to complete the AHA.002 project (Multi Nut Runner Fly Wheel MC for AE 1 Machine) with the PERT method is 49.5 weeks.

Keywords: Project Management, Project Evaluation and Review Technique (PERT), Critical Path Method (CPM), QM for Windows V5 software.

1. Introduction
PT. Matahari Megah is a company that has an engineer to order for the production system. The company will receive product orders by new customized machine projects from customers. Therefore, company representatives from the marketing team and engineering team will first hold a meeting with customers to discuss the products to be produced in terms of product design, product functions, supporting component descriptions, and price quotes according to specifications and time of completion of requests from customers.

During the meeting, PT. Matahari Megah will provide a "design and development request" form that explains the custom product description and specifications, as well as a product price. There is an agreement between the company and the customer. The engineering team will design the required products and components in the form of a drawing.

After the final design from the engineering team, the PPIC division will then analyze what material requirements are needed, which will be purchased, and standard components that are still in stock from the previous project in the warehouse. The PPIC division will be listing the requirements for raw materials, some standard materials or components, and component arrival time management from the suppliers.

In project implementation, many important things influence the success and smoothness of it, one of which is planning the timing of the right and efficient work. The PPIC division and project managers also calculate the estimated production scheduling time to complete a project from receiving Purchase Order activities to sending products to customers. In this research, the writer will explain the application of the PERT method and QM for windows V5 software to determine the project completion time. Activity scheduling needs to be considered in project management to determine the duration and sequence of project activities so that realistic scheduling is formed using a definite duration estimate.
1.1 Objectives

This study aims to analyze and control the schedule of the AHA.002 project (Multi Nut Runner Fly Wheel MC for AE 1 Machine) uses the time data for each activity to determine the estimated project completion if the calculation is by project management science using the PERT (Program Evaluation and Review Technique) method and QM for windows V5 software. The PERT method used to determine how long the duration of a project activity can be complete with the completion time of each activity is probabilistic, namely the most optimistic time, the most likely time, and the most pessimistic time using activity-on-node network diagrams, as well as knowing the existence of activities in the critical path.

So, the AHA 002 Project (Multi Nut Runner Fly Wheel MC for AE 1 Machine) is one of the projects that must be complete promptly. Therefore, from the PERT methods in handling the project completion time, the project can run on time and get the customer's satisfaction.

2. Literature Review

2.1. Project Management

Project management is the process of planning, leading, organizing, and controlling every activity and resource consisting of people and materials to achieve predetermined organizational goals, namely the scope of quality, work schedules, and production costs (Soeharto, 1999) [1]. According to Knutson and Bitz (1991), project management is a set of principles, methods, tools, and techniques for the effective management of goal-oriented work in the context of a specific and unique organizational environment [2]. The objective of project management (Soeharto, 1999) is to carry out each project effectively and efficiently so that the company can produce optimum results by predetermined requirements and provide maximum service to all customers.

The following are some of the project management functions, including (Dimyati dan Nurjaman, 2014) [3]:

1. Planning function.
   Project planning aims at making decisions that manage selected data and information, such as preparing long-term and short-term activity plans, the length of time needed.

2. Organizing function.
   The organizing function aims to unite several activities that can be interconnected and interact with the environment to achieve project goals and organizational goals, such as compiling the scope of activities, the order of activity scheduling.

3. Actuating function.
   The actuating function aims to align the resources involved in carrying out the activity or project so that task direction and motivation are needed to produce optimal results.

4. Controlling function.
   The control function aims to measure the quality of project implementation and evaluate activities to get suggestions for improvement.

2.2. Work Breakdown Structure

Work breakdown structure (WBS) is a grouping of a list of activities or work elements of a project shown in graphical form to organize the overall project scope. According to (Satzinger, et al., 2012), there are two general approaches in WBS, namely the first approach based on project objectives by identifying each activity needed to achieve project objectives. The second approach is based on the project timeline so that each task is carried out following the timeline sequence to reach the final goal of the project [4].

2.3. PERT (Program Evaluation and Review Technique)

The project can usually be defined as a series of related tasks directed toward a major output [5]. The characteristic of a project has specific goals with clear deadlines, is applied at a good time that displays the activities and works time in the entire project series. Therefore, it requires good planning, work scheduling, and project management so that it can take advantage of the capabilities of the available resources.

In preparing the activity schedule, you can use network analysis which illustrates that there is a graph of the relationship between project work sequences, what work must precede or be preceded by other work about time. This network very useful in planning and controlling projects, especially in the engineer-to-order industry [6].

The complexity of project management requires the identification and mapping of a series of activities that must be carried out sequentially. This mapping can be arranged in the form of a network model. Program Evaluation and Review Technique (PERT) is a network model capable of mapping the completion time of activities into three times estimates, namely the most optimistic time, the most likely time, and the most pessimistic time [7].
a. The pessimistic time is the longest time that may be required in an activity.
b. The most likely time is the time to complete the project activities that are most likely or have the highest probability.
c. The optimistic time is the fastest time that can be completed to carry out a project activity.

After determining the three-time estimates, we can determine the expected activity time with the following formula:

\[
\text{expected time } \mu = \frac{a + 4m + b}{6} \]

Information:
- \( a \): the most optimistic time
- \( m \): the most likely time
- \( b \): the most pessimistic time
- \( \mu \): the expected time

Calculate the variation of the duration for each activity using the formula:

\[
\sigma^2 = \left( \frac{b - a}{6} \right)^2
\]

2.4. Critical Path Method

Critical Path Method (CPM) is a method by constructing a network that is identified to the direction of activities and using simple time estimates for each activity indicating the duration of the implementation. In the process of identification of the critical path, several terms are used, including:

Earliest Start Time (ES) is the earliest (fastest) time an activity can be started, taking into account the expected activity time and the requirements for the sequence of activities carried out. Latest Start Time (LS) is the slowest time to start an activity without delaying the whole project.

Earliest Finish Time (EF) is the earliest time an activity can be completed, or equal to ES + the expected activity time. Latest Finish Time (LF) is the slowest time to be able to complete an activity without delaying the completion of the project as a whole, or equal to the LS + expected activity time [8].

The term critical path aims to identify activities that have a high level of sensitivity to delays in implementation to determine the level of policy priority in project implementation. CPM can provide information related to activities carried out first or afterward, duration of activities, time to delay an activity without changing the overall project duration [9].

Slack time is obtained using the formula:

\[
S_{ij} = LS_{ij} - ES_{ij} \text{ or } S_{ij} = LF_{ij} - EF_{ij}
\]

Information:
- \( LS \): Latest start time
- \( ES \): Earliest start time
- \( LF \): Latest finish time
- \( EF \): Earliest finish time

The activities network on the CPM can be reflected as a basis for project scheduling in the form of a Gantt Chart to preparing work breakdown structures and developing relations between activities [10].

3. Methods

This research method uses quantitative methods with the data collection stage, namely field observation and literature study. This research was carried out in the AHA. 002 project. CPM and PERT methods have differences. The first difference is that CPM uses one type of time to estimate activity time, while PERT used three types of estimated time, namely the optimal, most likely, and the pessimist time. The second difference is that CPM uses the time estimation of each activity to be clear and known, whereas PERT is used when the estimated time for the activity is uncertain and the project has never been carried out or has a high time variation.
Therefore, the project under study is a new project based on customer demand and has never been produced by the company so that the completion of the project with data analysis techniques using PERT (Project Evaluation and Review Technique) and by using QM for Windows V5 program.

The following is the flowchart for the research method, which can be seen in Figure 1.

Figure 1. Flowchart of Research Method

4. Data Collection

4.1. List of Activities in the Project

PT, Matahari Megah will produce on the AHA 002 project, namely the manufacture of the Multi Nut Runner Fly Wheel MC for AE1 machine with customers of PT. HPM. The following activities are planned in the project.

a. PO received by PT. Matahari Megah with machine specifications from customers
b. Approve design from engineering team to customer.

c. Drawing preparation included mechanical design, electrical and program design, and also layout design.
d. Procurement material part list to buy such as raw material to used mechanical structured and fabrication, electrical components, pneumatic components, part standard, control components, and wiring component.
e. Manufacture with milling machine, drill machine, welding, or etc according to machine specifications.
f. Post treatment with electro platting and wet painting.
g. Assembly parts of mechanical, electrical, pneumatic and control standard components.
h. Programming and wiring diagram.
i. Trial all system and machine function in PT. Matahari Megah.
j. Customers visit to review progress pre-delivery inspection and trial machine or the customers have a little improvement request.
k. Delivery planning to customer company.
l. Installation, setting, and integration of the machine included layout positioning, power connection, trial, and adjustment machine.

4.2. Estimation Time and Activities that preceded in AHA. 002 Project

The following are the time estimation data for the optimistic, the most likely, and pessimistic time of the work for all activities in the project which can be seen in Table 1.

Table 1. Data Collection of Project Activities

<table>
<thead>
<tr>
<th>Activities</th>
<th>Activities that preceded</th>
<th>The most optimistic time (a) (weeks)</th>
<th>The most likely time (m) (weeks)</th>
<th>The most pessimistic time (b) (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (PO received)</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B (Approve design)</td>
<td>A</td>
<td>24</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>C (Mechanical design)</td>
<td>B</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>D (Electrical and program design)</td>
<td>B</td>
<td>7</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>E (Layout design)</td>
<td>C, D</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>F (Raw material, mechanical structure and fabrication)</td>
<td>B</td>
<td>11</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>G (Standard part)</td>
<td>B</td>
<td>12</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>H (Pneumatic and festo component)</td>
<td>B</td>
<td>11</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>I (Control component)</td>
<td>B</td>
<td>11</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>J (Etic system/NMS supply)</td>
<td>B</td>
<td>10</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>K (Electric and wiring component)</td>
<td>B</td>
<td>10</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>L (Mechanical part)</td>
<td>B</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>M (Electro platting)</td>
<td>B</td>
<td>6</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>N (Wet painting)</td>
<td>B</td>
<td>7</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>O (Assembly Mechanical)</td>
<td>M, N</td>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>P (Assembly electrical, control, pneumatic, standard)</td>
<td>M, N</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Q (Programming and wiring diagram)</td>
<td>M, N</td>
<td>4</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>R (Trial all system and function)</td>
<td>E, F, G, H, I, J, K, L, O, P, Q</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S (Review progress pre delivery inspection and trial)</td>
<td>E, F, G, H, I, J, K, L, O, P, Q</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
5. Results and Discussion
5.1 Work Breakdown Structure (WBS)
In doing management planning good projects need to start with doing identification of activities undertaken. The scope of activities that will be carried out in a project can be described in a Work Breakdown Structure (WBS) which can be seen in Figure 2.

![Figure 2. Work Breakdown Structure AHA.002 Project](image)

5.2. PERT Method
Results of data analysis with the PERT Method and uses three estimation time, namely a, b, m, $\mu$, and $\sigma^2$.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Activities that preceded</th>
<th>The most optimistic time (a) (weeks)</th>
<th>The most likely time (m) (weeks)</th>
<th>The most pessimistic time (b) (weeks)</th>
<th>The expected time $\mu$ (weeks)</th>
<th>$\sigma^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>(\frac{1}{36})</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>24</td>
<td>25</td>
<td>25</td>
<td>(\frac{149}{6})</td>
<td>(\frac{1}{36})</td>
</tr>
<tr>
<td>Activities</td>
<td>Activities that preceded</td>
<td>The most optimistic time (a) (weeks)</td>
<td>The most likely time (m) (weeks)</td>
<td>The most pessimistic time (b) (weeks)</td>
<td>The expected time $\mu$ (weeks)</td>
<td>$\sigma^2$</td>
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</tr>
<tr>
<td>C</td>
<td>B</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>$\frac{35}{6}$</td>
<td>$\frac{1}{36}$</td>
</tr>
<tr>
<td>D</td>
<td>B</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>$\frac{15}{2}$</td>
<td>$\frac{1}{4}$</td>
</tr>
<tr>
<td>E</td>
<td>C, D</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>$\frac{14}{3}$</td>
<td>$\frac{1}{9}$</td>
</tr>
<tr>
<td>F</td>
<td>B</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>$\frac{67}{6}$</td>
<td>$\frac{1}{36}$</td>
</tr>
<tr>
<td>G</td>
<td>B</td>
<td>12</td>
<td>12</td>
<td>14</td>
<td>$\frac{37}{3}$</td>
<td>$\frac{1}{9}$</td>
</tr>
<tr>
<td>H</td>
<td>B</td>
<td>11</td>
<td>15</td>
<td>15</td>
<td>$\frac{43}{3}$</td>
<td>$\frac{4}{9}$</td>
</tr>
<tr>
<td>I</td>
<td>B</td>
<td>11</td>
<td>11</td>
<td>15</td>
<td>$\frac{35}{3}$</td>
<td>$\frac{4}{9}$</td>
</tr>
<tr>
<td>J</td>
<td>B</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>$\frac{65}{6}$</td>
<td>$\frac{1}{36}$</td>
</tr>
<tr>
<td>K</td>
<td>B</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>$\frac{40}{3}$</td>
<td>$\frac{4}{9}$</td>
</tr>
<tr>
<td>L</td>
<td>B</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>M</td>
<td>B</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>$\frac{20}{3}$</td>
<td>$\frac{4}{9}$</td>
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<tr>
<td>N</td>
<td>B</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>$\frac{15}{2}$</td>
<td>$\frac{1}{4}$</td>
</tr>
<tr>
<td>O</td>
<td>M, N</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>$\frac{37}{6}$</td>
<td>$\frac{1}{36}$</td>
</tr>
<tr>
<td>P</td>
<td>M, N</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>$\frac{25}{6}$</td>
<td>$\frac{1}{36}$</td>
</tr>
<tr>
<td>Q</td>
<td>M, N</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>$\frac{49}{6}$</td>
<td>$\frac{25}{36}$</td>
</tr>
<tr>
<td>R</td>
<td>E, F, G, H, I, J, K, L, O, P, Q</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>S</td>
<td>E, F, G, H, I, J, K, L, O, P, Q</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>E, F, G, H, I, J, K, L, O, P, Q</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>U</td>
<td>R, S, T</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

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Activities | Activities that preceded | The most optimistic time (a) (weeks) | The most likely time (m) (weeks) | The most pessimistic time (b) (weeks) | The expected time $\mu$ (weeks) | $\sigma^2$
--- | --- | --- | --- | --- | --- | ---
V | U | 2 | 2 | 2 | 2 | 0
W | U | 1 | 1 | 1 | 1 | 0
X | V, W | 1 | 1 | 1 | 1 | 0

The network diagram uses the AON (Activity on Node) diagram has the earliest start time (ES), earliest finish time (EF), latest start time (LS), and latest finish time (LF), as well as the activity slack (S) to show the longest time activity can be postponed without affecting the completion time of the entire project.

Based on the table above, it will be spelled out in the form of a node plan with the number of activities listed in the table and connecting these nodes with arrows. On calculations using the PERT method and the AON diagram, the critical path in this project is in a series of A-B-N-Q-T-U-V-X activities with $\mu = 49.5$ weeks, which can be seen in Figure 3.

![Figure 3. AON Diagram of AHA.002 Project](image-url)
5.3 Graphical Results with QM for windows V5 Software

The results of the calculation with the PERT method using QM for Windows V5 shows as below.

The following is the Gantt chart of the final results of calculating the PERT method using the QM for Windows V5 software which can be seen in Figure 5.

Figure 4. The Results of QM for Windows V5 Software

Figure 5. Gantt Chart QM for Windows V5 Software
6. Conclusion

Based on data analysis and the discussion that has been done, the conclusions that can be drawn in this research is we know that completion projects using the PERT method have a completion time of 49.5 weeks with 24 activities to complete the overall project.

Reference


Biographies

**Aurellia Kharisty Tjusila** is a student in the Industrial Engineering Department at Universitas Tarumanagara since 2017. She actively joins two organizations and committees, namely UKM POUT (Persekutuan Oikoumene Universitas Tarumanagara) as a member and has served as a division coordinator of Kelompok Kecil for one year and also she has been an active participant in the committee on activities held by IMADUTA (Ikatan Mahasiswa Teknik Industri) since 2017. She received a scholarship as a Beswan Djarum Universitas Tarumanagara from Djarum Foundation-Djarum Beasiswa Plus in 2019 for one year. She has internship experience at PT. Matahari Megah and interested in industrial management science.

**Lina Gozali** is a lecturer in the Industrial Engineering Department at Universitas Trisakti since 1995 and a freelance lecturer at Universitas Trisakti since 1995. She got her Bachelor's degree at Trisakti University, Jakarta - Indonesia, then she graduated Master's Degree at STIE IBII, Jakarta – Indonesia, and graduated with her Ph.D. at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia in 2018. Her apprentice college experience was in paper at Kertas Bekasi Teguh, shoe at PT Jaya Harapan Barutama, automotive chain drive industry at Federal Superior Chain Manufacturing. She teaches Production System and Supply Chain Management Subjects and her Ph.D. research about Indonesian Business Incubator. She actively writes for almost 40 publications since 2008 in the Industrial Engineering research sector, such as Production Scheduling, Plant Layout, Maintenance, Line Balancing, Supply Chain Management, Production Planning, and Inventory Control. She had been worked at PT. Astra Otoparts Tbk as International Business Development Department for four years, Citibank, N.A as customer service for one year, PT. Pandrol as assistant marketing manager for one year, PT. Texmaco as a merchandiser for three years.

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