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Project Performance Analysis in Hydrant and Plumbing. Case Study: Biopharmaceutical Manufacturing Facility

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ABSTRACT: PT. Karya Sejuk Mandiri is a general contractor company primarily engaged in Mechanical, Electrical, and Plumbing (MEP) which is currently working on Plumbing and Hydrant work with a work value of Rp586,000,000 with an estimated completion time of 7 months.
From the budget aspect data, this project is projected to experience a cost overrun of Rp82,099,035 and an additional 23 weeks of working time. This condition can get worse if PT. Karya Sejuk Mandiri did not take corrective action for the losses incurred.
The study begins by analyzing the level of work performance as an initial reference that the job is in trouble. Using the Current Reality Tree (CRT), this study finds two root causes of problems that cause work to experience cost overruns and delays. Three alternative options are given for each root cause of the problem and then selected using the Analytical Hierarchy Process (AHP) to get the best course of action.
This research concludes by providing two corrective actions and also a plan for their implementation during the work. Thus, it is hoped that there will be an increase in the level of performance so that the project can be completed properly.

KEYWORDS: Analytical Hierarchy Process, Cost Overruns, Current Reality Tree, Project Delays, Work Performance.

I. INTRODUCTION

Banten province is one of the provinces that has the highest contribution to Indonesia's GDP. In 2020, it contributed 4.05% to Indonesia's GDP or equivalent to 626 trillion Rupiah, with the biggest component being the industry sector with 31% contribution (Kontan, 2021). The province is arguably one of the most advanced areas for Industry activities, to the point that it is selected by the Ministry of Industry to become an exemplary model for Industrial Estate areas outside of the Java Island. One of the largest Industrial Estates in the province is Modern Cikande Industrial Estate (MCIE). The Industrial Estate occupies an area of 3,175 hectares and houses more than 207 companies across a wide variety of industries from chemical manufacturers to shoe components including Jakarta Biopharmaceutical Industry (JBio), a vaccine manufacturing and biopharmaceutical company which started its construction in 2020. As of July 2022, the construction of the JBio building is currently in progress. It's located in a 14,850 square meters site, and the amount of investment into the project will take up approximately 500 billion rupiah. This project will be conducted by several selected contractors in each area such as architectural, structural, civil, mechanical, electrical, and plumbing. PT. KIK will be working as main contractor and appointing PT. Karya Sejuk Mandiri as the subcontractor for plumbing and hydrant installation. The said installation will take place from March 2022 in a period span of 6 months with a project value of 586 million rupiah.

Considering that the project life cycle is required to be flexible to changes in the project (PMBOK, 2017), the company must be able to create a proper corrective action immediately. This study will explore the monitoring and controlling process in the manufacturing facility of biopharmaceutical product plumbing and hydrant projects. Up to 12nd week of the project, several internal and external obstacles occurred, which caused the company to suffer delays and losses. In order to find out the causes, a performance report needs to be obtained by analyzing the cost baseline, schedule baseline, actual cost, and actual progress. In addition, this study also provides alternative corrective actions, which will be implemented directly to minimize the gap between the base plan and actual progress. By exploring the controlling and monitoring process, stakeholders will know the current project conditions and be able to prepare and create corrective actions. One method for controlling the project is the Earned Value Management (EVM) method, which measures financial and scheduling performance. The analysis is in the form of a comparison between Plan Value (PV), Earned Value (EV), and Actual Cost (AC) to obtain the Schedule Performance Index (SPI) and Cost Performance Index (CPI). Then forecasting needs to be done to get Estimate to Completion (EAC), Estimate to Complete (ETC), Variance at Completion (VAC), and To-complete Performance Index (TCPI).

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The application of the EVM method has difficulties in data collection because analyzing it requires complex data such as Scope Statement, Schedule Management Plan, PV, EV, AC, and Work Breakdown Structure (WBS). In addition, data processing requires data accuracy following the conditions in the field so that the results obtained can be valid as a measurement indicator. However, the EVM method is not difficult to do in the calculation process. Because EVM provides plan value, actual cost, and earned value in a curve, it would be beneficial to track project problems in the first place. Especially in large-scale projects with high complexity and long project work times, such as the Plumbing and Hydrant installation projects at the Manufacturing Facility of Biopharmaceutical Product. According to (Wenjing Xu, 2021), since EVM also aims to save cost, it makes EVM very useful to improve the project's current value and even maximize the target profit by conducting a comprehensive improvement. Therefore, using the EVM method can assist PT. Karya Sejuk Mandiri in taking corrective actions to minimize the possibility of delays or cost overruns on the project.

II. LITERATURE REVIEW

A. Project

A project is a temporary endeavor undertaken to create a product or service with a unique outcome. Projects are temporary because a job has a working period's beginning and end. A project has ended when the objectives have been completed or the project has been terminated because the objectives were not or could not be achieved. The results of a project are unique because the technical and implementation in completing the project will be different even though it is carried out on projects of the same type (PMBOK, 2017).

B. Plumbing and Hydrant

In a multi-story building, or the object of this research is a manufacturing facility of biopharmaceutical product, several systems are helpful to meet the needs of supporting activities that run every time. The system is divided into three parts: mechanical, electrical, plumbing, and hydrant. Plumbing and hydrant are everything related to installing pipes in a building, including rainwater, wastewater, and drinking water pipes connected to a system (BSN, 2015). Kamble, et al. (2015) defines Plumbing as a system of pipes, drain fittings, valves, valve assemblies, and other devices installed in a building for the distribution of water, and the skilled trade of working with pipes, tubing, and other fixtures in such system. At the same time, the plumbing and hydrant system is a piping network that includes the provision of clean water, handling of dirty water, distribution, and drainage, including all connections and equipment installed in a building. For the plumbing and hydrant system at the Manufacturing Facility of Biopharmaceutical Product, the design of the clean water flow uses a tank system on the roof or referred to as a roof tank. In the roof tank system, the incoming water is pumped into the tank on the 3rd floor using a pump machine. According to the Collins Dictionary, a fire hydrant is a pipe in a street or building that is used to provide water to put out fires. Fire hydrants with connection to a water service network must be installed in all buildings and location, public or private as the backbone of the firefighting measures.

C. Project Management

Project management is the application, knowledge, skills, tools, and techniques used in project activities to meet the project's requirements (PMBOK, 2017). Project management is carried out by implementing and integrating the management processes identified in the project. Project management can include:

1. Respond to various needs, problems, and expectations from stakeholders.
2. Build and maintain good relationships with stakeholders.
3. Manage resources, both material and labor; and

Circumstances in a project will affect the project management process and the selection of problem boundaries that need to be prioritized.

D. Earned Value Management

In assessing the performance and progress of the project, a method is needed to integrate the scope with costs and scheduling called Earned Value Management (EVM) so that performance measurement is obtained. EVM compares the work measurement basis with actual schedules and costs so that project management can assess the level of performance and progress of projects that are currently in the implementation phase (PMBOK, 2017). This allows project managers to know the estimated time and cost of completing projects in the future to make the right decisions to avoid delays and cost overruns on the project.

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Work Breakdown Structure (WBS) is a hierarchical decomposition of the total scope of work that organizes and defines the work to be carried out by the project team to achieve project goals to create final results that are in accordance with project deliverables and WBS Dictionary is a supporting document for the WBS that describes detailed information about the final project results, activities, and schedules contained in the WBS (PMBOK, 2017). In EVM, three components are used to review project performance, namely:

1. Planned Value (PV); a fundamental value that has been set as a reference for doing work per period as planned. PV is a valid budget that is budgeted for work to be completed within the Work Breakdown Structure (WBS) component (PMBOK, 2017).
2. Earned Value (EV); a value of work completed per period based on the work's progress against the plan's value reported in the form of a budget (PMBOK, 2017). EV value reporting is done cumulatively in a certain period to calculate the percentage of work progress in a project to determine long-term performance trend. The EV formula, according to the Project Management Body of Knowledge 2017, is:

   Earned Value = % of work progress x planning value

3. Actual Cost (AC); a cost that has been incurred to complete work that has been done over a certain period of time (PMBOK, 2017). AC value is then reported cumulatively in a certain period to be able to monitor all costs that have been incurred.

The S curve is a chart showing the movement of three parameters in Earned Value Analysis, namely PV, EV, and AC, which can be monitored and reported cumulatively (PMBOK, 2017). The purpose of providing S curve is to measure the utilization of the financial outlays and status of a construction project. By analyzing the S-Curve, project managers can quickly identify project growth, slippage, and potential issues that may impact the outcome of the project. (Willmer Limited, 2014).

E. Project Performance Analysis

Project performance analysis attempts to compare the basis for measuring work with actual costs and schedules to analyze the project status in a certain period (PMBOK, 2017). In addition, management can find out the forecast about the project's completion and the total cost spent until the project is completed by analyzing project performance. Project performance is crucial to be implemented in any projects, as it is detrimental to the project's success (Sandayanake, 2010).

In analyzing project performance, several components are needed, divided into two types: performance variance and performance index. There is a Cost Variance (CV) and a Schedule Variance (SV) in the performance variance. At the same time, the performance index contains a Cost Performance Index (CPI) and a Schedule Performance Index (SPI).

1. Cost Variance (CV) is the amount of deficit or surplus in the project budget at a certain point in time which is used as a measure of cost performance on a project. CV is obtained from the reduction between Earned Value (EV) and Actual Cost (AC).
   CV= EV – AC (II.1)
2. Schedule Variance (SV) measures schedule performance expressed from the difference between Earned Value and Planned Value. The result of the SV is an indicator of the project's scheduling status. SV is obtained from the result of subtraction between EV and PV.
   SV= EV – PV (II.2)
3. Cost Performance Index (CPI) is a measure of cost efficiency which represents the comparison between Earned Value and Actual Cost. CPI measures the level of cost efficiency for the work that has been completed at a certain point in time. The CPI results are obtained from the quotient between EV and AC.
   CPI= EV/AC (II.3)
4. Schedule Performance Index (SPI) is a measure of the effectiveness of the schedule expressed as a comparison between Earned Value and Planned Value. SPI measures the level of effectiveness of the project team in completing the work per period. The SPI results are obtained from the quotient between EV and PV.
   SPI= EV/PV (II.4)

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F. Forecast

After conducting a work performance analysis, project management can perform forecasting to estimate the time and cost when the project is completed. Forecasting is needed to determine what steps must be prepared to achieve the project objectives specified at the initiation stage. Forecasts are created, updated, and published based on work performance data as the project is executed. The data includes previous project performance and information that may affect future projects (PMBOK, 2017). Forecasting in a project management can be used to obtain early warnings against potential problems by comparing predictions and project's objectives. Thus, project managers rely on making reliable forecasts in a timely manner for an effective project control (Kim, 2007). Forecasting methods used are Time Estimate, Estimate to Completion (EAC), Estimate to Complete (ETC), Variance at Completion (VAC), and To-complete Performance Index (TCPI).

1. Schedule Forecast
   Schedule Forecast is the estimated time the project will be completed by looking at the schedule performance index on the work that has been done (PMBOK, 2017). The calculation of the estimated time is the quotient between the number of the initial schedule and the SPI value. The formula obtains the results of the schedule forecast:
   Schedule Forecast = (Initial Schedule)/SPI (II.5)
2. Estimate to Completion (EAC)
   EAC is the total expected cost to complete all the work obtained from the sum of the actual costs and the estimated costs to be completed (PMBOK, 2017). The EAC results are obtained by the following formulas:
   - EAC = AC + BAC – EV (II.6)
     This formula accepts the actual project performance (whether favorable or unfavorable) as represented by actual costs and on the condition that all future ETC work will be completed at the budgeted rate (PMBOK, 2017).
   - EAC = BAC/CPI (II.7)
     This method assumes that what the remaining project has experienced can be expected to continue in the future (PMBOK, 2017).
   - EAC = AC + (BAC-EV)/(CPI x SPI) (II.8)
     This formula is used when CPI and SPI affect the remaining work. The calculation will represent the level of efficiency that considers the cost index and performance schedule. This method is most useful when the project schedule influences ETC efforts (PMBOK, 2017).
   - EAC = AC + Bottom-up ETC (II.9)
     This formula represents the condition when the remaining work that has not been done is recalculated. To find out the EAC value, the actual costs that have been spent on the work that has been done are added up with the re-estimated cost of the work that has not been done. With the need for a re-calculation of the work that has not been done, in this research, no calculations were carried out using this formula due to limited time and available data.
3. Estimate to Complete (ETC)
   ETC is the expected cost to complete all remaining project work. Assuming the work goes according to plan, the cost to complete the remaining work can be calculated using:
   ETC= EAC – AC (II.10)
4. Variance at Completion (VAC)
   VAC is a projection of the total budget deficit or surplus obtained from the difference between the budget at the time of completion and the estimated time of completion (PMBOK, 2017). VAC can be calculated using:
   VAC= BAC – EAC (II.11)
5. To-complete Performance Index (TCPI)
   TCPI is a measure of performance that must be achieved to meet the goals that have been set using the remaining resources (PMBOK, 2017). The result of TCPI is the quotient between the cost to complete the work with the available budget or can use the following formula:
   TCPI= ((BAC-EV))/((EAC-AC)) (II.12)

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G. Root Cause Analysis

Root cause analysis (RCA) is a process designed to investigate and categorize the root cause of a problem that affects safety, health, environment, quality, reliability, and production. In simple terms, RCA is a tool designed to help identify not only what and how an event occurred. Moreover, RCA is useful for knowing why it happened. Understanding the root cause of an event is the key to developing practical recommendations. (Branislav, 2011).

In this research, two techniques are used to carry out root cause analysis of problems, namely:

1. Brainstorming/Interviewing
   Brainstorming technique is a creative idea generation as well as a problem-solving technique. It provides free environment for the participants to present individual ideas without attracting criticism to anyone. Every generated idea is recorded and regarded as a solution to the problem discussed (Kumbhar, 2018). This technique is the most commonly used technique to determine the cause of the problem by collecting as many opinions as possible from project participants (Vorley, 2008).
2. Current Reality Tree (CRT)
   CRT is is a visual root cause analysis approach in the form of a graphical statement used within the Theory of Constraints, identifying root causes that are common to some or most problems under study. A CRT maps out a sequence of cause and effect from the core problem to the symptoms (MBA Brief, 2022). According to research conducted by Sirias, Current Reality Tree (CRT) helps to determine the root cause of problems. The CRT is a method for identifying a system's main issue. It begins with a collection of issues and/or symptoms that have been noticed in the system under study. These are also known as undesired effects (UDEs). Then, cause and effect connections are used to link these UDEs. The goal is to build a logical tree with a common cause connecting all UDEs. From the symptoms to the main issue, a chain of causes and effects is illustrated in a tree. Most symptoms have a single, fundamental issue or conflict at their root. Working backward from the undesirable effects or symptoms frequently reveals the fundamental problem. (Sirias, 1997).

III. METHODOLOGY

A. Identification Phase

The identification stage is the initial stage carried out in research that will determine the description, problems, and objectives of the study to be carried out. This stage consists of:

1. Field Research
   Field studies were carried out by direct observation of the project site. In addition, a series of interviews were conducted with the project supervisor and project leader for plumbing and hydrant work related to the existing project conditions.
2. Problem Identification
   Problem identification is carried out after knowing the existing project conditions during the field research. This stage is carried out to determine the formulation of the problem and the purpose of the study. The problem identification process is carried out by looking at the data provided by the project supervisor and project leader through interviews.
3. Literature Research
   The literature research stage is done by looking at books, journals, and previous research. This stage helps find references on science relevant to the research that is used as a reference in solving problems.
4. Problem Formulation
   This section is obtained after knowing the problems that exist in the project then the problem is studied based on the existing literature research. The problem formulation helps explain the main issues in the plumbing and hydrant installation project at the Manufacturing Facility of Biopharmaceutical Product so that research objectives can be found.
5. Research Objective
   The research aims to answer the problem formulation from the study of Work Performance Analysis in the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Installation Project, which will later be used as a solution to these problems.

B. Data Collection Phase

At this stage, information is collected supporting the success of research regarding Work Performance Analysis in the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Installation Project. Data collection is carried out

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by looking directly at the project area and conducting interviews with project supervisors and project leaders regarding scope statements, schedule management plans, plan values, earned values, and actual costs.

C. Data Analysis Phase

The data analysis phase is carried out after the data has been collected based on observations in the field. The data obtained, such as scope statement, schedule management plan, plan value, earned value, and actual cost, are then followed up using the EVM method to obtain Schedule Variance (SV), Cost Variance (CV), Schedule Performance Index (SPI), and Cost Performance Index (CPI). After getting the SV, CV, SPI, and CPI, then proceed with the calculation of Estimate Duration, Estimate to Completion (EAC), Estimate to Complete (ETC), Variance at Completion (VAC), and To-complete Performance Index (TCPI). During the data analysis phase, an explanation of the data obtained is carried out until the calculation results are obtained. The data analysis phase aims to provide detailed information about the data obtained from the collection phase and the data obtained from the processing phase to answer the objectives and formulation of research problems regarding Work Performance Analysis in the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Installation Project. The data were analyzed based on how it was obtained, the processing process, and the results obtained to provide detailed and precise information regarding the data and the results obtained.

D. Root Cause and Business Solution Analysis Phase

At this stage, the research is continued by finding the root cause of the problems shown from the results of the Work Performance Analysis in the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Installation Project. Root cause analysis is carried out using the Current Reality Tree (CRT) method and each root cause will be given a business solution so that it is hoped that problems can be solved both in existing and future projects.

E. Implementation Plan Phase

In the Implementation plan phase, planning for the implementation of business solutions that have been obtained in the root cause and business solution analysis phase is carried out. Planning is displayed through the Gantt Chart in units of weeks which will be input for the company to deal with problems that are happening.

F. Conclusion Phase

The conclusion phase is carried out after all stages of the research have been completed and the results of each analysis are obtained. The conclusion of this research is the performance assessment results following the indicators in the EVM method in terms of cost performance and schedule performance. In addition, this research also provides solutions to the causes of existing problems. Suggestions are addressed to stakeholders in the project so they can utilize it as a lesson learned to develop existing or further projects.

IV. RESEARCH FINDINGS

Data collection is carried out directly from project leader, operational manager, and director of PT. Karya Sejuk Mandiri. The data collection obtained several documents regarding Scope Baseline, Plan Value, Earned Value, and Actual Cost. Data collection was carried out based on research at PT. Karya Sejuk Mandiri, in this research, discusses the work on the Manufacturing Facility of Biopharmaceutical Product development project. The project was carried out PT. KIK as the main contractor, which then determined PT. Karya Sejuk Mandiri as a Plumbing and Hydrant sub-contractor. PT. Karya Sejuk Mandiri, as the MEP sub-contractor in the Plumbing and Hydrant section, is responsible for installing clean water pipes, dirty water, and air vents for each room in the Manufacturing Facility of Biopharmaceutical Product. The slow material procurement and high turnover rate cause Plumbing and Hydrant sub-contractors to often experience work delays. Therefore, this project requires a performance analysis so that work can be well controlled and monitored.

The indicators used in this research are analysis of variance and performance index in the scope of costs and schedules, then forecasting and analysis of the causes of under/over budget and early/late finish on the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant installation project. The result of this research is corrective action which serves as input for real implications to minimize the actual and planning gaps.

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A. Scope Statement

The Scope Statement will discuss project scope, project deliverables, success criteria, and project limitations. The following Scope Statement on the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant installation project is presented in Table IV.1 Scope Statement.

Table IV.1 Scope Statement

Project Scope The project was carried out to install a pipe system for clean water, dirty water, recycled water, rainwater, and hydrants used to meet all the plumbing and hydrant system needs at the Manufacturing Facility of Biopharmaceutical Product. The contractor for this plumbing and hydrant project is PT. KIK, which then appointed PT. Karya Sejuk Mandiri as a subcontractor refers to the work contract under PT. KIK. The work system is carried out using a Lump Sum contract with the technical specifications contained in the contract, including shop drawing, technical payments, and worker qualification requirements).
Project Deliverables Creating a plumbing and hydrant system in accordance with a shop drawing that can pass the commissioning test stage by the owner. Until the handover of work by PT. KIK is at the closing stage. In addition, additional work is also calculated if there is work carried out outside the contract.
Success Criteria The success of the project is measured by the costs incurred not exceeding what was done, the processing time not exceeding the initial schedule, and being able to produce a plumbing system that is in accordance with shop drawing, passing the commissioning test by the owner, and handing over the work by PT. KIK.
Project Limitations The contractor must complete the project in accordance with what is stated in the contract. If there is a design change, it must be recalculated to determine the added and less work, which will be approved by the Project Manager of PT. KIK. In addition, if there is a change in the work plan, hire or fire workers, to the work progress calculation, it is entirely carried out with the permission of the Project Manager PT. KIK through their supervisor.

B. Plan Value

Plan Value in this study is the weekly data provided by PT. Karya Sejuk Mandiri, which is presented as follows:

Table IV.2 Plan Value

Week	Weekly PV	Cumulative PV
1	Rp 16,143,763	Rp 16,143,763
2	Rp 14,459,600	Rp 30,603,363
3	Rp 6,559,250	Rp 37,162,613
…	…	…
28	Rp 6,583,988	Rp 586,000,000

C. Earned Value

Earned Value describes the calculation of the overall EV data for each week:

Table IV.3 Earned Value

Week	*% of Work*	Weekly EV	Cumulative EV
1	2,81%	Rp 15.303.345	Rp 15.303.345
2	2,41%	Rp 13.110.518	Rp 28.413.863
3	0,73%	Rp 3.969.350	Rp 32.383.213
…	…	…	…
12	1,20%	Rp 6.525.323	Rp 91.492.545

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On the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant installation project, EV is obtained from the start of the project to EV at week 12. After being compared with PV, there are several differences in the realization of work in the field. For example, week-1 data analysis which will be explained in detail as follows:

Week-1

Table IV.4 Earned Value Analysis (1st week)

No.	Element	Plan	Realization
1	Preliminary	Rp8.250.000	Rp10.725.000
2.1.3	(Clean Water System) Plumbing Installation Work	Rp1,684,163	Rp673,665
2.3.2	(Dirty Water System) Plumbing Installation Work	Rp894,600	Rp715,680
2.4	Rain Water System	Rp5,315,000	Rp3,189,000

From Table IV.4 it can be shown the earned value analysis of the work breakdown structure for each element. In the 1st week, PT. Karya Sejuk Mandiri was able to get a progress value of Rp16,143,763. However, the realization is worth Rp15,503,345 which lead to a negative deviation and it can be seen in the 1st week the project experienced a delay of Rp840,418.

D. Actual Cost

Table IV.5 Actual Cost

Week	Weekly AC	Cumulative AC
1	Rp 24,655,000	Rp 24,655,000
2	Rp 5,506,875	Rp 30,161,875
3	Rp 500,000	Rp 30,661,875
…	…	…
12	Rp 15,518,750	Rp 106,570,250

From Table IV.5, it can be known the calculation of the overall AC data for each week. Actual Cost in this report is obtained from the results of the financial recapitulation of PT. Karya Sejuk Mandiri towards expenses for the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant installation project.

E. Schedule Variance

An example of SV calculation in week 1 of the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant installation project is as follows:

SV = EV – PV

SV = Rp15,303,345 – Rp16,143,763

SV = -Rp840,417

Table IV.6 Schedule Variance

Week	EV	PV	SV
1	Rp 15.303.345	Rp 16.143.763	-Rp 840.417
2	Rp 28.413.863	Rp 30.603.363	-Rp 2.189.500
3	Rp 32.383.213	Rp 37.162.613	-Rp 4.779.400
…	….	….	….
12	Rp 91.492.545	Rp 166.628.563	-Rp 75.136.018

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From Table IV.6, it can be seen the Schedule Variance data which describes the calculation of the overall SV data for each week. The result of the SV is an indicator of the status of the project schedule that is useful to see whether the project is running slower, faster, or right according to the schedule baseline for each period. SV is obtained from the result of subtraction between EV and PV. If the SV is negative, the project progress is indicated to have been delayed from the schedule baseline or referred to as behind schedule because EV is smaller than PV, if it is positive, the project progress is indicated to be faster than the schedule baseline or referred to as ahead of schedule because EV is greater than PV. and if the value is equal to zero then the project progress is indicated in accordance with the schedule baseline or referred to as on schedule because EV is equal to PV.

Based on the results of research at the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant installation project, it was found that SV and SPI were negative from the 1st to the 12th week, which means that the progress of the work that has been completed and the level of effectiveness of the project team in completing the work per period is indicated to be delayed. from the schedule baseline or referred to as behind schedule because the number of jobs that have been completed is less than the number of jobs planned.

F. Cost Variance

Examples of CV calculations in week 1 for project performance analysis in hydrant and plumbing. Case study: biopharmaceutical manufacturing facility is as follows:

CV = EV – AC
CV = Rp15,303,345 – Rp24,655,000
CV = -Rp9,351,655

Table IV.7 Cost Variance

Week	EV	AC	CV
1	Rp 15.303.345	Rp 24.655.000	-Rp 9.351.655
2	Rp 28.413.863	Rp 30.161.875	-Rp 1.748.013
3	Rp 32.383.213	Rp 30.661.875	Rp 1.721.338
…	….	….	….
12	Rp 91.492.545	Rp 106.570.250	-Rp 15.077.705

From Table IV.7, it can be known the Cost Variance data which describes the calculation of the total CV data for each week. CV is obtained from the reduction between Earned Value (EV) and Actual Cost (AC). If the CV is negative then the project status is indicated to cost more than the baseline or referred to as over planned cost because EV is smaller than AC, if it is positive then the project status is indicated to cost less than the baseline or referred to as under planned cost because EV is greater than AC, and if the value is equal to zero (neutral) then the project status is indicated in accordance with the baseline or referred to as on planned cost because EV is equal to AC. Based on the results of the research, it was found that CV was negative in the 1st week to the 12th week, which means that the costs incurred in those weeks were greater than the planned costs or referred to as over planned costs because the AC was greater than the EV.

G. Schedule Performance Index

An example of SPI calculation in week 1 for project performance analysis in hydrant and plumbing. Case study: biopharmaceutical manufacturing facility is as follows:

$SPI = \frac{EV}{PV}$

$SPI = \frac{Rp15,303,345}{Rp\ 16,143,763}$

SPI = 0.95

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Table IV.8 Schedule Performance Index

Week	EV	PV	SPI
1	Rp 15.303.345	Rp 16.143.763	0,95
2	Rp 28.413.863	Rp 30.603.363	0,93
3	Rp 32.383.213	Rp 37.162.613	0,87
…	….	….	…
12	Rp 91.492.545	Rp 166.628.563	0,55

From Table IV.8, it can be seen the Schedule Performance Index which describes the calculation of the overall SPI data for each week. SPI results are obtained from the quotient between EV and PV. If the SPI is worth less than one, the efficiency level of the project team is indicated to be behind schedule or referred to as behind schedule because EV is smaller than PV. If it is worth more than one, the efficiency level of the project team is indicated to have accelerated from schedule or is referred to as ahead of schedule because EV is greater than PV. If the value is equal to one, the project progress is indicated according to schedule or referred to as on schedule because EV is equal to PV.

Based on the results of research for project performance analysis in hydrant and plumbing. Case study: biopharmaceutical manufacturing facility, it was found that the SPI is worth less than one from the 1st to the 12th week, which means that the progress of the work that has been completed and the level of effectiveness of the project team in completing the work per period is indicated to be delayed from the schedule baseline or referred to as behind schedule because the number of works that have been completed is less than the number of works planned.

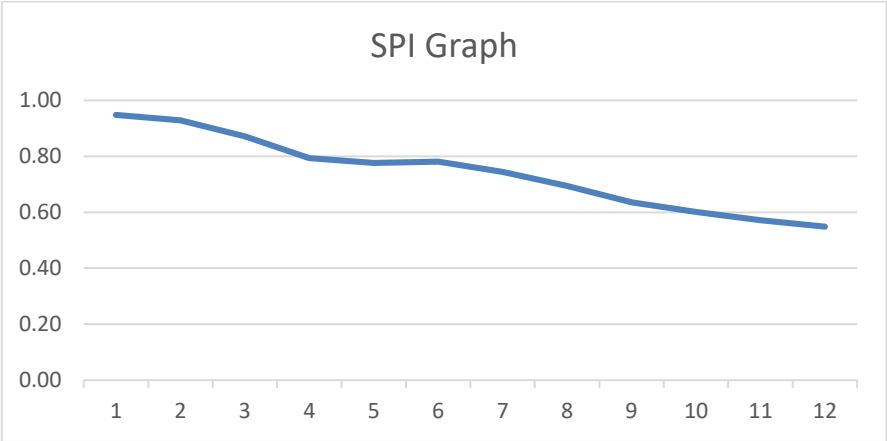

Figure IV.1 SPI Graph

From Figure IV.1, it can be seen an SPI graph of project performance analysis in hydrant and plumbing. Case study: biopharmaceutical manufacturing facility until the 12th week. The SPI chart shows a constant decline from the first week to the 12th week. The progress of work is indicated to be delayed and the rate of delay is getting worse every week.

H. Cost Performance Index

An example of calculating CPI in week 1 for project performance analysis in hydrant and plumbing. Case study: biopharmaceutical manufacturing facility is as follows:

$$CPI = \frac{EV}{AC}$$

$$CPI = \frac{Rp\ 15{,}303{,}345}{Rp\ 24{,}655{,}000}$$

$$CPI = 0.62$$

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Table IV.9 Cost Performance Index

Week	EV	AC	CPI
1	Rp 15.303.345	Rp 24.655.000	0,62
2	Rp 28.413.863	Rp 30.161.875	0,94
3	Rp 32.383.213	Rp 30.661.875	1,06
…	….	….	….
12	Rp 91.492.545	Rp 106.570.250	0,86

From Table IV.9 it can be known the Cost Performance Index which describes the calculation of the overall CPI data for each week. The CPI results are obtained from the quotient between EV and AC. If the CPI is less than one, the project cost efficiency level is indicated to cost more than the baseline or referred to as over planned cost because EV is smaller than AC. If it is worth more than one, the project cost efficiency level is indicated to cost less than the baseline or referred to as under planned cost because EV is greater than AC. If the value is equal to one, the project status is indicated according to the baseline or referred to as on planned cost because EV is equal to AC.

Based on the research results of project performance analysis in hydrant and plumbing. Case study: biopharmaceutical manufacturing facility, it was found that the CPI was worth less than one from the 1st week to the 12th week, which means that the costs incurred in those weeks were greater than the planned costs or referred to as over planned cost because AC is bigger than EV.

I. Forecasting

Table IV.10 Forecasting Calculations

No.	EAC	ETC	VAC	TCPI
1	= AC + BAC – EV = Rp106,570,250 + Rp586,000,000 - Rp91,492,545 = Rp601,077,705	= EAC – AC = Rp601,077,705 - Rp106,570,250 = Rp494,507,455	= BAC – EAC = Rp586,000,000 - Rp601,077,705 = -Rp15,077,705	$= \frac{(BAC-EV)}{(EAC-AC)}$ $= \frac{(Rp586,000,000 - Rp91,492,545)}{(Rp601,077,705-Rp106,570,250)}$ = 1.00
2	$= \frac{BAC}{CPI}$ $= \frac{Rp586,000,000}{0,86}$ Rp682,571,094	= EAC – AC = Rp682,571,094 - Rp106,570,250 = Rp576,000,844	= BAC – EAC = Rp586,000,000 - Rp682,571,094 = -Rp96,571,094	$= \frac{(BAC-EV)}{(EAC-AC)}$ $= \frac{(Rp586,000,000 - Rp91,492,545)}{(Rp682,571,094-Rp106,570,250)}$ = 0.86
3	$= AC + \frac{BAC-EV}{CPI \times SPI}$ $= Rp106,570,250 + \frac{(Rp586,000,000 - Rp91,492,545))}{0.86 \times 0.55}$ = Rp879,760,389	= EAC – AC = Rp879,760,389 - Rp106,570,250 = Rp773,190,139	= BAC – EAC = Rp586,000,000 - Rp879,760,389 = -Rp293,760,389	$= \frac{(BAC-EV)}{(EAC-AC)}$ $= \frac{(Rp586,000,000 - Rp91,492,545)}{(Rp879,760,389-Rp106,570,250)}$ = 0.64

V. DISCUSION

A. Tools Factor

Choosing what tools to be used is an important part of a project. Any manual tools or software used is detrimental to the efficiency of managing and handling of the project (Xuan et al, 2019). In the early stages of the project, PT. Karya Sejuk Mandiri bought a number of machines and work tools and set up a warehouse to store the work tools needed until the project was completed. Therefore, on the actual cost (spending) graph there is a very significant increase in the initial phase of the project, while in the middle to the end of the project it is relatively less. In addition to speeding up the installation process and avoiding delays in the installation process, the plan also serves to avoid if the price of machinery and work tools suddenly rises, causing

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the installation price to be more expensive than planned. However, until the 12th week there are many work tools that have been damaged so that work activities have experienced delays. After making observations in the field, workers tend not to be careful in using work tools. In addition, there is no data collection system for work tools from the warehouse to monitor the entry and exit of work tools.

B. Manpower Factor

Manpower factor takes an important role in a project. As all projects are resource-driven, with resources being manpower and finances, the selection of both of the components contributes directly to the success of the project (Dokras, 2019). Until the 12th week, Manpower PT. Karya Sejuk Mandiri at the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Project consists of one supervisor, 12 active workers, and one person who is responsible for warehouse and work equipment. First, the analysis is carried out on the weekly schedule to find out the targets that must be achieved by manpower. For example, for the rainwater pipe installation work in the 1st week, it is targeted to install Rp5,315,000. Based on the work contract for the installation of a 150mm diameter rainwater pipe, the unit price of the work is Rp60,000 per meter. So that in one week, workers must install as many as 89 meters to reach the target. According PT. KSM's Operational Manager, one set of workers (consisting of one handyman and one helper) in a day is able to work an average of 20 meters of 150mm rainwater pipes because the pipes tend to be straight from the roof to the ground floor. Thus, a set of workers in one week is able to install 140 meters. However, in this project, earned value in week 1 for rainwater pipe installation work is only Rp3,189,000. This value is only 60% of the weekly target, which proves that the performance of manpower is below average. This is not spared from the less-than-optimal role of a project leader in the field so that there is a failure in optimizing the existing workforce.

C. Process and Method Factor

Choosing the suitable process and method takes an important step in a project High-intensity work tends to have a high risk of delay. The tolerance for process or method errors will be very small so that if an error occurs it will directly affect the value of the work and can cause delays to losses. An example is in the processes and methods that exist in the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Project, according to PT. Karya Sejuk Mandiri's Operational Manager, there are several processes and methods that are not appropriate in project implementation. The work team was assessed using inefficient techniques when carrying out a series of plumbing and hydrant work. The workers did not take measurements before installing the pipe, which caused the length of the pipe to not match the planning drawings. Therefore, before carrying out pipe installation, measurements should be made using threads to obtain precise measurements and elevation angles for the pipes to be used. So as to minimize errors during the installation process. In addition, design changes also often occur so that some work needs to be reworked. This causes the productivity level of workers to be disrupted and causes other jobs to be late.

D. Work Order Factor

Work order (scheduling) factor takes an important role in a project. Work orders formally states, or requests, work to be performed. By creating work orders, a project manager communicate important information about a task or a short-term project to those who are involved (Oracle, 2006). In addition to the factors above, the weekly target for the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Project was not achieved due to the accumulation of work orders. As in the work of a water-based fire extinguishing system (piping installation in the main building), the process that was carried out until the 12th week was considered to be one of the main factors causing the target not to be achieved. Instead of focusing on 1st floor work, work starts from the 2nd floor which has a higher level of difficulty so that it has a smaller profit margin. According to the project leader, in the 2nd week there was land that could not be worked on on the 1st floor so the work had to be shifted to focus on the 2nd floor. However, according to the project supervisor from PT. KIK, the work area on the 1st floor can be done since the 5th week. Therefore, starting from the 5th week, the priority of work on the water-based fire extinguishing system (piping installation in the main building) is focused on the 1st floor.

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E. Current Reality Tree (CRT)

Figure V.1 Current Reality Tree

Based on Figure V.1 Current Reality Tree, it can be known that the main problem with this project is that the project is delayed and overbudgeted. The problem lies in operational factors in the field, causing low levels of productivity and quality that are below the consultant's standard. The cause of the low quality is because the workers are considered unprofessional in doing their work, causing the work to need to be improved continuously. In addition, the disproportionate number of workers is one of the factors causing the low level of productivity in the field. Instead of doing work with a greater value of work, the team of workers in the field tends to do work with a lower value. From a series of poor project planning and execution problems, it is known that the root cause of the problem is (1) unsatisfactory project manager performance regarding planning, monitoring and controlling process.

Furthermore, there are also problems with the inventory. Another factor of the low level of productivity is the lack of tools in the field. This happens because there are many damaged work tools. After reviewing the conditions in the field, it was found that there was no data collection on the work tools used by the workers. Therefore, it can be said that the root cause of the problem in the inventory section is (2) inadequate tools and equipment usage system.

F. Issue Exploration Conclusion

In the business issue section, it is known that the main problems in this research are project delays and overbudgets. Detailed calculations are carried out in the business issue exploration section, which produces forecasting data as shown in Table II.10 Forecasting Calculations. According to the forecast data, it can be concluded that if corrective actions are not taken, the losses

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will be worse which is estimated to reach -Rp96,571,094 and the work is predicted to be completed within 51 weeks, which means there is an additional 23 weeks from the planning schedule.

In addition, there are two critical root causes that cause delays and cost overruns on projects which are identified as follows:

1. **Unsatisfactory project manager performance regarding planning, monitoring and controlling process (Problem-1)**
   Poor planning of hydrant work causes low productivity which results in the earned value being smaller than the actual cost. In other words, the value of the work completed is not able to cover the costs in the field during the construction period. Scheduling existing hydrant work focuses on work that tends to be complicated with a small profit margin, namely the installation of inch and 1 inch diameter branch pipes. In addition, poor scheduling of hydrant work also causes an imbalance in the number of skilled workers (welders). There are many large hydrant pipe areas that can be worked on, but the welder has not been brought in because the existing schedule focuses on branch pipe work. Moreover, welders who have been officially certified are not easy to get. In terms of monitoring and controlling process, the high volume of work that needs to be reworked is one of the most dangerous things in a project that has a tight schedule. The reason is, each work team has a schedule and work target that must be completed every week. If the frequency of repair work is too high, the work target can be disrupted and cause delays. In general, the work that needs to be repaired is work that is not in accordance with the standards by the quality control department such as the level of elevation and position that is not in accordance with shop drawing, pipe installation is not straight, connections between pipes are not well connected, and pipe holders are not neat. This generally occurs because of the low expertise of man power so that the techniques used are not in accordance with the materials used and the existing difficulty factor. The root cause is the low role of a project leader in the field which causes lack of supervision so that he does not know about underperforming workers and make mistakes in the field.
2. **Inadequate tools and equipment usage system (Problem-2)**
   In addition to the man power factor, tools and equipment are also vital in a project. The level of work productivity is influenced by the availability of work tools. The more and better the quality of the work tools, the faster the man power will be in completing the work. In addition to its availability, the system for using work tools is also very important to note. The reason is that a poor system for using work tools will cause work tools to be uncontrolled during the project. No matter how good and how many work tools there are, there will be a risk of being damaged and lost if the system is not managed properly. In this project, according to the Operational Manager, requests for procurement of work tools are too often carried out by the project leader. He said that the work tools were not well maintained which caused them to break down too quickly. The results of field observations with the project leader show that so far there has been no data collection related to the use of work tools. This causes the workers to not have a sense of belonging to the work tools they use every day. Even if it is damaged, it will not be detected who the worker who caused the damage is because there is no data collection on the use of work tools.

G. Analysis of Business Solution

Based on the results of the analysis through the Current Reality Tree diagram, there are two root causes of delays and cost overruns. In this section, each root cause of the problem will be given a solution so that it is expected to be able to overcome these problems both in the short and long term which will be described in detail as follows:

1. **Solutions of Root Cause Problem-1**
   In order to address the first root cause problem; unsatisfactory project manager performance regarding planning, monitoring and controlling process, there are three alternative solutions as follows:
   - Daily project report assessment and schedule adjustment
     The objective is to document and report the progress of work in the field. Project report assessment will be conducted using project report form. Project leader will take the responsibility to fulfill the project report form through monitoring and controlling project in a daily basis. Other than that, as the project leader knows the budget plan for the entire work, he must make an adjustment for hydrant schedule by prioritizing the works with highest value according to the budget plan. At the end, progress of project will always be reported and it will be used to assess whether the project aligns with the schedule and the earned value higher than actual cost or not. This solution does not need big investment and the most important thing is the visibility of the progress in a daily basis.
   - Conducting project management training and certification for project leaders

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According to the Project Management Institute (PMI) website, in general there are two most popular types of certifications related to project management, namely Certified Associate in Project Management (CAPM) and Project Management Professional (PMP). In short, to have a PMP certificate, a project manager must have a CAPM certificate and have at least 36 months of experience managing projects. Considering the cost (CAPM of $300 and PMP of $555) and also the current certification status of the project leader who does not yet have a CAPM certificate, the best option is to take CAPM certification training. By having a CAPM certificate, it is hoped that the project leader in this project will be able to improve the ability to manage projects so that they are able to solve existing problems. However, this certification training also requires at least 23 hours of project management education.

- Replace the existing project leader with a certified project leader
  The replacement of the project leader is an alternative that can be used if conditions are urgent. However, according to the PMI website, a project manager who already has a CAPM certificate has a higher salary than a non-certified project manager. Thus, the operational costs will increase every month until the project is completed.

2. Solutions of Root Cause Problem-2

Alternative solutions for inadequate tools and equipment usage system have purpose to establish a sustainable system which supports man-power and project leader to control and supervise tools and equipment in the project. Those alternative solutions are:

- Creating an inventory system for work tools supervised by the project leader
  Initially, all work tools will be assigned a different "item code". Suppose there are three grinding machines, the three machines will have different codes even though they have the same specifications and year of purchase. After that, all work tools will be recorded in the system according to their respective item codes. The inventory system will record the name of the tool, specifications, condition, time of borrowing, and also the person who borrows the tool every day through a form using the Microsoft Excel application on a laptop provided by the office. By recording the workers who use work tools, the inventory system is expected to be able to monitor the work tools used by each worker which are recorded every day. The first alternative gives responsibility for the inventory system to the project leader. So that the project leader is able to participate in supervising the use of in-person work tools.
- Employ experienced inventory supervisors
  Taking into account the current busyness of the project leader, it will be quite risky if the inventory system is also the responsibility of the project leader. Therefore, the second alternative suggests hiring an experienced inventory supervisor who will manage all things related to work tools. However, hiring an inventory supervisor means increasing operating costs.
- Employ a dedicated person in the existing project to run the inventory system
  The third alternative is to delegate the inventory system to someone who has a low workload in the current project. Thus, there is no need for additional costs for the problem of monitoring work tools.

H. Analytical Hierarchy Process (AHP)

To overcome those root cause problems, there are several priorities that have to be considered according to the operational manager in the field. It's known that this is an ongoing project, thus, the chosen solutions must prioritize the duration time for each solution. The faster corrective action can be implemented, the better it gets. In addition, the cheaper solution is much better considering the project is also experiencing cost overruns. Therefore, cost needs to be taken into consideration. At the end of these processes, the effectiveness of each solution also takes an important part that needs to be considered. It shows how impactful given solution regarding the existing problems.

J. Conclusion of Solution Analysis

In the analysis of business solutions section, a comprehensive description of the proposed corrective actions has been obtained to resolve any root cause problems that exist in this project. Each root cause problem has three alternative business solutions. Considering the priority of each root cause, the Analytic Hierarchy Process (AHP) is used to assist research in determining the proposed business solution from the three alternatives, which in the end each root cause problem has one proposed solution as follows:

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➢ ***Chosen Solution for Root Cause Problem-1***

Table V.1 AHP Result (Problem-1)

Criterion	Score
Time	55,63%
Cost	14,76%
Effectiveness	29,61%

Alternative Solution	Time	Cost	Effectiveness
RA	73,42%	81,09%	38,84%
PMT	7,78%	10,37%	14,79%
PLR	18,80%	8,55%	46,37%

Alternative Solution	Score	Rank
RA	64,31%	1
PMT	10,24%	3
PLR	25,45%	2

There are three criteria for choosing the best solution which are time, cost, and effectiveness, as follows:

- Time tells how quickly the substitute solution can be put into action. The sooner alternative solutions can be implemented, the better.
- Cost represents how much PT. Karya Sejuk Mandiri would spend an additional budget to execute the alternative solutions. The cheaper the cost to implement alternative solutions, the better.
- Effectiveness shows how the alternative solution can make a direct improvement to the problems.

According to AHP result, the preferred solution for the unsatisfactory project manager performance regarding planning, monitoring and controlling process is to establish a daily project report assessment and schedule adjustment (RA). The AHP results show that the score for the alternative option is 64.31% with "time" as the main consideration. The reason on choosing this solution is because the project is forcing to conduct a fast corrective action due to hectic schedule. Furthermore, the company have a tendency to save the operational cost as much as possible due to cost variance data that shows a negative result which means that the costs incurred in those weeks were greater than the earned value. Thus, the cheaper option is to perform a daily project report assessment and schedule adjustment.

➢ ***Chosen Solution for Root Cause Problem-2***

Table V.2 AHP Result (Problem-2)

Criterion	Score
Resistance	15,82%
Cost	50,42%
Effectiveness	33,77%

Alternative Solution	Time	Cost	Effectiveness
PL	11,70%	35,89%	11,27%
IS	43,43%	13,49%	45,72%
DP	44,87%	50,61%	43,01%

Alternative Solution	Score	Rank
PL	23,75%	3
IS	29,11%	2
DP	47,14%	1

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There are three criteria for choosing the best solution which are resistance, cost, and effectiveness, as follows:

- Resistance tells how an additional responsibility will affect the manpower.
- Cost represents how much PT. Karya Sejuk Mandiri would spend an additional budget to conduct the alternative solutions. The cheaper the cost to implement alternative solutions, the better.
- Effectiveness shows how the alternative solution can make an instant improvement to the problems.

According to AHP result, the preferred solution for inadequate tools and equipment usage system is to employ a dedicated person in the existing project to run the inventory system (DP). For a more detailed explanation, see the Appendix. AHP results show a score of 47.14% for implementing an inventory system using workers in the existing project. The biggest consideration is Cost with a score of 50.42% when compared to other criteria, namely resistance and effectiveness.

VI. CONCLUSION

After conducting research on this project, the level of performance in the Manufacturing Facility of Biopharmaceutical Product Plumbing and Hydrant Project using the Earned Value Management method is concluded. The research results can be viewed from several indicators, including:

- Based on the schedule variance, it was found that from the first week to the 12th week, the project experienced delays when viewed from the schedule baseline or referred to as behind schedule.
- Based on the cost variance, it is known that the project experienced over planned costs from the first week to the 12th week which is the result of a review of the actual cost and earned value. In this case, the total earned value up to week 12 is still below the actual cost.
- The schedule and cost performance index also shows that the progress of the work is indicated to be delayed from the schedule baseline or referred to as behind schedule and the costs incurred in those weeks were greater than the planned costs or referred to as over planned costs.
- The schedule forecast calculation shows the project is projected to experience cost overruns of Rp. 82,099,035 and experience an additional 23 weeks of working time.

This study also reveals the root cause of the above problems. By using the CRT Diagram, two root cause problems were found in this project. Then the research was continued by providing three alternative solutions. By doing AHP, one best alternative solution is obtained for each existing root cause, as follows:

- Unsatisfactory project manager performance regarding planning, monitoring and controlling process: a solution was found, namely making a daily project report assessment and schedule adjustment that will be explained in implementation plan section.
- Inadequate tools and equipment usage system: a solution was found, namely employing a dedicated person in the existing project to run the inventory system.

REFERENCES

1. Merriam-Webster. (n.d.). Lump sum. In Merriam-Webster.com dictionary. Retrieved August 25, 2022, from https://www.merriam-webster.com/dictionary/lump%20sum
2. Mr. Shashikant Gopal Kamble, & Prof. M. B. Kumthekar. (2015). Problems Associated With Plumbing and its Maintenance. International Journal of Engineering Research And, V4(04). https://doi.org/10.17577/ijertv4is040484
3. Collins Dictionary. (n.d.). Fire hydrant. In Collins dictionary. Retrieved August 25, 2022, from https://www.collinsdictionary.com/dictionary/english/fire-hydrant#:~:text=countable%20noun,for%20putting%20out%20a%20fire
4. Willmer Limited. (2014, October). White Paper – Using S-Curves to improve Project Performance. https://projectpro-ph.com/wp-content/uploads/2017/03/Using-S-Curves-to-Improve-Project-Performance.pdf
5. K., Wadugodapitiya, & Sandanayake, Y. & Thurairajah, Niraj. (2010). Building Project Performance Evaluation Model. https://www.researchgate.net/publication/332846660_Building_Project_Performance_Evaluation_Model

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6. Eirgash, M. A. (2021). Project Monitoring and Early Warning of Time-Cost Overruns in Earned Value Management. Current Trends in Civil & Structural Engineering, 7(5). https://doi.org/10.33552/ctcse.2021.07.000673
7. Kim, Byung-Cheol. (2007). Forecasting Project Progress and Early Warning of Project Overruns with Probabilistic Methods. https://www.researchgate.net/publication/41014773_Forecasting_Project_Progress_and_Early_Warning_of_Project_Overruns_with_Probabilistic_Methods
8. Kumbhar, Kalayan. (2018). Brainstorming technique: Innovative Quality Management Tool for Library. https://www.researchgate.net/publication/325594636_Brainstorming_technique_Innovative_Quality_Management_Tool_for_Library
9. Alutbi, Mohaymen. (2020). WORK BREAKDOWN STRUCTURE (WBS). https://www.researchgate.net/publication/342163727_WORK_BREAKDOWN_STRUCTURE_WBS
10. Brief, ©.M. (n.d.). What is a Current Reality Tree? Definition and meaning. MBA Brief. Retrieved August 26, 2022, from https://www.mbabrief.com/what_is_current_reality_tree.asp
11. JD Edwards World. (2007, January). Work Order Management Guide Version A9.1. https://docs.oracle.com/cd/E22655_01/nav/JD_Edwards_World_Work_Order_Management_A91_Guide.pdf
12. Project Planning and Management (PPM) V2.0. (2014, August). WBS Dictionary: Software as Service (SaaS) Version 1.0. https://www.hud.gov/sites/documents/WBS_SAAS_DICTIONARY.PDF
13. Xuan, Q. L. H., Moslehpour, M., & Tien, D. T. (2019). An evaluation of project management tools and techniques in Vietnam. Management Science Letters, 283–300. https://doi.org/10.5267/j.msl.2018.11.011
14. Dokras, U. (2019). The Role of Human Resources in a Project Management Plan.pdf. Indo Swedisg Author's Collective. https://www.academia.edu/38376823/The_Role_of_Human_Resources_in_a_Project_Management_Plan_pdf?source=swp_share
15. Agus, R. (2022, June 28). Banten MENATAP Masa Depan Dari Kawasan Industri - bisnis Indonesia. Bisnisindonesia.id. Retrieved July 4, 2022, from https://bisnisindonesia.id/article/banten-menatap-masa-depan-dari-kawasan-industri
16. Fredendall, Lawrence & Patterson, J. & Lenhartz, C & Mitchell, Bryant. (2002). What Should Be Changed? A comparison of cause and effect diagrams and current reality trees shows which will bring optimum results when making improvements. Quality Progress. 35. 50-59.
17. Government of Indonesia. Indonesia Investment Coordinating Board. 2019. A Brief Guide of Investment in The Industrial Estates. Jakarta.
18. Government of Indonesia. President of the Republic of Indonesia. 2015. Regulation no. 142 of 2015 on Industrial Estate. Ministry of Law and Human Rights of Republic of Indonesia. Jakarta.
19. Hanipa, Hepy (2021). Project Cost Overrun Analysis Case Study: A Rotating Equipment Services Company (PT Z).
20. Hidayat, F. (2022). ModernCikande Raih Predikat Best Industrial Estate Development. beritasatu.com. Retrieved 4 July 2022, from https://www.beritasatu.com/ekonomi/576070/moderncikande-raih-predikat-best-industrial-estate-development
21. Indonesia Window. (2020, October 13). Indonesia's industrial estate areas increase in five years. Indonesia Window. Retrieved July 4, 2022, from https://indonesiawindow.com/en/indonesias-industrial-estate-areas-increase-in-five-years
22. Kawasan Industri ModernCikande Industrial Estate (MCIE) oleh Modern Group. Modern-cikande.co.id. (2022). Retrieved 4 July 2022, from https://www.modern-cikande.co.id/lang_id/aboutus.html.
23. Kontan. (2021, September 20). Kawasan Industri berikan kontribusi signifikan Bagi Ekonomi Daerah. pressrelease.id. Retrieved July 4, 2022, from https://pressrelease.kontan.co.id/release/kawasan-industri-berikan-kontribusi-signifikan-bagi-ekonomi-daerah
24. Mahardika, T. (2020, November 24). Gelontorkan RP500 M, jbio Bangun Pabrik biofarmasi Dan Vaksin modern Di Banten. SINDOnews.com. Retrieved July 4, 2022, from https://ekbis.sindonews.com/read/243958/34/gelontorkan-rp500-m-jbio-bangun-pabrik-biofarmasi-dan-vaksin-modern-di-banten-1606212678
25. Noviansyah, Angga (2021). Minimizing Project Completion Delays and Operational Cost, A Case Study: Pt. Bina Karya (Persero) Project.
26. Project Management Institute. (2017). A guide to the Project Management Body of Knowledge (PMBOK guide) (6th ed.). Project Management Institute.

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27. Puspaningtyas, L. (2022). Kawasan Industri Halal akan Dapat Insentif Fiskal dan Non-Fiskal |Republika Online. Republika Online. Retrieved 4 July 2022, from https://www.republika.co.id/berita/re8lrd383/kawasan-industri-halal-akan-dapat-insentif-fiskal-dan-nonfiskal
28. Sirias, Danilo (1997). Using Theory of Constraints To Teach Introduction to MIS. Proceedings of the International Academy for Information Management Annual Conference.

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