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Evaluation of Achievement of Overburden Production Target Using Fishbone Diagram Method at Pit A Site B PT XYZ, South Sumatera Province

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Abstract

PT XYZ is the companies engaged in the coal mining and energy. Mining activities at the Pit A Site B are still focused on stripping overburden using the Komatsu PC-3000E power shovel. The company has established a 513,333 BCM production target of overburden stripping in November 2020. The existence of factors that affect the productivity of the equipment will determine the achievement of production targets. One of the methods that can be used to determine the factors causing problems in achievement production target is a fishbone diagram. The purpose of this research is to calculate overburden production in November 2020, identify factors that influence the achievement of overburden production targets using a fishbone diagram, and make recommendations for improvement plans based on factors that affect the achievement of overburden production targets. Based on the results of the fishbone diagram analysis, there are four factors that influence the achievement of overburden production targets, which is manpower, material, machine and methods. The problems that affect the achievement of production targets on the machine factor is equipment failure, the manpower factor is time discipline, the method factor is not maximum material pick up and the material factor is material type. The recommended improvement plan for each factor causing the problem are four recommendations for improvement plans on manpower factors, three recommendations on improvement plans on machine factors, three recommendations on improvement plans on material factors and three recommendations on improvement plans on method factors.

Keywords: Coal; excavator; fishbone diagram; overburden

1. Introduction

PT XYZ is a company engaged in coal mining and energy in South Sumatra Province. Since December 2016, mining activities at Site B, which consist of Pit A and Pit C East, have been electrified (self-managed) or carried out and managed by the company itself. Mining activities at the Pit A mine site are still focused on overburden stripping. The equipment used is a Komatsu PC-3000E power shovel with three units.

Several factors can affect the equipment productivity, including equipment cycle time are caused by the difficulty of loading material, queues occur on hauler, long hauling distances, operator performance that is not optimal at work, machine conditions, excavation height, equipment rotation angle, loading factor for equipment [1]–[3].

Mining companies calculate cycle times to determine equipment performance and operator work efficiency [4]. The calculation of the equipment cycle time is carried out by monitoring the movement pattern of mechanical equipment during activities [5]. The cycle time for equipment is the total time it takes the equipment to complete one cycle [6]. The better of level use the equipment, the greater the productivity produced by the equipment [7].

One of parameters that can be used to determine the results of the work (success) of a mechanical earthmoving equipment are good or bad is the total production that can be achieved by the heavy equipment used [8]. The company has assign a production target of overburden stripping in November 2020 of 513,333 BCM. The existence of factors that affect the equipment productivity will determine the achievement of production targets, so it is necessary to evaluate production by identifying the factors causing the problem. These factors can be classified based on the cause of the problem including man power factors, machine factors, method factors and material factors [1].

One of method that can be used to determine the root cause of the problem can be determined using a fishbone diagram. The fishbone diagram or also known as the cause and effect diagram or ishikawa diagram was first introduced by its originator, Kaoru Ishikawa (1915-

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1989), a professor at the University of Tokyo [9]. Fishbone diagram is a method used to identify the root cause of a quality problem [10].

Fishbone diagrams which are shaped like a fish bone are a common tool used for cause and effect analysis to identify causal relationships in a particular problem or event [11]. The benefit of a fishbone diagram is that it focuses individuals or organizations on the main problem [12]. The parts of the fishbone diagram consist of fish heads used to state the main problem that needs to be solved, fins are used to write down problem groups and fish bone are used to state the cause of the problem [13].

Based on the results of the fishbone diagram analysis, recommendations for improvement plans can be designed for each factor causing the problem, so the overburden production target can be achieved. Therefore, this study was conducted to identify the root cause of the problem using a fishbone diagram to arrange recommendations for improvement plans, so the overburden production target at Pit A Site B PT XYZ can be achieved.

2. Research Methods

The research activity was carried out in PT XYZ department unit which is responsible for managing production activities at Pit A Site B. The overburden production target assigned by in November 2020 at the Pit A Site B is 513,333 BCM/month. Equipment productivity is very influential on whether or not the production target is achieved. Equipment productivity is influenced by several factors, therefore it is necessary to evaluate the factors that affect the overburden production target.

2.1. Data Collection

Data collection in this study consisted of:

- Cycle time

  Cycle time data of two units of the Komatsu PC-3000E power shovel were gathered by direct observation in the mining area of Pit A Site B. The data collection period was on November 30, 2020 for 32 cycles for the Komatsu PC-3002 power shovel and 29 cycles for the Komatsu PC-3003 power shovel with a bucket capacity of 16 m^3.

- Productive working time

  The data obtained in the form of the amount of productive working time in one month consisting of an effective working time of 660 hours and loss time data of the Komatsu PC-3000E power shovel.

- Swell Factor

  Swell factor used is determined by the company at 0.72.

- Equipment correction factor

  The correction factor for the Komatsu PC-3000E power shovel tool is shown in Table 1.

- Equipment specifications

  The required specification of the Komatsu PC-3000E power shovel is a bucket capacity of 16 m^3.

Table 1. Correction factor of the Komatsu PC-3000E power shovel

Correction Factor	Unit PC	
	3002	3003
	Cycle Time	
	27.31 seconds	28.29 seconds
Bucket fill factor	1.04	1.04
Time efficiency	0.52	0.59
Machine Condition	0.97	1.00
Operator Skill	0.95	0.95
Material Properties	0.95	0.95
Field Condition	1.00	1.00
Weather	0.90	0.90
Total	0.43	0.50

- Cause of problem factors

  The research questionnaires was conducted to determine the factors that effect the failure to achieve the overburden production target using purposive sampling method. Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience [14].

Respondents in this study were determined based on the results of discussions with the company, therefore it resulted in the people most responsible for the production of overburden. There are 14 respondents of the questionnaire, which consist of one self-managed Mining Manager, two Supervisors and 11 Dispatchers.

2.2. Data Processing

Data processing is carried out at the Mine Planning and Valuation Laboratory with the following stages:

- Calculating power shovel productivity

  The productivity of the Komatsu PC-3000E power shovel is calculated using Equation 1 (company's formula).

$$Q = ql \times fk \times \frac{3600}{Ct} \times SF \quad (1)$$

- Making diagram fishbone

  The steps of fishbone diagram analysis are:

  a. Determine the root cause of the problem based on the results of the questionnaire.

     Determine the possible causes of the main factors that become the basis of the problem of achieving the overburden production target based on the results of the questionnaire. The possible causes of each factor are described as small bones in the main bone. Each possible cause is also searched for the root cause and can be described as a branch in the outline of the previous possible cause.

  b. Making fishbone diagram outline

     The fishbone diagram outline includes the fish head which is placed on the right side of the diagram. This fish head is used to state the main problem, namely the achievement of the overburden production target. The second part is

the fin used to write down the group of causes of the problem and the third part is the thorn used to state the possible causes of the problem.

c. Grouping the cause of problem factors
Factors that influence the achievement of overburden production targets are grouped into four categories namely, man power factors, machine factors, method factors and material factors. These factors are assigned to the fish fins on the fishbone diagram.

d. Analyzing fishbone diagrams
After making a fishbone diagram, it can be seen all the root causes of the problem of achieving the overburden production target. The root causes that have been found are further analyzed for the priority and significance of the causes. Solutions are given to solve the existing problem by solving the root of the problem.

e. Arrange recommendations for improvement plans
The 5W + 1H technique is used to arrange recommendations for improvement plans after knowing the factors and sources of problems so that production targets can be achieved.

3. Research Results

3.1. Overburden production

Overburden production is calculated from the productivity of the Komatsu PC-3000E power shovel with total of two unit, which are PC-3002 and PC-3003. The data used to calculate the productivity of power shovel (Q) are cycle time (Ct), swell factor (Sf), correction factor (Fk) (Table 1), and bucket capacity (Ql). The cycle time of the power shovel (Ct) is calculated by adding up each component of the time required to perform one cycle, namely the digging time, fill swing time, loading time, and empty swing time.

The average cycle time (Ct) of the PC-3002 and PC-3003 power shovel obtained were 27.31 seconds and 28.29 seconds, respectively. Swell factor (Sf) obtained from the company is 0.72. Correction factor (Fk) obtained from the company is 0.43 for PC-3002 and 0.50 for PC-3003. The bucket capacity (Ql) of the PC-3000 power shovel is 16m^3. The results of the calculation of the power shovel productivity using Eq. 1 can be seen in Table 2.

The productivity of the Komatsu PC-3002 power shovel was obtained at 652.98 BCM/hour and PC-3003 at 732.98 BCM/hour. The production of overburden in November 2020 is calculated by multiplying the productivity value of power shovel the per hour (Table 3.1) by the productive working time in November 2020 which is shown in Table 3.

Table 2. Productivity of Power Shovel Komatsu PC-3002 and PC-3003

Unit	Ql (m^3)	Sf	Fk	Ct (Seconds)	Q (BCM/Hour)
PC-3002	16	0.72	0.43	27.31	652.98
PC-3003	16	0.72	0.50	28.29	732.98

Table 3. Overburden production in November 2020

Unit	Q (BCM/ Hour)	Productive Working Time (Hour/ Month)	Q (BCM/ Month)	Total Production (BCM/ Month)
PC-3002	652.98	306.98	200,138,37	488,162
PC-3003	732.98	392.95	287,024.49	

Total overburden production at Pit A Site B in November 2020 is 488,162 BCM while the overburden production target obtained was 513,333 BCM. The production of overburden indicates that the production target is not achieved or the production achieved is only 95% of the production target that has been assign. Factors that influence the achievement of overburden production targets are analyzed for cause and effect using a fishbone diagram based on the results of the questionnaire.

3.2. Fishbone diagram

The fishbone diagram is used to identify the cause and effect of problems regarding the achievement of PT XYZ's overburden production target in November 2020. The pattern used to make the fishbone diagram is the 4M pattern consisting of machines, methods, materials and manpower.

3.2.1. Root cause of the problem

The root cause of the problem of achieving the overburden production target can be identified based on the results of the questionnaire. The results of the questionnaire show the root cause of the problem in each factor, namely the machine factor, man power factor, method factor and material factor. Determination of the root cause of the problem based on the problem with the highest frequency for each factor.

- Machines Factor
  The problems affecting the achievement of overburden production targets on the machines factor consist of:
  a. Equipment failure
     There are three units of Komatsu PC-3000E power shovel used in Pit A Site B, namely PC-3002 and PC-3003. During data collection, the Komatsu PC-3002 power shovel was failure because it was used more than the working time of the equipment.
  b. Loss time
     The increase in the value of working time constraints affects the productivity of the Komatsu PC-3000E power shovel because the productive working time of the equipment is limited.
  c. Equipment maintenance
     Proper management and maintenance of equipment is very influential in accelerating overburden stripping activities, so that the work is completed on time and production targets can be achieved [15].

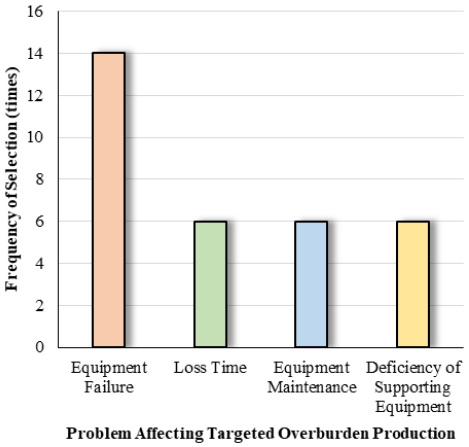

Figure 1. Machine factor

d. Deficiency supporting equipment
Mining support equipment has an important role in the process of overburden stripping activities. Mining support equipment such as dozers function as equipment can clear the land if that land still has shrubs or trees and is also used for the formation of a flat surface [3].

A bar chart of problems affecting the achievement of the machines factor overburden production target is shown in Fig. 1.

Equipment failure has a selection frequency of 14 times, while the loss time, equipment maintenance and deficiency supporting equipment have a frequency of 6 times. The problem with machines factor that has the highest influence on the production target is equipment failure.

- Manpower factor
The problems affecting the achievement of overburden production targets on man power factors consist of:
  a. Lack of training for operators
  Operators who lack of training have an effect on their skills, so that technical errors often occur due to operators themselves, such as too long a time needed to move the equipment from one location to another and too many maneuvers on the hauler.
  b. Time discipline
  The operator's time discipline affects the start time of the overburden stripping operation. Operators are usually ±30-60 minutes late from the scheduled time to start overburden removal operations.
  c. Work experience
  The average operators work experience of operating equipment is ±2 years at the research site, this affects the achievement of overburden production targets.
  d. Health
  The operator's working time is divided into two shifts, one shift consists of 11 hours and is only given a break of about one hour for each shift. The working time affects the operator's health such as eye fatigue and decreased concentration power.

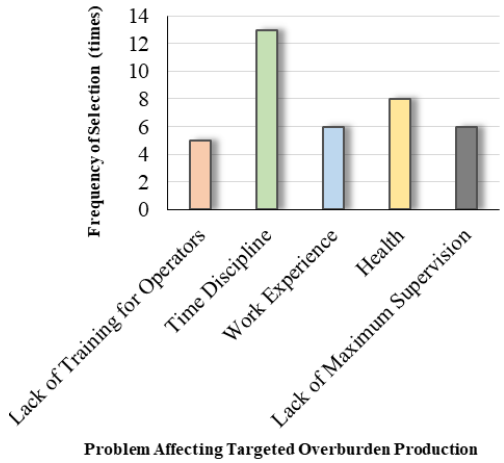

Figure 2. Manpower factor

e. Lack of maximum supervision
Supervision of the overburden stripping activity process is not optimal due to a shortage of manpower in the field of supervision at Site B, especially Pit A.

A bar chart of problems affecting the achievement of man power factor overburden production targets is shown in Fig. 2.

Lack of training for operators has a selection frequency of 5 times, time discipline has a frequency of 13 times, work experience and health has a frequency of 8 times, and lack of maximum supervison has a frequency of 6 times. The problem with man power factor that has the highest influence on the production target is time discipline.

- Method Factor
The problems affecting the achievement of overburden production targets on method factors consist of:
  a. Non-maximum material pick-up
  The overburden material was taken using a bottom loading technique with a slope height that was not in accordance with the standard so that the material was not taken optimally. Taking of material that is not optimal causes too many buckets needed for material loading on the hauler, this can affect a large value of the cycle time on the Komatsu PC-3000E power shovel and affect the achievement of production targets.
  b. Hauler maneuvers excessively
  Hauler maneuvers excessively causing an increase in the value of the hauler cycle time and causing the Komatsu PC-3000E power shovel to wait, thus affecting the achievement of production targets.

A bar chart of the problems affecting the achievement of the overburden production target by the method factor is shown in Fig. 3.

Non-maximum material pick up has a selection frequency of 6 times and hauler maneuvers excessively has a selection frequency of 9 times. The problem with the method factor that has the highest influence on the production target is non-maximum material pick up.

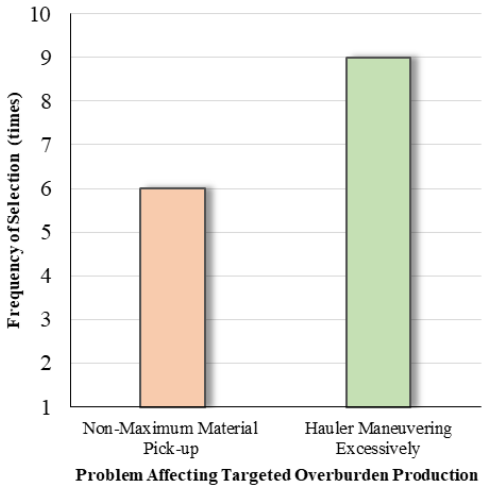

Figure 3. Method factor

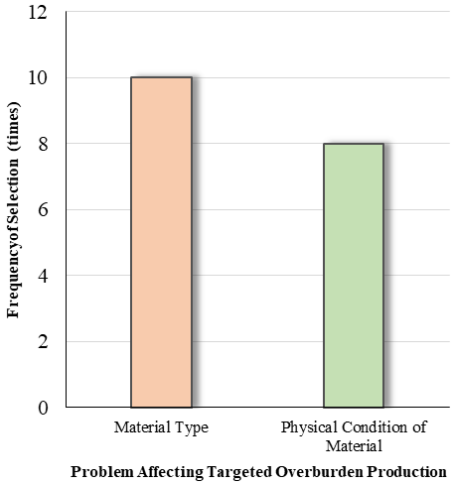

Figure 4. Material factor

- Material Factor
  The problems affecting the achievement of overburden production targets on material factors consist of:
  a. Material type
     The road building material is in the form of clay and sand that easily sinks and breaks down quickly causes obstruction for the hauler.
  b. Physical condition of material
     The overburden material consists of hard clay which then affects the productivity of the Komatsu PC-3000E power shovel.

A bar chart of the problems affecting the achievement of the overburden production target by the material factor is shown in Fig. 4.

Material type has a selection frequency of 10 times and physical condition of material has a selection frequency of 8 times. The problem with the material factor that has the highest influence on the production target is the type of material.

The root causes of the problems that most influence the achievement of overburden production targets are equipment failure with a selection frequency of 14 times, time discipline with a frequency of selection of 13 times, hauler maneuvering with a frequency of selection of 9 times and the material type with a frequency of selection of 10 times.

3.2.2. Fishbone diagram outline

The fishbone diagram outline for problems affecting the achievement of overburden production targets consists of:

- Fish head
  Fish head represent the main problem, which is achieving the overburden production target. The head is placed on the right side of the fishbone diagram (Fig. 5).
- Fish fin
  Fish fins are used to write groups that cause problems. The groups of problems in achieving the overburden production target are man power factors, machine factors, method factors, and material factors (Fig. 6).

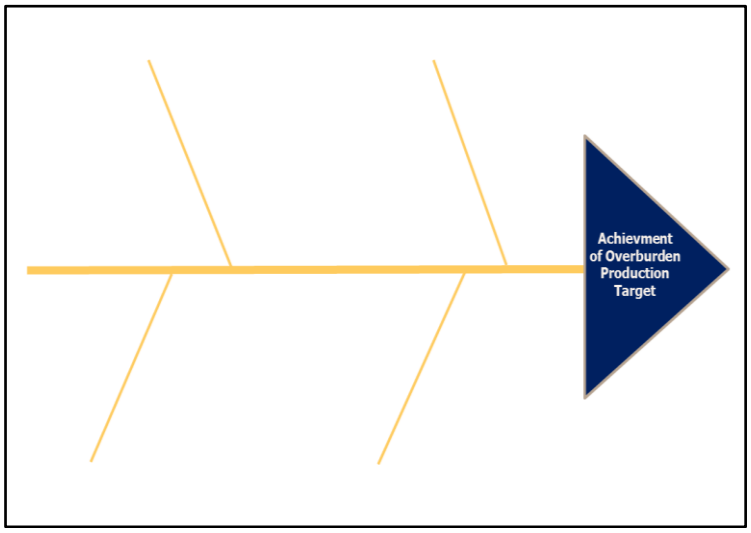

Figure 5. Fish head of fishbone diagram

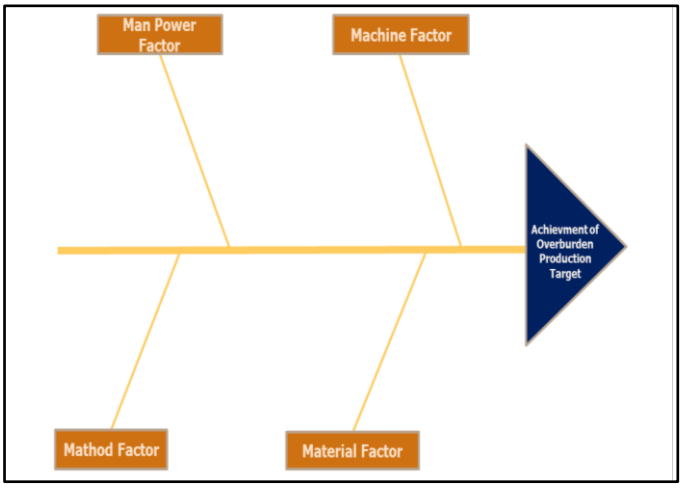

Figure 6. Fish fin of fishbone diagram

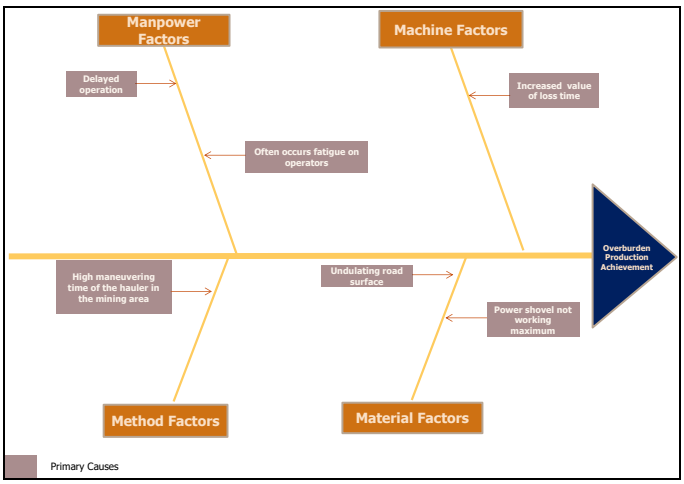

Figure 7. The primary causes on the fishbone diagram

- Fish bone

Fish bone are used to state the possible causes of problems for each group. Fish bones consist of primary causes, secondary causes and tertiary causes which are determined based on the results of questionnaires, direct observations and interviews. Primary causes consist of:

a. Man power factors are delayed operation and often occurs fatigue on operators.
b. Machine factors is the increase in the value of loss time.
c. Method factors is high maneuvering time of hauler in the mining area.
d. The material factors are the undulating road surface and the power shovel not working maximum.

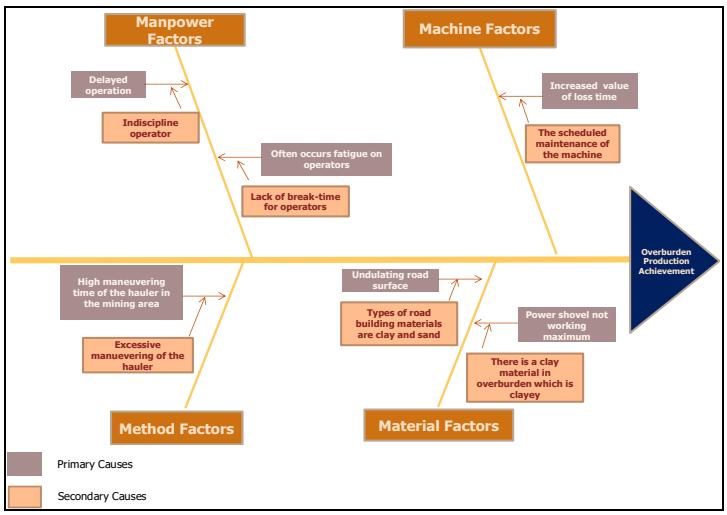

Figure 8. The secondary causes on the fishbone diagram

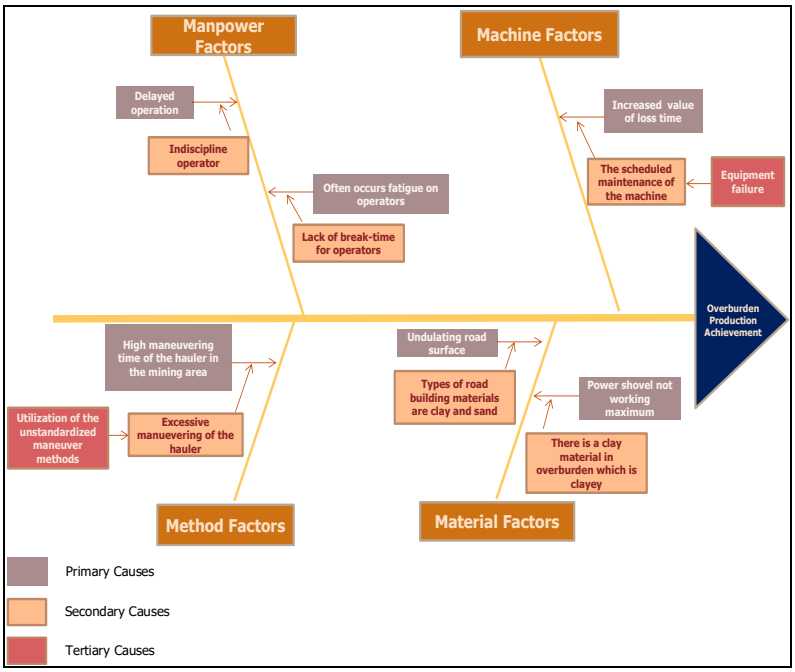

Figure 9. The tertiary causes on the fishbone diagram

Figure 7 shows the primary causes on the fishbone diagram. Secondary causes consist of:

a. Man power factors are indiscipline operator and lack of breaktime for operators.
b. Machine factors is the scheduled maintenance of the machine.
c. Method factors is excessive maneuvering of the hauler.
d. Material factors there is a clay material in overburden which is clayey.

Figure 8 shows secondary causes on a fishbone diagram.

Tertiary causes consist of:

a. Machine factor is equipment failure.
b. Method factor is utilization of the unstandardizied maneuver methods.

Figure 9 shows the tertiary causes on the fishbone diagram.

3.2.3. Group of factors causing problem

Factors that affect the achievement of overburden production targets are grouped into four categories, which are man power factors, machines factors, method factors and material factors. These factors are assigned to the fish fins on the fishbone diagram.

Man power factor are delayed operation and often occurs fatigue on operators. Machine factor is increase value of loss time. Method factors is high maneuvering time of hauler in the mining area. The material factors are the undulating road surface and the power shovel can't work to the maximum.

3.3. Fishbone Diagram Analysis

Fishbone diagram analysis was carried out to identify the root cause of the problem of achieving PT XYZ's overburden production target in November 2020. The analysis was carried out based on four causal factors, which are man power factors, machine factors, method factors and material factors. These causative factors are:

- Manpower factor

The causes that affect the achievement of overburden production targets from man power factors are:

a. Indiscipline operators cause delays in starting overburden stripping operations.
b. Lack of breaktime for operators which causes often occurs fatigue on operators.

- Material factor

The causes that affect the achievement of overburden production targets from material factors are:

a. There is an overburden material in the form of clay that is clayey or sticky when the material is dry it will become a hard lump, so that the power shovel not working maximum.
b. The type of road building material in the form of clay and sand causes the road surface to be undulating.

- Machine factor

The causes that affect the achievement of overburden production targets from machine factors is equipment failure causes the equipment need maintenance which results in an increase in the value of the loss time.

- Method factor

The causes that affect the achievement of overburden production targets from method factors are is utilizing unstandardized maneuver methods causes hauler maneuvers excessively, resulting in a high maneuvering time for the hauler to adjust its position with the loader in the mining area.

The causes that affect the achievement of overburden production targets from each factor can be classified in tabular form based on data and facts that occur in the field. The classification of the problem of achieving the overburden production target can be seen in Table 4.

Table 4. Classification of problems for achievement of overburden production targets

No.	Data and Facts	Problem Statements	Stratification Factor
1.	a. The increase value of the loss time. b. Indiscipline operators.	Delayed operation	Manpower
2.	Lack of breaktime for operators	Often occurs fatigue on operators	Manpower
3.	Equipment failure	The increase value of the loss time.	Machine
4.	Utilizing unstandardized maneuver methods on hauler	The hauler maneuvers excessively, resulting in a high maneuvering time for the hauler to adjust its position with the loader in the mining area.	Method
5.	Types of road construction in the form of clay and sand	Undulating road surface	Material
6.	There is a clay material in overburden which is clayey	Power shovel can not work maximum	Material

3.4. Recommended improvement plan

Recommendations for improvement plans are prepared after the root cause of the problem is determined so that the overburden production target can be achieved using the 5W+1H technique. The 5W+1H technique is an analytical method that is used as the basis for determining corrective action against each root of the problem and consists of what shows the problem, why shows the reason for recommending a repair plan for each problem, where indicates the location of the repair plan, when shows the time of the problem, who indicates the person in charge answer of each problem and how to show recommendations for improvement plans for each problem.

Recommendations for improvement plans are carried out in two stages, the first stage is the determination of the improvement plan (how) is carried out by the interview process and the second stage is the determination of the improvement plan recommendations based on the results of discussions conducted three times, namely on 21, 23, 25 December 2020 with other parties companies in the office.

3.4.1. Manpower factor

The causes of the unachieved overburden production target on the man power factor are indiscipline operator lack of breaktime for operators. The operator's work schedule is divided into two shifts, one shift consisting of 12 hours each working day starting Monday-Sunday. Shift one starts from 06.00-18.00 and shift two starts from 18.00 06.00. However, indiscipline operators resulted in a delay in the start of the operation by about ±30-60 minutes, resulting in a mismatch of the predetermined work schedule. The improvement plans are:

- Updating initial standard of the operation.
- Providing penalty against operators who commit an infringement and perform real time attendance.

Lack of break time for operators resulted in frequent fatigue on the operator. The improvement plan are:

- Identify, evaluate and controlling factors that may cause operator fatigue.
- Assess and manage operator fatigue levels before working shifts and during work.

Recommendations for improvement plans using the 5W+1H technique for man power factors can be seen in Table 5.

3.4.2. Material factor

The cause of the non-achievement of the overburden production target is the material factor, namely road construction in the form of clay and sand as well as hard materials. Hard materials make it difficult during overburden excavation activities which result in the power shovel not working optimally. If the power shovel is operated not in accordance with its capabilities, it will cause equipment failure. The improvement plans are:

- Undertake overburden blasting activities on dry material.
- Undertake ripping and dozing activities on wet materials.

Table 5. Recommendations for improvement plans on manpower factors

No	*What*	*Why*	*Where*	*When*	*Who*	*How*
1.	Indiscipline operators	Increased of effective working hours	Pit A	November period	Self-managed mining	1. Updating initial standart of the operation. 2. Providing penalty against operators who commit an infringement and perform real time attendance.
2.	Lack of break time for operators	Minimizing Work Accidents	Pit A	November period	Self-managed mining	2. Identify, evaluate and controlling factors that may cause operator fatigue. 3. Assess and manage operator fatigue levels before working shifts and during work.

Table 6. Recommendations for improvement plans on material factors

No	*What*	*Why*	*Where*	*When*	*Who*	*How*
1.	There is a clay material in overburden which is clayey	Efficient material loading activities	Pit A	November period	Self-managed mining	1. Undertake overburden blasting activities on dry material. 2. Undertake ripping and dozing activities on wet materials.
2.	The types of road building materials are clay and sand	Undulating road surface	Pit A	November period	Self-managed mining	1. Aggrandize the use a motor grader on mine roads to compact the road building materials

The types of materials that compose the mining road are clay and sand which basically have pores, so that if they are under pressure they will be compacted and cause the road surface to be undulating or failure quickly and result in obstruction of hauler to the mining site. The improvement plan is to aggrandize the use a motor grader on mine roads to compact the road building materials. Recommendations for improvement plans using the 5W+1H technique for material factors can be seen in Table 6.

3.4.3. Machine factor

The causes of not achieving the overburden production target on the machine factor is equipment failure. Equipment failure factor on the PC-3002 unit occurs because the use of the equipment exceeds the maximum working time, the breakdown of equipment, so the equipment must get maintenance. Types of equipment failure consist of breakdown schedule and breakdown unschedule. Breakdown schedule is equipment maintenance that is carried out every month while breakdown unschedule is equipment failure when the process of stripping the overburden is in progress. Breakdown schedule and breakdown unschedule can cause an increase in the value of the working time of the PC-3002 and PC 3003 units to 11 hours and 6 hours, respectively. The improvement plan is managing the utilization of equipment by checking before and after the equipment to avoid major failure.

Recommendations for improvement plans using the 5W+1H technique for the machine factor can be seen in Table 7.

3.4.4. Method factor

The cause of not achieving the overburden production target on the method factor does not use standard maneuvering methods on transportation equipment. The factor of the method of maneuvering the hauler used in the field is the 1.5 side loading maneuver method but the maneuver method used several times at the research location is often not in accordance with the standard maneuver method, causing hauler to maneuver too much and result in a high average the maneuvering time of hauler in the mining area is 41.87 seconds. The improvement plan is to improve supervision and controlling operators as performing maneuvers. Recommendations for improvement plans using the 5W+1H technique for method factors can be seen in Table 8.

Based on the results of the fishbone diagram analysis, there are four factors that affect the achievement of overburden production targets, namely man power, materials, machine and methods. The problems in the man power factor caused by the operator with four recommendations for improvement. The problem with the machine factor is caused by equipment failure which is given one recommendation for improvement. The problem with the material factor is caused by the type of road building material and there is a clay material in overburden which is clayey with three recommendations for improvement plans. The problem with the method factor is caused by utilizing unstandardizied maneuver methods given one recommendation for improvement plan.

4. Conclusion

The conclusions obtained from this research are the overburden production target at Pit A Site B in November 2020 is 513,333 BCM while the total overburden production obtained is 488,162 BCM which shows the production target was not achieved. Factors influencing the achievement of overburden production targets are machine factor that has the highest influence is equipment failure with a frequency of 14 times, man power factor that has the highest influence is time discipline with a frequency of 13 times, method factor that has the highest influence is hauler maneuvers excessively with a frequency of 9 times and material factor that has the highest influence is material type with a frequency of 10 times.

Table 7. Recommendations for improvement plans on machine factors

No	*What*	*Why*	*Where*	*When*	*Who*	*How*
1.	Equipment failure	Increasing loss time	Pit A	November period	Self-managed mining	1. Managing the utilization of equipment by checking before and after the equipment to avoid major failure.

Table 8. Recommendations for Improvement Plans on Method Factors

No	*What*	*Why*	*Where*	*When*	*Who*	*How*
1.	Unstandardized maneuvering methods	The cycle time of the hauler is relatively small	Pit A	November period	Self-managed mining	1. Improve supervision and controlling operators as performing maneuvers

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