Analysis productivity of the mine facility department using the objective matrix method (OMAX): case study in coal mining company

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Abstract. PT Kideco Jaya Agung is one of the coal mining companies in Paser Regency, East Kalimantan, using an open pit mining system which at the end of 2012 succeeded in realizing the production, transportation, shipping target of 34 million tons. Coal mining is carried out using excavating equipment and hauling equipment. Activities begin with land clearing using bulldozers and/or small excavators, blasting overburden and/or removal of overburden, cleaning coal, loading and transporting coal to the ROM stockpile. Throughout 2021 there has been a decrease in production results, it is necessary to analyze the productivity of the company's performance, which in this case leads to the mine facility department because it is directly related to production. The need to analyze productivity measurements so that it can be seen whether the mine facility department in this company is productive or not. The productivity measurement method that can be used to solve the problem is Objective Matrix (OMAX), because the OMAX productivity measurement model overcomes the problems of complexity and difficulty of productivity measurement by combining all important productivity criteria into an integrated form and interrelated with each other and easy to combine.

Keywords: productivity, objective matrix, fishbone diagram.

1. Introduction

In the industrial world, productivity is something that is absolutely necessary. Good productivity will be able to increase the percentage of the amount of production produced. Good productivity can be known through the effective working time of a production process, the shorter the working time of a work process, the productivity will increase. For this reason, it is necessary to calculate working time so that high productivity can be achieved. According to (Beatrix & Dewi, 2019), By knowing the level of productivity, the company can evaluate the performance that has been done and assess the efficiency of using a number of inputs in producing certain outputs. The level of productivity achieved by the company is an indicator that shows how efficient the company is in combining the resources in the company.

PT Kideco Jaya Agung (PT KJA) is a coal mining company in Paser Regency, East Kalimantan Province, operating under PKP2B license with cooperation contract No. J2/Ji,DU/40/82 dated September 14, 1982, PT Kideco Jaya Agung is a PMA (Foreign Investment) coal mining company whose majority shares belong to Samtan Co., Ltd. Seoul Korea (99.9%), The KP area of PT KJA is 50,400 hectares with coal reserves of approximately 2,071 million tons of coal. Using an open pit mining system which at the end of 2012 successfully realized the production, hauling, shipping target of 34 million tons. Coal mining is carried out using equipment such as excavator/backhoe as a digging tool and dump truck as a hauling tool. Activities begin with land clearing using bulldozers and/or small excavators, blasting overburden and/or removal of overburden, cleaning coal, loading and transporting coal to the ROM Stockpile. Reclamation and revegetation activities are carried out as soon as possible after the land is no longer disturbed (final).

According to (Fithri & Firdaus, 2016), the notion of productivity is very different from production. People often connect the notion of productivity with production, this is because production is real and directly measurable. Production is an activity to produce goods and services, while productivity is closely related to the use of resources to produce goods and services. Productivity is important for a company to know whether the company's performance is progressing or regressing. If the productivity of a company has decreased, the thing to do is to identify the causes of decreased productivity and also make improvements so that the company's productivity can increase. If the

productivity of the company increases, the profits generated by the company will also increase so that it will improve the welfare and quality of a company. Therefore, it is necessary to measure productivity at PT Kideco Jaya Agung. it is necessary to analyze the productivity of the performance of PT Kideco Jaya Agung, which in this case leads to the Mine Facility department because it is directly related to production. For a description of the production process in the Mine Facility department itself, there are several stages, namely Dump Truck (DT) operators dumping coal into the Feeder Breaker pit, then Wheel Loader operators and Dozer operators transferring coal to the Hopper and Feeder Breaker for production, with a total number of 96 workers working 3 shifts a day. Here are some productivity measurement models:

1. Model Marvin E. Mundel
   Basically, the Marvin E. Mundel model is a productivity measurement model based on concepts in the form of industrial engineering along with cost definitions in cost accounting. This model requires that the company to be measured productivity has a standard time to work (operation time standard), a condition that is still difficult to fulfill by the majority of companies in Indonesia (Rizky Prastyo dan Lukmandono, 2019)

2. Model APC (American Productivity Center)
   According to (Deoranto et al., 2016), APC is a method that compares base period data with current data used to determine the level of productivity and its impact on profitability. The APC method is a method that produces three productivity measures including productivity index, profitability index and price improvement index (IPH) (Ristanti et al., 2018).

3. Model OMAX (Objective Matrix)
   Objectives matrix or OMAX is a partial productivity measurement system developed to monitor the productivity of each part of the organization by considering productivity criteria appropriate to the existence of the part (Mukti et al., 2021). According (Supriyanto et al., 2016), the OMAX method has advantages over other methods, namely:
   a. Some of the factors that influence productivity improvement are well identified and can be quantified,
   b. There is a notion of weight that reflects the influence of each factor on increasing the company's productivity, the determination of which requires management approval,
   c. This model also combines all factors that affect productivity improvement and is assessed in a single indicator or index.

According to (Setiowati, 2017), The Objective Matrix (OMAX) measurement method has several advantages, namely, it can be used to measure all aspects of performance or productivity criteria considered in the relevant work unit. Then the work indicators for each input and output can be clearly defined. The form of this model is flexible, the determination of criteria depends on the environment in which it is applied because it includes management considerations in determining weights, the calculation of performance indicators is quite simple. In this case it also means that the data needed in this model is easily obtained in the company environment where this model is used. This study also aims to determine the productivity of the company using the Objective Matrix (OMAX) method by knowing what criteria cause decreased productivity in the company and the use of Fishbone Diagrams to determine poor/decreased productivity in oil palm plantations, and propose recommendations for improvements that must be made to minimize productivity problems at PT Kideco Jaya Agung.

2. Methods

In this study, data collection was carried out by conducting interviews with Mr. Herman Hidayat regarding the criteria that determine productivity in the Mine Facility Department. After the interview, it is known that the ratio criteria are total production data, total labor, working hours, overtime hours, and total raw materials. The data used in this study are production data for the 2021 and 2022 periods.

Objective Matrix (OMAX)

The definition of productivity according to the 1984 Oslo Conference, explains that productivity is a universal concept and aims to provide more goods and services for more people using fewer and fewer resources (Wahyuni, 2017). According to (Waluyo, 2018), that the factors that affect

productivity can be grouped into 3 groups, namely:

a. Factors that affect the productivity of the economy or industries as a whole,
b. Factors affecting the productivity of individual organizations, business units or factories,
c. Factors affecting individual productivity.

According to (Ramayanti et al., 2020; Wulandari et al., 2021), the steps of measuring productivity using the OMAX method include calculating the ratio of criteria, measuring standard values, determining short-term and long-term goals, determining the lowest score, determining the actual value and score, determining the productivity value and productivity index. The results of the OMAX method are the basis for determining the corrective measures that will be taken to improve suboptimal performance. According to (Nasution, 2006), the activities of the OMAX method are:

a. As a means of measuring productivity,
b. As a productivity problem-solving tool,
c. As a productivity growth monitoring tool,

According to (Faris & Helianty, 2015; Septifani et al., 2021), measuring the productivity of the production section with the OMAX method, the stages are as follows:

1. Criteria determination,
   Determination of criteria is adjusted to the work unit where the measurement is carried out, the criteria must state the conditions and activities that support the controllable work unit. In this study, measurements were made in the production work unit, the criteria that the production floor wanted to measure were as follows:
   Criterion 1 is production productivity (ratio 1),
   Criterion 2 is labor productivity (ratio 2),
   Criterion 3 is labor hour productivity (ratio 3),
   Criterion 4 is raw material productivity (ratio 4).

2. Performance determination
   Below are the measurement formulas for each criterion of raw materials, working hours, number of workers, and production effectiveness,

$$\text{Ratio 1} = \frac{\text{Number of products produced (Ton)}}{\text{Working hours (Hours)}} \quad (1)$$

$$\text{Ratio 2} = \frac{\text{Number of products produced (Ton)}}{\text{Total labor (Person)}} \quad (2)$$

$$\text{Ratio 3} = \frac{\text{Overtime working hours(Hours)}}{\text{Normal work hours (Hours)}} \quad (3)$$

$$\text{Ratio 4} = \frac{\text{Number of products produced (Ton)}}{\text{Quantity of raw materials (Ton)}} \quad (4)$$

3. Determination of average productivity value (Level 3)
   The average value (level 3) or also called the standard performance value is obtained from the average calculation of each performance ratio for each criterion during the measurement period and is placed at level 3.

4. Determination of the highest productivity value (Level 10),
   Level 10 is obtained from the highest (maximum) value in the ratio of each criterion during the measurement period.

5. Determination of the lowest productivity value (Level 0),
   Level 0 is obtained from the lowest (minimum) value in the ratio of each criterion during the measurement period.

6. Determination of realistic productivity values (Levels 1-2 and 4-9),
   The realistic productivity value is the value that may be achieved before the final goal or called the performance scale, which is the value between level 1 to level 3 and the value between level 4 to level 10 obtained in the following way:

$$\text{Scale } (1-2) = \frac{\text{Level 3-Level 0}}{(3\text{-}0)} \quad (5)$$

$$\text{Scale } (4-9) = \frac{\text{Level 10-Level 3}}{(10\text{-}3)} \qquad (6)$$

7. Determination of scores, weights and values,
   The score is obtained by looking at the performance measurement data and determining which performance measurement is currently at a level that is close to the number at level 0 - level 10, then the level of performance is written in the score column, what is written is the performance level not the performance value. The weight of each criterion is determined by the company staff which expresses the degree of importance (in units of %) that shows the relative influence of the criteria on the productivity of the unit being measured. The value is the multiplication of the weight and the score.
8. Productivity index measurement,
   Productivity Index measurement can be done if the ratio calculation has been done, and the target and weight have been determined. The productivity index is conducted to determine the increase or decrease in productivity.
9. Performance Indicator
   The performance indicator is the sum of all values and shows the performance of all criteria in each period.

3. Result and Discussion

After collecting data, the next step is to process the data. Data processing in this study, namely; determining productivity criteria, determining performance, determining the highest productivity value (level 10), determining the average value (level 3), determining the lowest productivity value (level 0), determining realistic productivity values (level 1-2 and level 4-9), determining (weights, scores and values), calculating the productivity index, determining performance indicators, determining the productivity index against standard performance, determining productivity indicators against previous performance and achieving scores on each criterion. The following is data processing on the productivity of oil palm plantations using the Objective Matrix (OMAX) method for the 2021 and 2022 period as shown in Table 1 and Table 2.

Table 1 Calculation results of productivity ratio in year 2021

Month	Ratio 1	Ratio 2	Ratio 3	Ratio 4
January	6.812	63.866	0.210	0.218
February	7.193	59.343	0.179	0.220
March	6.650	61.513	0.194	0.210
April	6.565	57.443	0.167	0.211
May	6.829	64.874	0.226	0.207
June	6.365	55.697	0.167	0.192
July	7.001	66.507	0.226	0.209
August	7.492	72.115	0.242	0.216
September	7.000	62.997	0.200	0.200
October	6.472	58.244	0.161	0.213
November	5.837	48.887	0.117	0.212
December	5.227	43.773	0.081	0.223
Average Ratio	**6.620**	**59.605**	**0.181**	**0.211**
Lowest Ratio	**5.227**	**43.773**	**0.081**	**0.192**
Highest Ratio	**7.492**	**72.115**	**0.242**	**0.223**

Table 2 Calculation results of productivity ratio in year 2022

Month	Ratio 1	Ratio 2	Ratio 3	Ratio 4
January	6.803	64.631	0.226	0.197
February	7.408	63.890	0.232	0.215
March	6.853	64.247	0.210	0.194
April	6.984	63.729	0.217	0.205
May	6.991	66.412	0.226	0.190
June	7.010	63.090	0.200	0.204

Month	Ratio 1	Ratio 2	Ratio 3	Ratio 4
July	7.075	67.208	0.226	0.197
August	7.235	68.737	0.226	0.191
September	7.032	63.287	0.200	0.181
October	6.877	64.474	0.210	0.209
November	6.905	62.141	0.200	0.237
December	6.609	60.308	0.177	0.267
Average Ratio	**6.982**	**64.346**	**0.212**	**0.207**
Lowest Ratio	**6.609**	**60.308**	**0.177**	**0.181**
Highest Ratio	**7.408**	**68.737**	**0.232**	**0.267**

Determine the Highest Ratio (Level 10), Average Ratio (Level 3), and Lowest Ratio (Level 0) values

The results of the calculation of the ratio value level 10 (highest ratio), level 3 (average ratio) and level 0 (lowest ratio ratio) are obtained through the calculation of performance in each month of the ratio, the calculation results for the 2021 and 2022 periods can be seen in Table 3 and Table 4.

Table 3 Ratio values of level 10, level 3 and level 0 for the 2021 period

	Ratio value			
Level 10	7.492	72.115	0.242	0.223
Level 3	6.620	60.567	0.181	0.212
Level 0	5.227	43.773	0.081	0.192

Table 4 Ratio values of level 10, level 3 and level 0 for the 2021 period

	Ratio value			
Level 10	7.408	68.737	0.232	0.267
Level 3	6.982	64.346	0.212	0.207
Level 0	6.609	60.308	0.177	0.181

Determining Realistic Productivity Values (Level 1-2 and Level 4-9)

The realistic productivity value is the value of the range of achievements ranging from the lowest to the highest value, which will be known to the score that will be achieved during the measurement period, the results in measuring levels 1-2 and levels 4-9 for the 2021 and 2022 periods can be seen in Table 5 and Table 6.

Table 5 Scale value of level 1-2 and level 4-9 for the 2021 period

Scale	Ratio 1	Ratio 2	Ratio 3	Ratio 4
***Level* 1-2**	0.465	5.277	0.020	0.006
***Level* 4-9**	0.125	1.787	0.009	0.002

Table 6 Scale value of level 1-2 and level 4-9 for the 2021 period

Scale	Ratio 1	Ratio 2	Ratio 3	Ratio 4
***Level* 1-2**	0.124	1.346	0.003	0.009
***Level* 4-9**	0.061	0.627	0.107	0.009

Determine Weight, Score, and Value

Determination of the score is obtained by looking at the performance that is close to the performance ratio for that period on the lowest to highest performance indicator (level 1 - level 10), Determination of the weight of each criterion is done by comparing which priority scale is more important between one criterion and another, The value is obtained by multiplying the score and weight that has been determined, Determination of this weight is carried out by Mr. Herman Hidayat as manager of the Mine Facility Department which can be seen in Table 7.

Table 7 Weight value in year 2021 and 2022

No	Productivity Criteria	Weight (%)
1	Production	34
2	Labor	32
3	Working Hours	23
4	Raw Materials	11

Determine Current, Productivity Index, and Previous Values

Before calculating the productivity index, it is necessary to calculate the productivity level (current) first, this calculation is done by adding up the values of all productivity ratios, here is an example of calculating the productivity level (current) in the January 2021 period:

$$170 + 160 + 138 + 77 = 545$$

Then after calculating the current for each productivity period, the next step is to calculate the productivity index for each period, here is an example of calculating the productivity index for the January 2021 period:

$$\text{Productivity Index} = \frac{545 - 300}{300} x100\% = 81.33\%$$

The calculation of the productivity index against the previous period (previous) is carried out to determine the increase or decrease in productivity in a certain period against the productivity of the previous period, the following is the calculation of productivity against the previous period in February 2021:

$$\textit{Previous} \text{ Februari 2021} = \frac{\textit{Current} \text{ period Februari} - \textit{Current} \text{ period Januari}}{\textit{Current} \text{ period Januari}} x100\%$$

$$= \frac{479 - 544}{544} x100\% = -11.95\%$$

After determining the highest ratio, average ratio, lowest ratio and scale values of level 1-2 and level 4-9, weights, scores, values, current, productivity index and previous in the 2021 and 2022 periods, the next step is to enter the measurement results in the performance indicator matrix table, The results of the performance indicator matrix calculation for the 2021 and 2022 periods can be seen in Table 8 and Table 9.

Table 8 Performance indicator matrix for January 2021

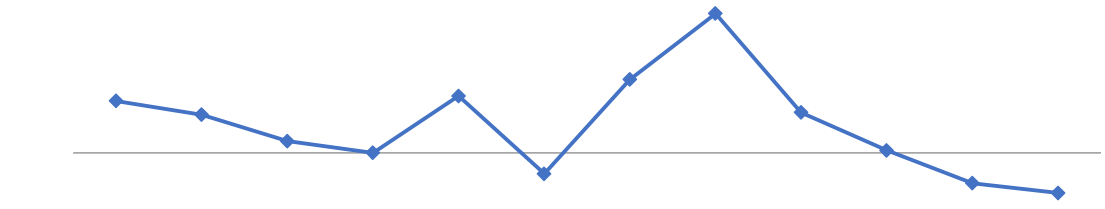
Criteria Performance		Ratio 1	Ratio 2	Ratio 3	Ratio 4
Target		6.812	63.866	0.210	0.218
Standard Performance	10	7.492	72.115	0.242	0.223
	9	7.368	70.327	0.233	0.221
	8	7.243	68.540	0.224	0.220
	7	7.119	66.753	0.216	0.218
	6	6.994	64.966	0.207	0.216
	5	6.869	63.179	0.198	0.214
	4	6.745	61.392	0.189	0.213
	3	6.620	59.605	0.181	0.211
	2	6.156	54.328	0.122	0.205
	1	5.691	49.050	0.101	0.198
	0	5.227	43.773	0.081	0.192
Score		**5**	**5**	**6**	**7**
Weight %		**34**	**32**	**23**	**11**
Value		**170**	**160**	**138**	**77**
Performance Indicator				***Current***	**545**
				Indeks	**81.33**
				Previous	**0.00**

Tabel 11 Performance indicator matrix for January 2022

Criteria		Ratio 1	Ratio 2	Ratio 3	Ratio 4
Performance Target		6.803	64.631	0.226	0.197
Standard Performance	10	7.408	68.737	0.232	0.267
	9	7.347	68.110	0.229	0.259
	8	7.286	67.482	0.226	0.250
	7	7.225	66.855	0.223	0.241
	6	7.165	66.228	0.221	0.233
	5	7.104	65.601	0.218	0.224
	4	7.043	64.973	0.215	0.216
	3	6.982	64.346	0.212	0.207
	2	6.858	63.000	0.390	0.198
	1	6.733	61.654	0.283	0.190
	0	6.609	60.308	0.177	0.181
Score		2	3	8	2
Weight %		34	32	23	11
Value		68	96	184	22
Performance Indicator				*Current*	370
				Indeks	23.33
				Previous	0.00

Standardized Productivity Index Graph Analysis

Determination of the productivity index (IP) is carried out to determine the decrease or increase that occurs in each period, the Productivity Index for the 2021 and 2022 periods can be seen in Figure 2 and Figure 3.

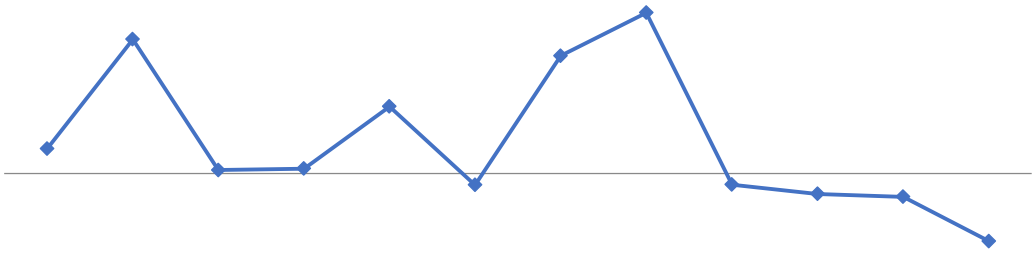


	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agu	Sep	Okt	Nov	Des
Indeks	81,33	59,67	18,33	0,00	89,33	-33,00	115,00	218,67	63,33	3,67	-48,00	-63,33

Figure 3 Productivity index 2021.

Figure 3 of the productivity index graph above shows that during the 2021 period the highest productivity index occurred in August, which was 218.67%, the productivity index was due to the fact that in this period the scores of the ratio 1 criterion, ratio 2 criterion and ratio 3 machine criteria were above average/achieved the desired target, which was at level 10. The lowest productivity index during the 2021 period occurred in the December period, which was -63.33, this is because the scores of the ratio 1, ratio 2 and ratio 3 criteria were at the lowest level, namely level 0.

Figure 4 of the productivity index graph above shows that during the 2022 period the highest productivity was in the August period, with a productivity index of 151.00%, the high productivity was because in this month the value of the ratio 2 criteria was above average/achieved the target, which was at level 10, while the lowest productivity during the 2022 period was in the December period with a productivity level of -63.33%, this was because the criteria for ratio 1, ratio 2 and ratio 3 were at the lowest level or below the average, namely level 0.



	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agu	Sep	Okt	Nov	Des
Indeks	23,33	126,00	3,33	4,67	63,00	-10,67	110,67	151,00	-10,33	-19,00	-21,67	-63,33

Figure 4 Productivity index 2022.

Determining the Score Value of Each Ratio

The score achievement of each ratio criterion is used to determine the worst ratio to be used in the proposed improvement, the score achievement of each ratio for the 2021 period can be seen in Table 12.

Table 12 Achievement score of each criterion for the 2021 period

No	Month	Achivement Score			
		Ratio 1	Ratio 2	Ratio 3	Ratio 4
1	January	5	5	6	7
2	February	8	3	0	8
3	March	3	4	4	3
4	April	3	3	3	3
5	May	5	6	8	2
6	June	2	2	3	0
7	July	6	7	8	3
8	August	10	10	10	6
9	September	6	5	5	1
10	October	3	3	3	4
11	November	1	1	2	4
12	December	0	0	0	10

The results of Table 12 show that during the 2021 period ratio 3 (Labor Hour Productivity) is the lowest ratio (level 0), the cause of the decline in productivity in the 2021 period is because there are several months with the lowest productivity (level 0), namely in February and December so that this criterion needs to be proposed improvements.

The results of Table 13 show that during the 2021 period ratio 4 (Raw Material Productivity) is the lowest ratio (level 0), the cause of the decline in productivity in the 2022 period is because the number of ratio 4 scores is the lowest compared to other ratios so that this criterion needs to be proposed for improvement.

Table 13 Achievement score of each criterion for the 2022 period

No	Month	Achivement Score			
		Ratio 1	Ratio 2	Ratio 3	Ratio 4
1	January	2	3	8	2
2	February	10	3	10	4
3	March	2	3	3	2
4	April	3	3	5	3
5	May	3	6	8	1
6	June	3	2	3	3
7	July	5	8	8	2
8	August	7	10	8	1

No	Month	Achivement Score			
		Ratio 1	Ratio 2	Ratio 3	Ratio 4
9	September	4	2	3	0
10	October	2	3	3	3
11	November	2	1	3	6
12	December	0	0	0	10

Fishbone Diagram

The cause and effect diagram is a diagram developed by Dr. Kaory Ishikawa in 1943 which is used to show the causal relationship of a problem or deviation (Eviyanti, 2021). According to (Saori et al., 2021), states that this diagram is also called a fishbone chart and is useful for showing the main factors that affect quality and have an effect on the problem we are studying, besides that we can also see more detailed factors that affect and have an effect on these main factors which we can see on the arrows in the form of fish bones on the fishbone diagram.

The Cause and Effect Diagram is used to find the root cause of the decline in productivity for the 2021 and 2022 periods. In the 2021 period, the cause and effect diagram is made for the ratio that has the lowest performance (level 0). Problem identification is obtained through interviews with Mr. Herman Hidayat as Manager in the Mine Facility Department. The following is a problem identification using a causal diagram can be seen in Figure 5.

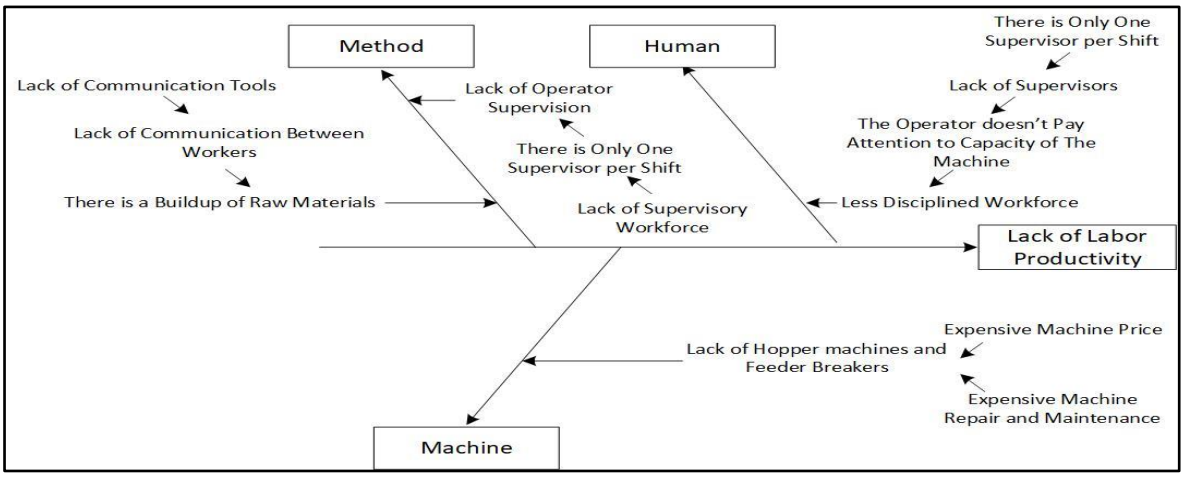
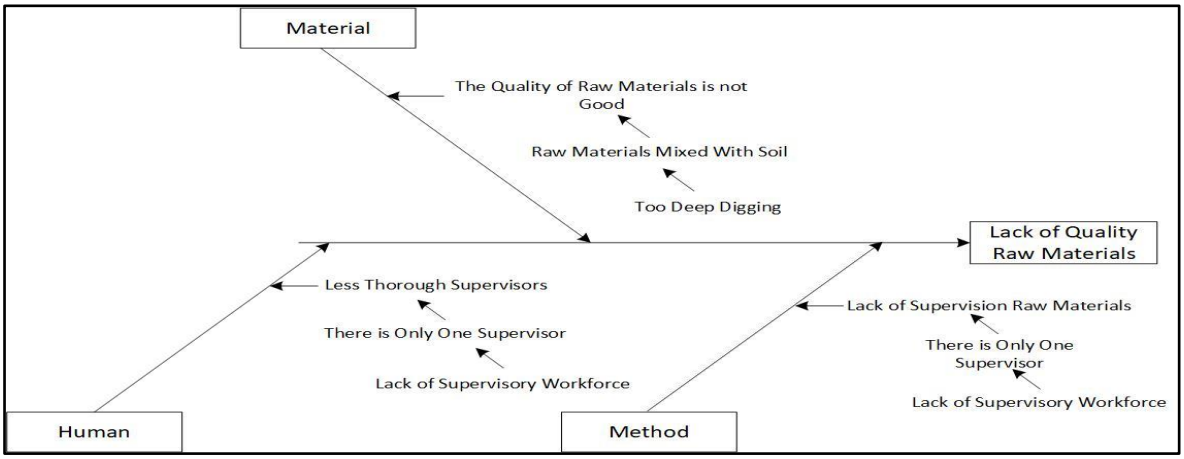


Figure 5 Diagram lack of labor productivity.

Productivity for the period 2022, in Figure 6 below is a causal diagram of the ratio of 4 criteria for the production target not being achieved which is influenced by several factors, namely human factors, materials and methods.



Gambar 6 Fishbone diagram of unachieved production target.

Determining Improvement Proposals

Based on the results of identifying the causes of declining productivity in the company using a cause and effect diagram, it is necessary to propose improvements/improvement solutions, Proposed improvements that need to be done can be seen in Table 14.

Table 14 Proposed Improvements

Problem	Proposed improvements
Surveillance	It is necessary to increase the number of supervisory labor in each shift such as adding 2 supervisors to each shift which at the beginning was only 1 supervisor, so in each shift there are 3 supervisors who are in charge of supervising 1 supervisor operator, who is in charge of supervising 1 supervisor's machine and who is in charge of supervising 1 supervisor's raw material so that everything is not charged only to 1 supervisor in each shift.
Raw Materials	It is necessary to supervise the raw materials that will be used in production, therefore if the supervisor knows the quality of coal that is not good, the supervisor will provide this information to the excavation department so that the quality of the next coal will be better than before.
Labor	More supervision of operators is needed, such as increasing the number of supervisory workers in each shift. Two-way communication tools such as Handy Talkie (HT) are needed, which is a communication tool that utilizes radio frequencies.
Machine	Routine machine repairs are required within a certain time such as once a month to keep production running normally.

4. Conclusion

The highest productivity index is in August with a total value of 218.67%, the high productivity in August is due to the value of ratio 1, ratio 2, and ratio 3 above the average/reaching the target while the lowest is in June with a total value of -63.33%, this is because in June the value of criteria in ratio 1, ratio 2 and ratio 4 is below average, While during the 2022 period the highest productivity index was in August with a total value of 151.00%, the high productivity in August was due to the value of ratio 1 and ratio 3 above average and also ratio 2 which reached the target, while the lowest was in December with a total of -63.33%, this is because in December ratio 1, ratio 2 and ratio 3 were below average.

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