



# CYCLE DEVELOPMENT PROCESS IMPROVEMENT IN EXTRACTION LEVEL ON PRODUCTION PLAN UNDERGROUND GRASBERG BLOCK CAVE (GBC) AT PT.FREEPORT INDONESIA

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**Abstract:** Development is a process of making aperture (tunnel) is done by dismantling (excavation) both manually and mechanically. The results to be obtained that is in the form of opening holes according to Grasberg Block Cave (GBC Mine) production plan based on the purpose of the open pit function. Propose is done to support other fix facility in order to support the Production Plan in 2018. Completion of a hole openings (Tunnel) with the rule that is a continuous stage (cycle development) that there must be a good control system of development process. Control that is done design engineering and its application in the field. The fact is that in 2015 - 2016, the target gain is not in line with expectations and causes the meter (d Equivalent meter) of operational development at the extraction level in the GBC Underground mine to decrease by 50 - 55% or about 641 meter up to 1000 meter difference of the second plan of the year.

Identification of the current problem is the process of progress of opening aperture that has not reached the target because one of the process in the cycle development of Mucking and Hauling not achieved the target because of some basic things. The minimal information and low support of the reporting system caused some strategic decisions to be delayed and caused simultaneous cycles to experience significant constraints. A centralized and fast-accessible Information System from either input or share data by all stakeholders responsible for operational project development tunnel is very supportive. Good motivation greatly affects the performance of each stakeholder working on the project, so that the appropriate approach according to Human needs can be done in order to increase productivity.

Project Management with CPM method as well as Human Resource Management (Motivation application of Abraham Maslow) becomes an option in humanizing according to the Root problem obtained by the Current Reality Tree method. The hope is that the development process runs quickly, safely and safely and operational with little operational expense and minimal repetitive

**Keywords:** cycle development, production plan, underground mine

## PENDAHULUAN

PTFI Operated one of the largest copper and gold mines in the world located within the high land of Sudirman Mountain Range in the highland of Papua, the Easter most province in Indonesia. PTFI commenced mining operating at this site in 1972 and in 1988 discovered by Grasberg mine. PTFI operated under a Contract of Work (COW) with the Government of Indonesia that allows PTFI to undertake the exploration mining and production activities in the highland.

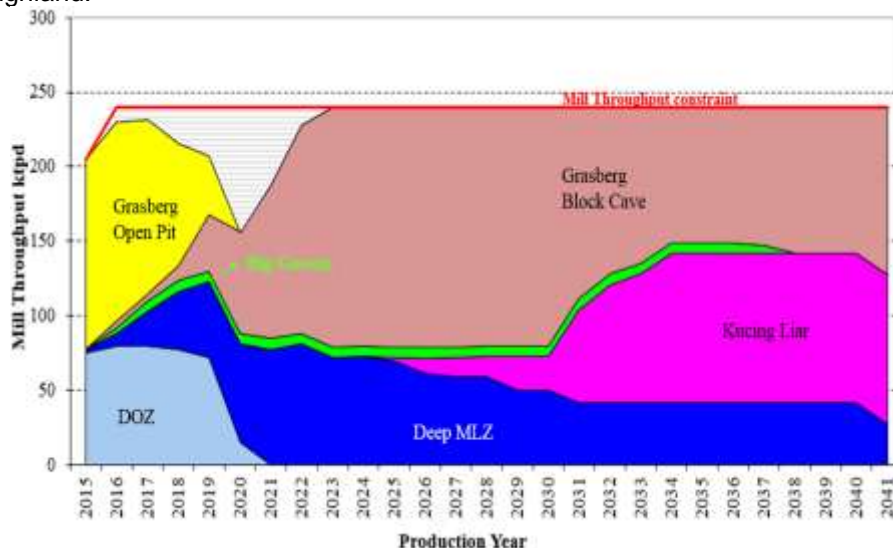


Figure 1. Contribution by Ore Body from each PTFI Mine

PTFI Operated two mining operation in the Grasberg (open Pit) with Productivity average 190 ktpd Ore and Underground specially Grasberg Ore Body will take production peak on 2022 (160 ktpd). Produces Production with a rate of 160 ktpd is the accumulation of several underground mines operating at PT. Freeport Indonesia consisting of: Deep Ore Zon Mine (DOZ), Big Gossan Mine, Kucing Liar Mine, DMLZ Mine (Deep Mill Ore Zone), GBC Mine (Grasberg Block Cave)

Surface mine (Grasberg Pit) will transition to underground mine. Grasberg Block Cave is one of the underground mine is still in the development stage. The underground mine is located between 2535 MSL (lowest) and 3060 MSL (highest). Base on study 10-k reserve on 2014 around 1.012 million ton specific content of minerals are 1.00% Cu, 0.77g/t Au and 3.49 g/t Ag.

GBC Mine is one of future mine of PT. Freeport Indonesia currently still doing the Preparation Tunnel to separated level to implementasion Block Caving Method to support GBC Production on 2018. There are level produce or development Level Undercut (2850L), Level Extrction (2830L), Level Haulage (2760L), Level Conveyor (2700L) and last one is Level Services (3060L).

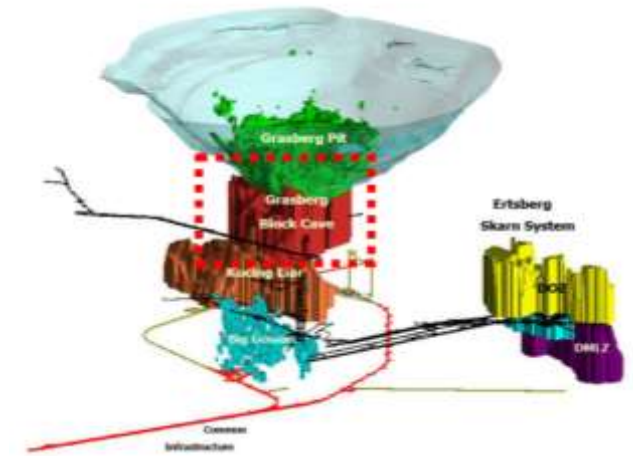


Figure 2. Underground Map (Research Area in Red Box)

**GBC Extraction Panel Project**

Extraction Level (2830L) is one of production level that functions as a separation area for the ore materials with high economic value and also for the waste. The separation process need some holes to be constructed called the draw point which has the purpose as separation spots with bigger dimension and area. In the process of developing this area, there are main activities that have to be accurately measured and done such as:

Main Activity are: Drilling and Blasting, Mucking and Hauling, Primary Support, Secondary Support (Shotcrete/spray).

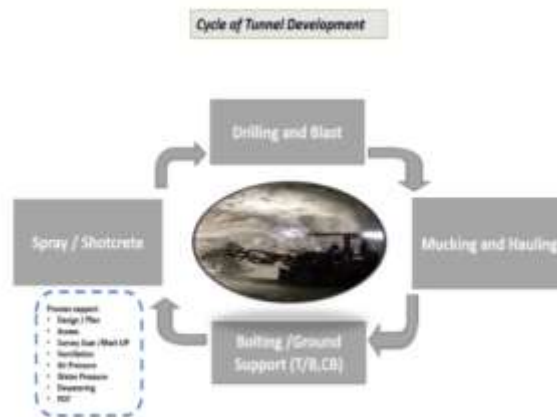


Figure 3. The Concept of Development Cycle

While never forgetting that there are some additional concerns regarding this development cycle such as: Approved design/ plan, Access, Surveying, Ventilation, Electricity power, Water and air pressure, Pull out test data, Dewatering

**Business Issue**

The speed of tunneling development in extraction level which is indicated by the target achieved results in the positivity of production plan that has to be fulfilled in the first quarter of 2018. The current development is racing by time with calculated amount of active working time around next 7 – 8 months so that the operation can be done well and integrated In planning and execution. The target of 1.404 mDeq is a number that has been agreed in 2015 becomes the main data in analyzing this research. The achievement of 763 mDeq or just around 50-55

% in 2015 resulted in 641 mDeq gap that has to be chased as a backlog progress in that period (2015 forecast) and 45 % is production loss on that period and budgeting loss around 115 billion Rupiah. Actual data in table and chart is shown below.

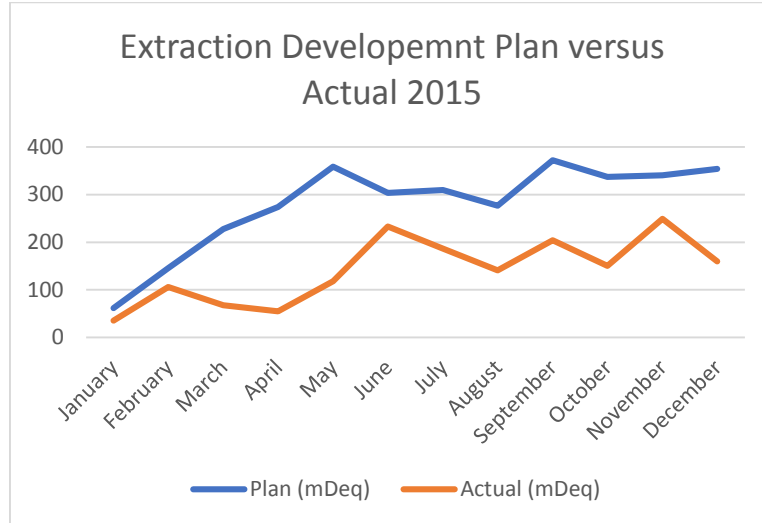


Figure 4. Grafik Plan vs Actual Development 2015

Table below show about Plan, actual and GAP of GBC Extraction development Plan on 2015 -2016  
 Table 1. Plan versus Actual Development Meter during 2015-2016

Summary Achievement meter Development 2015-2016			
Year	Plan	Actual	Diff
2015	1403.7	762.8	640.9
2016	2647.2	1642.5	1004.7
<b>Total</b>	<b>4050.9</b>	<b>2405.3</b>	<b>1645.6</b>

Below is the identify Symptom of the to effort production loss (GAP):

1. Lots of muck being stuck with the reason of no loader unit
2. Line services (piping) which are not hanged up but placed on the muck.
3. Little information of damaged equipment or tools to supervisor to be fixed.
4. Problems occurred with units but reported slowly to be followed up
5. Lack of spareparts and manpower

**Conceptual Framework**

The process of earning meter D equivalent focused in extraction panel can be explained in the concept below. The goal of this concept is to identify the concern by looking through the critical path from the main operational and support which can be explained by relevant theory. The analysis to this conceptual framework which is proposed for conclusion of this thesis is shown below.

Conceptual Framework :

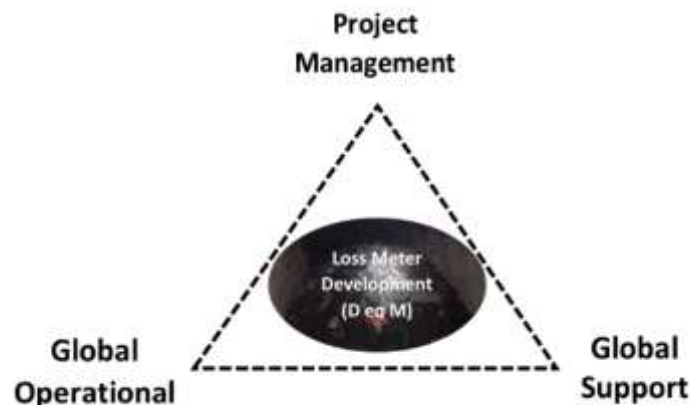


Figure 4. Conceptual Framework dari Process meter Development

**5. Main Operational Process (Global Operational) and Main Support Process**

Main Operation (global Process) can not be running without Support Operation Process. **Mine Operational** is the four of Critical Path iin Development Cycle.there are : Drill and Blast,Mucking and Hauling,Primary Support and Secondary Support.

**Main supports** are activities that have essential parts in supporting the main operational in mine life cycle. There are : ventilastion,electric,air and water pressure,Drainage,Surveying,QC/Pull out Test.

Below are icture show about Main Operation and Main Support Operational



Figure 5. Broken down Loader and waiting Mechanic Repair

The current critical path in extraction gbc project is muck. Immediate predecessors from the critical path above are the cause of the problem arises. Mucking process is essential to the successor activity because the duration needed after the actual blasting is 2 hours but can be delayed till 24 hours of variance. The mucking process described before is the status of obstructed operational caused by mis communication in information and response regarding the readiness of the area or other issues such as unit broken down in the main access, have to wait for the spare parts that which are not noted well in the inventory system and etcSome problems that occurred in extraction project are shown by pictures below:



Figure 6. Muck after Blasting,services line top on stuck muck and broken down ventbag (Main Support Process)

Imagine condition is area has clean from muck and not more material blcoks the access or propose mucking area so Immediate predecessors keep going well.show by pictures below:



Figure 7. Primary Support Activities (Mine Global Process)

**Project Manajement.**

Project management is a structured activity to maximize every resource based on the pillars that consist of Cost, time and scope of the work which hoped to run well and presented in high grade quality. It is called efficient and

effective if only all the pillars rely on side by side and supporting each other with any practical method that suits the condition of the project.

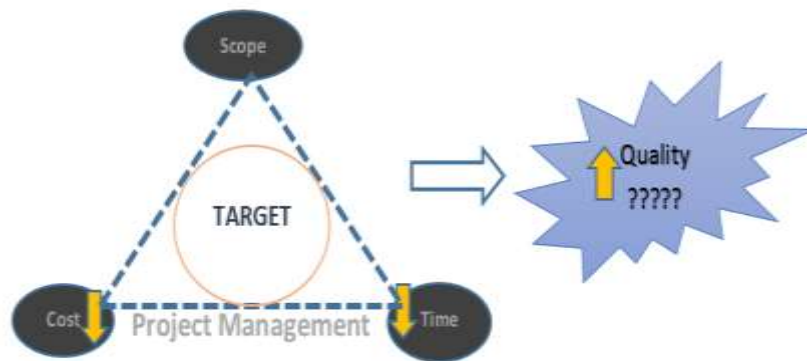


Figure 8. Pillar of Project Management

The purpose of project management is to assure all the process is going well whereas the observation can be done by looking at these aspects below:

1. Time: the duration of a project has to be as short as possible and not wasting time. Not forgetting that the possibility of re-work or doing the same activity has to be decrease.
2. Scope: scope of work from this project is the speed or the resources ability to present the tunnel which is clean from development material and any other issues so, the next process can continue smoothly.
3. Cost: the budget has to be used wisely in order to achieve maximum result. The usage of budget has to be as little as possible and avoid additional budget in some critical point of a project.

Project management consist of three big process such as: Planning, Organizing/ scheduling and Controlling. Schematic or Critical Activities below is sample of CPM Provided and doing control and how to optimize time to control critical activities. The schematic critical path method is delivered in the flowchart shown below:

Identify and Critical Path correlation

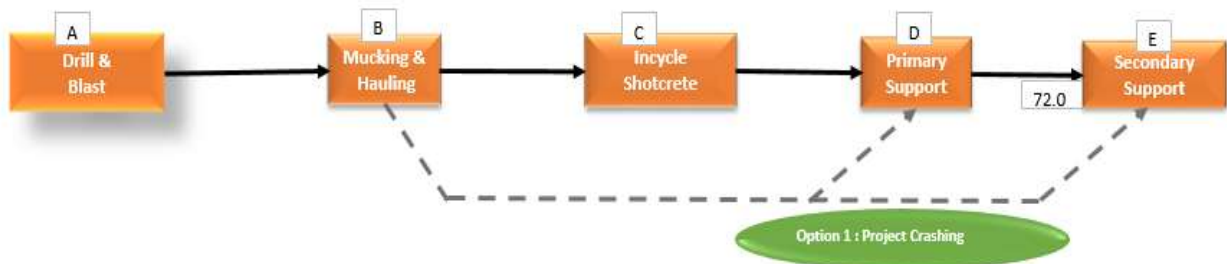


Figure 9. Critical Path Identification

Sample of CPM and PERT Approach can show the estimation of time spent to finish the project with assumption of Optimistic, most likely, pessimistic and variance activities.

Table 2. Time Estimated for Cycle Development (Sample: Mucking and Hauling)

Global Operational Activities	Global Support Activities	Activity Desgin	Time Estimates (minute)			Expected Times (ET)	Activity Variance ( $\sigma^2$ )
			a	m	b	$a + 4m + b$	$b - a$
						$\bar{t}$	$\sigma$
Mucking & Hauling ( B )	Check and Clean up Access	B1	30	30	50	33.33	11.11
	Check blasted material (dev muck)	B2	30	10	40	18.33	2.78
	Check Ventilation Condition (turn on /off)	B3	30	30	50	33.33	11.11
	Spray material with water (dust ,smoke protection)	B4	30	30	180	55.00	625.00
	Set Up Mucking & Hauling Position	B5	30	10	50	20.00	11.11
	Do Mucking and Hauling	B6	120	120	1440	340.00	48400.00
	Finishing area before next job	B7	20	10	30	15.00	2.78
	Unit break down, Bad Communication (waiting mucking confirmation)	B8	120	120	1440	340.00	48400.00
	Total	Minute	410	360	3280	855.00	97463.89
	Hours	6.83	6.00	54.67	14.25	1624.40	

The **optimistic time (a)** of the Mucking & Hauling activity is 410 minutes obtained from some of the sub activity activities. If it is correlated with working hours, the value (a) in the operational is 6.83 = 7 hours).

From the table, the **most likely (m)** value is 360 minutes or 6 hours earned from accumulated the sub activity listed above.

While the **pessimistic time (b)** from the analysis is 3280 minutes or around 55 hours. This value is earned by accumulated some of the sub activities listed Mucking and hauling critical path.

From **Time Estimates**, the next step to be done is getting the expected time to predict the duration needed for finishing the project. The critical path for this analysis spreads between 15 minutes (lowest) to 340 minutes

(highest). The accumulation obtained from the expected time analysis is 855 minutes or around 14.25 hours of active working time.

Table 3. Variance Analysis of Activities

Summary of Variance Analysis					
Global Operational Activities	Global Support Activities	Analysis Activity Variance ( $\alpha 2$ )		Combine Variance in days	
		Activities Variance	Remarks	Hours	Days
Drill and Blast	Blasting (sleeping blast)	56406	Delay Blasting cause the KIM Owner on vacation and also Expired the blating license by Republik Indonesia Government	940.10	39.17
Mucking & Hauling	Do Mucing & Hauling	48400	Unit Loader broken down (Engine want to start and Flat Tyre),miss communication between Mechanic and Operation to provide material/spare part and direction to pick up other tyre from surface	806.67	33.61
	Unit Broken Down,Bad Communication (waiting mucking confirmation)	48400	Waiting time to execution mucking at the field cause no more information provided by Ops,mechanic or others team to make decision for mucking process	806.67	33.61
Incycle Shotcrete	Unit Down & Blocked Access	48400	Unit Broked down (Stroke Pump need replace and waiting part) and actually can move from the access	806.67	33.61
Primary Support	Unit Down & Blocked Access	48400	Unit Broken down and mechanic waiting part from overseas to repair that unit	806.67	33.61
Secondary Support	Drilling and Install T-Bars / Cablebolt (Stock cement)	490000	Waiting material (shotcrete chemical) cause the trasportation blocked by land slide at mine access from LL to HL	8166.67	340.28
	Unit Down & Blocked Access	48400	Hidraulick Pump is broken down and waiting mechanic to repair and moved from the access.	806.67	33.61

The delay contributions as result of the critical path (mucking and hauling) discovered in the 48,400 minutes. The highest value of the expected time analysis is 490000 minutes equal to 8166 hours or 340 project days. And the lowest is 48400 minutes equal to 806 hours or 34 project days. The huge difference in this estimation is possibly caused by internal and external status of the GBC Extraction Project activities. The most influencing contributor of the value is Secondary support operational. In the process of ground support which is drilling and cable bolt grouting, the essential materials needed is cement. Ideally, the amount of cements needed has already been planned according to the supply and demand on the field. But the fact is that this process always is always disturbed by external aspect of unpredictable incident like the main access which is used to transporting the material was blocked by the landslide.

The actions taken has to be strategic in order to minimize the progress delay caused by controlled activity such as : (1)The coordination between safety and training team in accommodating the detonating license update so the expired license case won't happen again.(2)The intense coordination with mechanic team regarding the response to broken down unit that cause delay because of the blocked access.(3)Maximize the reporting time by the mechanic with clear urgency level.(4)Spare part has to be ready all the time so that the "just in time" concept is applicable.(5)Unpredictable condition of the ground should be identified early by the geotech team so that the transportation schedule can be planned specifically.

Variance activities resulted from the PERT analysis presents some activities which are happened in normal condition do not give big impact (do Prevention action).

**Communication improvement** is a big thinks to know about how to control and manage operational. Longer time to communication about strategic palhn to execute the job is impacted to all working project plan so need improvent to be beter.Ideal communication in this project approach.

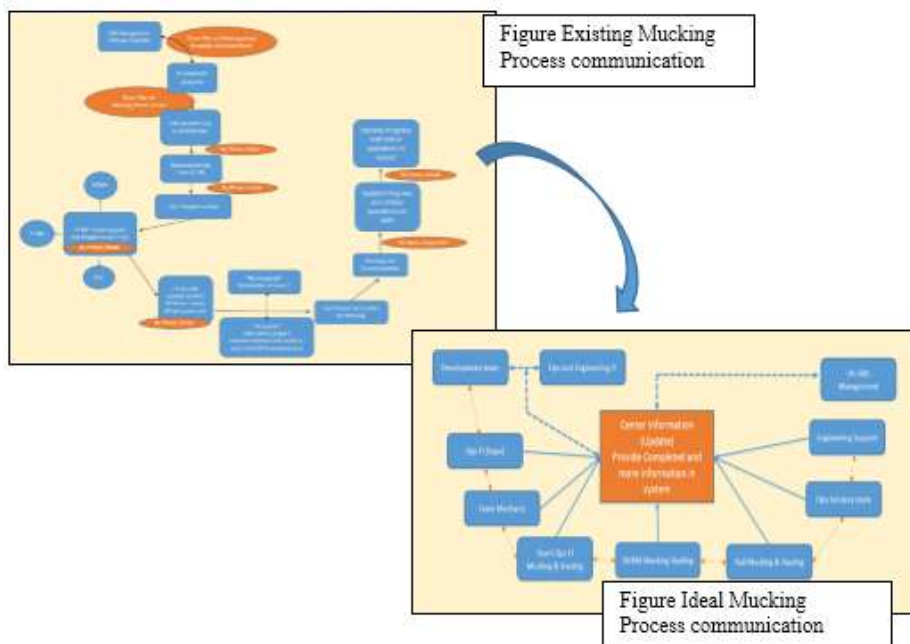


Figure 10. Existing and Ideal propose communication

The contractors involved in the operational development such as :

1. Development and hauling team by PT Redpath Indonesia
2. Hauling team PT.BUMA (Strukturindo Tifatama)
3. Alternative Hauling Team by Rail Track Team
4. Hauling team PT Freeport Indonesia.

8. Human (Motivation and Education)

Humans/people in the organization are the main component in running a project. Humans have the right and obligation in their essential positions of a project. A productive human is the one that has clear motivation, exact and has to be fulfilled.

Motivation is a human character in doing something indicated by *3 important elements which are Intensity, direction, and diligence that have to be managed right*. Motivation can give wide impact to the goal achieved by someone and push the others to do the same to reach the team targets. Here is the hierarchy of needs refer to **Abraham Maslow** concept.

Maslow explains the motivation theory by five (5) levels of human needs sorted from the highest to the lowest, which are

1. Physiological needs
2. Safety needs
3. Love needs
4. Esteem needs
5. Self-actualization needs

Based on this pyramid, stated that point 1 and 2 are the primary needs and the rest is the secondary needs which can be fulfilled if only the subject is already satisfied with the feeling of hungry, thirsty, sex and being loved in the society. The motivation theory by Maslow is considered relevant and can accommodate the needs of this study, which are Low motivation and low education. The focus of this writing is divided into those five points, which can be analyzed further to get the maximum result.

9. Root Cause Analysis

Root cause analysis is one of the technique to identify the root cause of problems that cause the delay of the operational. The approaching in gaining information to find the root cause through:

1. Focused Group Discussion with:
  - a. a mining operator
  - b. a Superintendent of development)
  - c. a Development General Foreman expert
  - d. Two Expat Experts
2. Review of the system

**FGD with two experts: Planner**

The structure of root cause identification is divided to 4 components with each function and responsibility and has close relationship to critical path operational. They are:

1. Skill of supervisor
2. Internal Develop labor
3. Equipment
4. Information and reporting system

Big impact made by the current system is that the meter development achievement by the operational excavation team in the underground mine is slow and far from the expected target. The writer is trying to analyzed it with current reality tree (CRT) and shown in the chart below.

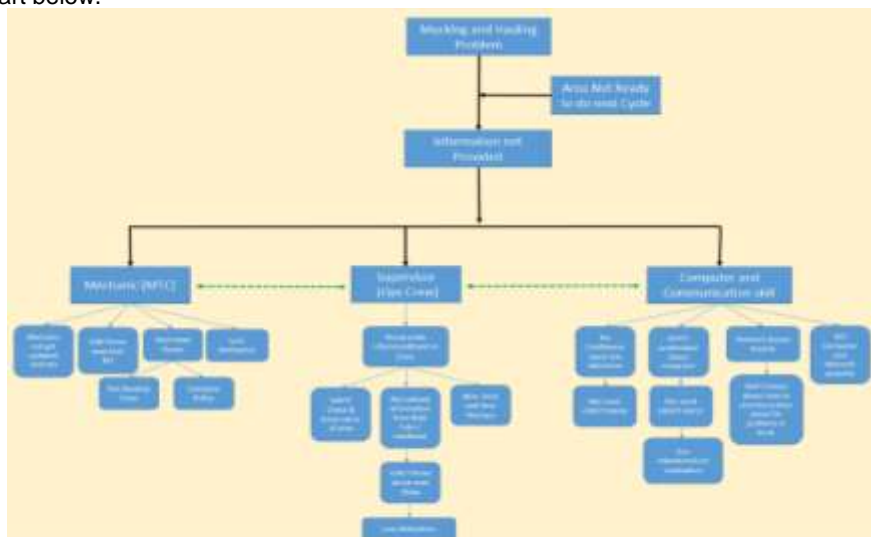


Figure 11. Current Reality Tree for Hauling Development Muck

This condition needs to be analyzed as soon as possible base on the work life cycle and dimension reference which is categorized as a small drift (4mHx4.4mW). The actual duration of mucking and hauling activity respectively is 2 hours in 1 normal shift due to the distance and location of the loading and unloading materials at the same level. During those times, there are some main support activity being done such as :

1. Cleaning up the main access area for mucking and hauling with loader
2. Making sure of the ventilation is running well
3. Checking the line power and supply

4. Blowing the dust with water and air pressure
5. Setting up mucking position if haul truck is used to make sure the raise is placed correctly for mucking out
6. Mucking and hauling till the surface till it is clean enough for next activity.

**10. Current Situation**

Current situation of human resources in the project is mainly because of low motivation showed by the employees. The unbalanced of right and obligation received by the employees is thought to be the reason why the employees performance are still below the meter development target.

The relationship between stakeholders in this case is related closely to the project's performance. The stakeholders which are involved and responsible for the sustainability of this project is GBC Management.



Figure 12.. Current Situation of Motivation in the team

There are some indicators, which make the front line management lose its credits. Three Pillar in this Current Situation must be do good communication and aware each and other. Transparation plan and other strategic must be share in the team and the effect is every stakeholder have great fill about them realy important. It meas we create sense of belonging of each and other.

**11. Alternative Solution and Solution Propose**

Alternative Solution, which is studied, based on the analysis result with some tools that is Rich Picture to analyze some process that considered quite influential in the process of Operational project is as follows:

1. Making Personal Development Plan (in line with Career Development Program)
2. Conducting Refresher & Training (Motivation) to the required employees.
3. Evaluation and Develop system communication (evaluation existings and propose ideal condition.

Table 4. Alternative Solution

Alternative Solution				
	Solution	Scope	Time	Cost
Scenario 1	Create (PDP / Career Development Program)	High (OK)	Short (OK)	Low (OK)
Scenario 2	Refresher & Training	High (OK)	Short (OK)	Low (OK)
Scenario 3	System Communication	High	Long	High

One of three solution propose, the Scenario 1 is exected with this current situation is Scenario 1<sup>st</sup> Making Personal Development Plan (Career Development Program. To Create the PDP or Career Development Program need to know about needs and combine with the company or project Plan. Need cleary information about the Scope of work / job (**effectivity**), **Time** need to running or implementation the plan and last one is How much **budget (cost)** to do implementation plan. To do weighted method, Focus group discussion always do by the team. **Weighted Average Method (WAM)** is a method to make decision to choose the good alternative.

**12. Proposed Solution**

Thus, the solution that can be delivered in responding to the situation in this study is realistic and measurable. Implementation of Scenario 1, Personal Development Plan in line with Career Development Program. To do 1<sup>st</sup> Scenario need to identify the candidats with selection method and Conducting Training Motivation and Class Education to employees can be done simultaneously by doing some steps Implementation that can be done that is:

1. Identify problems and link causes by taking into account Human Sources
  2. Designing an appropriate and easy-to-run development system with measurable time.
  3. Involve a broad range of stakeholders in training and education
- Provide Apresiasi and opportunity for Self Actualization so that team feel appreciated and motivated to be more productive.

### 13. The Propose Engagement to internal management

Things that can be done to ensure this plan can run optimally by performing strategic steps that support the implementation of the program or solution offered include:

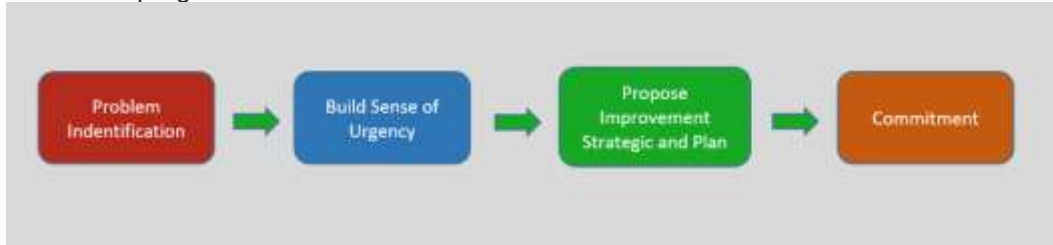


Figure 13. Engagement Step with Management Team (Stakeholder)

### The Propose Engagement to internal management (why is important) to success the project are:

1. Build sense of Urgency,
2. Get the Approval from Management,
3. Clearly communicate the problem
4. Get the support from internal workgroup.
5. Get the commitment from stakeholders to success the continuous improvement.

### 14. Implementation Plan

Based on the Propose Solution in the previous Chapter, Human Resources needs adequate management and needs to implement an applicable plan. The concept is presented in the following format.

Table 5. Action Plan for Human Resource

Action Plan for Human Resource					
Develop Item	Whom	Strategic Plan	Action	Duration	Pic
Motivation for employee (Base on Maslow Hierarchi)	Crew (Subordinate)	Motivation Training to control employee Physiologi,Safety ,Belonging ,esteem and self actualization	Do Motivaton Class Training to manage employee needs and how to solve the issue about low motivation	1-2 weeks	GBC Management,OD Dept & Employee
	Supervisor	Motivating leader or Manager to know about them self (them strength).	Do Motivating class to accommodate leader or manager to identify cause and solve just in time with them strength. Do Supervisor Training	1-2 week	GBC Management,OD Dept & Employee
Training to develop Employee	Employeer	Development skill Training	Development Class to built employee knowledge and skill to know them strengt Do Exercise about training to show them how to implementation Do Evaluation to know knowlrdge has accepted. Assign new job to built them self	2-4 weeks	GBC Management,OD Dept & Employee
	Employee	Education for Employee (affirmative program)	Do Class / school to teach people and built them knowledge to understand about them self. Include them in the team to learn about organization and team work.	3-5 weeks	GBC Managemnet,Organizati on Develepent Training & Employee

Table 6. Gant Chart Motivation and Improvement Plan

Simple Gantt Chart and Goal propose for Motivation and Education improvement																	
Action	Duration (weeks)															Goal	PIC
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11st	12nd	13rd	14th	15th		
Do Motivaton Class for Supervisor / Project Manager	█	█														Supervisor know about his strength to manage the team on current situation	GBC Management
Do Motivaton Class for Employee			█	█	█	█	█	█	█	█	█	█	█	█	█	Employee undertand about what them do to working together with team and know about how long them completed the job on all target	GBC Management
Skill Training Supervisor and Eemployee																Employee and Supervisor understand about what them strengt and control them activities (still in controll)	OD & GBC Management
Education/School for employee																Employee need to know about them skill and how to develop them self with them strength and how to implementation to achieved company or project target	OD & GBC Management

### CONCLUSION

The implementation can be limited within a certain time so that the budget can be controlled and clear determination of the Goal can direct where the purpose of the Program development that will be planned and has an accurate and targeted evaluation standards.

The hope is:

1. **Scope** of the Improvement of employees exactly as needed ie the provision of opportunities to grow by including employees in the Training with the duration of time measured (for example: 2-4 weeks).
2. **Low budgeting** can be done with the good management and relevant development plan for project development time in Extraction Panel
3. **Time**, The faster the implementation of Training and Class Learning then the results of work progress can be achieved quickly too.
4. Human Resources Management greatly affects the course of a Project and requires special handling.
5. Motivation to employee can be done according to requirement and must be accommodated by management also the production plan will be achieved.
6. Implementation alternative 1 can reduce the GAP with increase persen achieved from 55 up to 78 percent meter development

#### **Recommendation**

1. Continues improvement about communication to stakeholder about existing project target and condition.
2. Reward and punishment strategi apply and consist by management at this project
3. Improvement Supervisor style with good development process to develop leaders or employee to be good leader
4. Motivation is an interesting thing to study and there is still much to be reviewed considering that each person has a different motivational base.

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