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Increase Haul Truck Transmission Component Life with DMAIC Approach

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Abstract:- The haul truck is one of the main tools in the mining business. The function of tools to moving mining materials to refining and stacking, to making of haul truck became one of very large role in supporting the production quantity of mining companies. In mining trucks / haul trucks, the existing driving components are the engine, torque converter, transmission, differential, the final drive that is synergized, so that the performance of the haul truck is able to operate according to its carrying capacity. One of the main components is the transmission system to adjust the speed of the haul truck. PT XYZ is a mining company that entrusts maintenance and repair of heavy equipment at PT XXX with a Maintenance And Repair Contract. PT XXX is obliged to maintain the life of the component in accordance with the budget agreed by both parties to avoid losses. PT XXX must be able to return the transmission age from the replacement data that has been carried out less than the target age of replacement, so that based on the calculation, the losses to be experienced in the amount of US $ 1,800,000 can be avoided.

Keyword:- *DMAIC, Haul Truck Transmission, Maintenance.*

I. INTRODUCTION

Mining companies in Indonesia have considerable challenges in carrying out their activities. Various regulations are stipulated as conditions that must be done so that mining activities can run well, continue to grow, both regulations from the central government, as well as local governments.

The demands of the community around the mine and employees in the company itself cannot be underestimated, plus the demands of the capital owners, who want a high and fast rate of refund, increasingly making the financial burden on the mining company manager get heavier.

Mining company managers are starting to look for ways so that they can focus on the core business of the mining business itself, by making a strategic partnership relationship with those who are considered competent in carrying out support work for mining companies. This strategic partnership alliance also opens opportunities for heavy equipment providers to enlarge the company's portfolio not only to sell heavy equipment, but also to supply spare parts and maintenance. In addition, heavy equipment provider companies can also assist mining companies in optimizing the use of heavy equipment, thus increasing the output of mining companies and being efficient in the production process.

This can be realized with the strategic partnership alliance that is set forth in the Maintenance And Repair Contract, so that mining companies only pay for maintenance based on hours of heavy equipment usage. All risks that have been mutually agreed upon are the responsibility of the heavy equipment provider. Therefore, the agreement made must be based on careful and careful calculations. However, in implementing the contract, not all things are in accordance with the results of the calculation because of several things such as:

- Operator habits
- Area change due to time change
- Climate, weather and mine conditions

The things mentioned above can make the costs previously predicted miss.

II. THEORY

Sigma is a symbol standard deviation in statistics (Σ or σ) derived from Greek letters, a measure for expressing variance, or inaccuracy of a group of items or processes.The purpose of Sigma is to reduce variation in output so that it will not exceed six standard deviations (Sigma) between the closest mean (mean) and the limit of specifications. Sigma processes must produce errors of less than 3.4 per one million opportunities (per million opportunities) or reach 99.9966% success rate. The higher the sigma value, the less a process experiences variation and the fewer errors that will be experienced. Implementation Six Sigma focuses on processes, whether in the production process or service. When achieved, Six Sigma will be able to ensure that the entire production process runs at optimal efficiency. Of the many meanings above, it can be simplified into one complete and clear definition, namely: Six Sigma is a system that is comprehensive and flexible to achieve, provide support and maximize business processes, which focus on understanding customer needs using facts, data, and statistical analysis and continuously pay attention to arrangements, improvements and review of business processes.

Ratio Specification	DPMO	Sigma Level	Remark
0.31	691462	1-sigma	Very not competitive
0.692	308538	2-sigma	Average Indonesia Industry
0.9332	66807	3-sigma	Average Indonesia Industry
0.99379	6210	4-sigma	Average USA Industry
0.99977	233	5-sigma	Average USA Industry
0.999997	3.4	6-sigma	World Class Industry

Table 1:- Sigma achievement level

The advantages of applying Six Sigma are different for each company depending on the business that is carried out, the vision and mission and strategy of the company concerned. But generally with the application of Six Sigma there will be improvements in the following matters:

- Cost reduction.
- Growth in market share.
- Reduction of cycle time.
- Customer retention or customer loyalty.
- Reduction of errors in defective products or products.
- Changes in work culture.
- Development of products or services Six Sigma has similarities with quality principles and tools developed by W. Edwards Deming and Joseph Juran.

➢ *Six Sigma Methodology (DMAIC)*

- The most commonly used Six Sigma approach is DMAIC (Define - define, Measure - measure, analyze - analyze, improve - repair, control - control). There are two kinds of methodologies in Six Sigma. The first is DMAIC, for existing processes and the second is DMEDI (Define, Measure, Explore, Develop, Implement) for processes that do not yet exist.

There are three basic qualifications that must be met when using the DMAIC method, namely:

- There is a gap between current and expected performance. First of all it is necessary to determine what problems must be solved, or what opportunities will be achieved. In the case of process design, a new activity is launched where no process appears.
- The cause of the problem is not correctly understood. Management may only understand problems theoretically, but do not know the root cause of the problem.
- The solution has not been established. If management has planned short-term changes, there is still time to implement Six Sigma. Six Sigma applications can quickly save time for more accurate analysis. If a significant effort has been made to bridge the gap, the application of Six Sigma will not be useful.

➢ *Critical To Quality (CTQ)*

Critical to Quality (CTQ) is a way of measuring products / processes where performance standards or specification limits must be in accordance with customer satisfaction. CTQ aligns improvements with customer satisfaction requirements. CTQ represents the characteristics of products / services defined by customers, both internal and external customers. This CTQ includes the upper and lower specification limits or other factors related to the product / service. Usually this CTQ must be translated from a qualitative customer statement into a quantitative business specification action.

Tools used The causal diagram (Fishbone) is an analysis carried out by starting on the consequences or problems that arise then structurally looking for possible causes. In general there are six factors that can cause irregularities in business processes, namely 5 M (material, method, machine, measures, mother nature) and 1 P (people).

Pareto analysis is done by compiling or grouping data from the largest to the smallest. This Pareto diagram helps in identifying the causes of the problems that occur most often or makes the biggest contribution. This Pareto analysis usually uses the "80/20" rule which indicates that 80% of the costs incurred in the company are caused by 20% of problems.

III. METHOD

The method used in writing this journal is a study of six sigma projects that have been completed, other studies, observations, and sources from the internet.

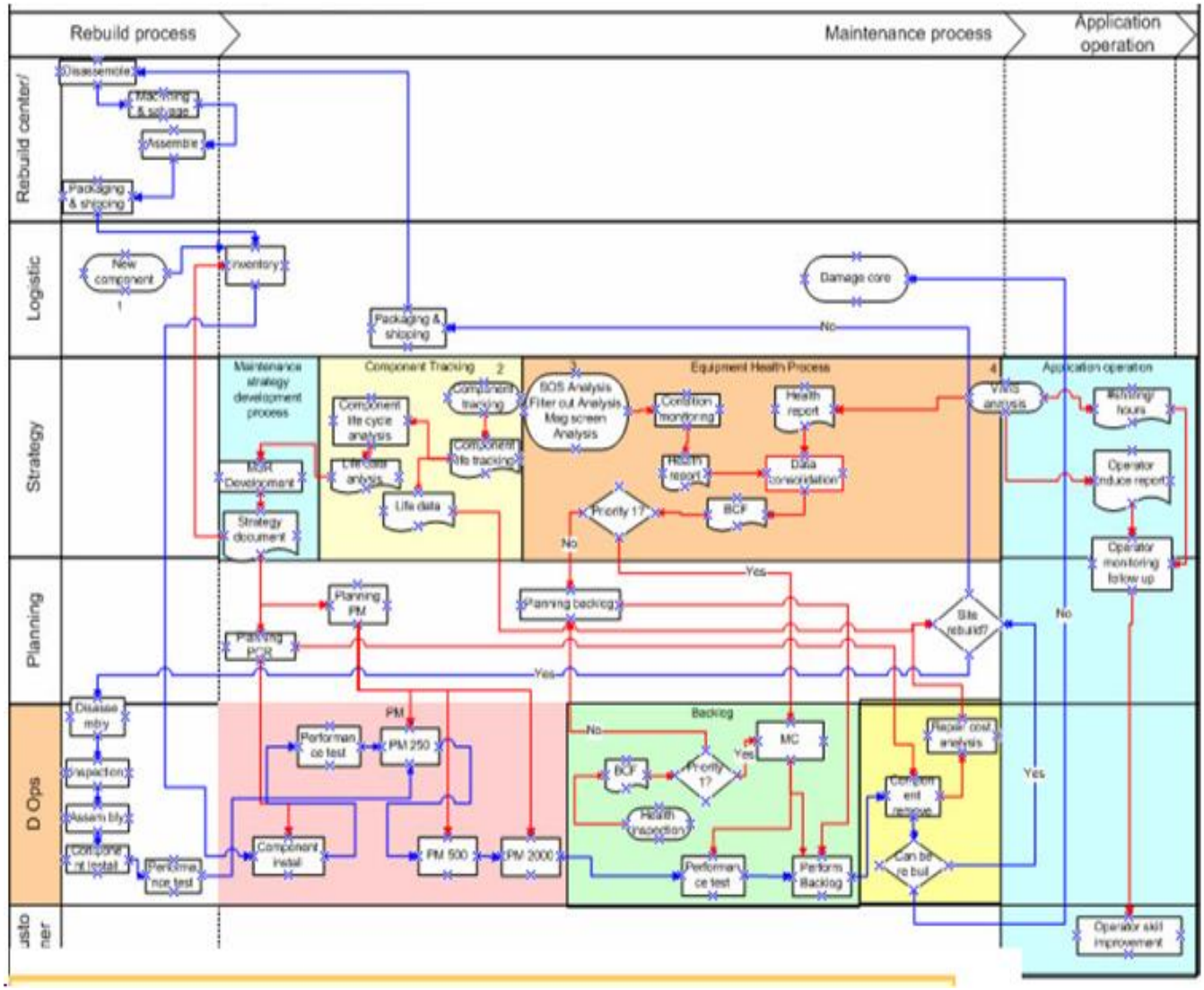

Fig 1:- Transmission Haul Truck Management Flow Chart

IV. ANALYSIS

A. Define

The Define stage is the first operational step in the Six Sigma quality improvement program. In the Define stage, potential project identification is carried out, defining the role of the people involved in the Six Siqma project, identifying key quality characteristics (CTQ) that relate directly to the specific needs of the customer and set goals. From the SIPOC diagram, it can be seen that the supplier in the transmission maintenance process consists of internal and external. For internal purposes, such as the workgroup strategy, planning group, and daily strategy, the data obtained are backlog tasks, maintenance schedules, and scope of work. Whereas from external such as logistics, repair center, and customer, which is obtained more in the form of objects.

The maintenance process consists of preventive maintenance such as oil handling, filter replacement, and filter inspection. Then there is the PCR process, which is the replacement of components based on a predetermined schedule, then performance tests, and inspections. The output of the portion is maintenance, and records that will be used by customers, and maintenance planners.

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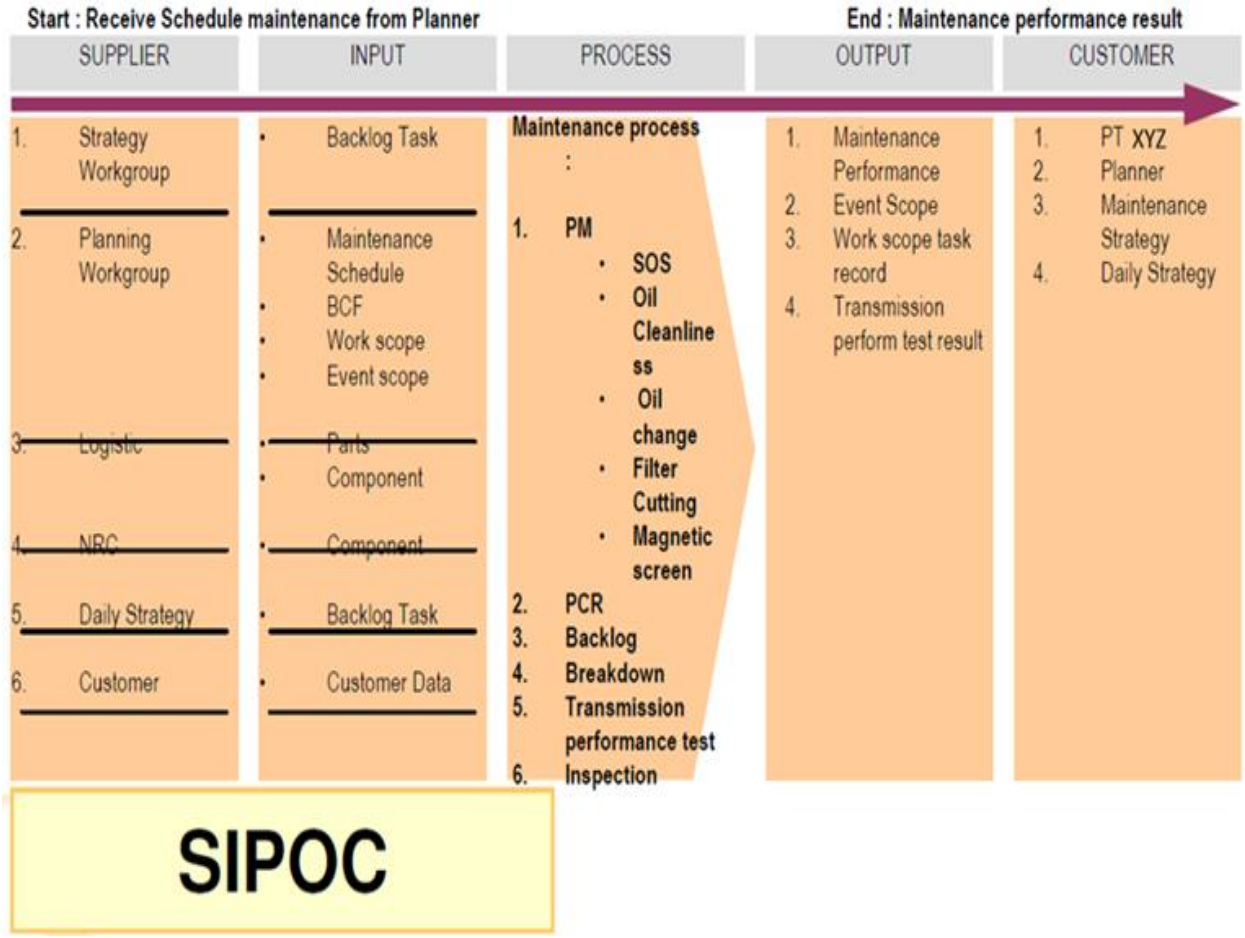

Fig 2:- SIPOC Diagram

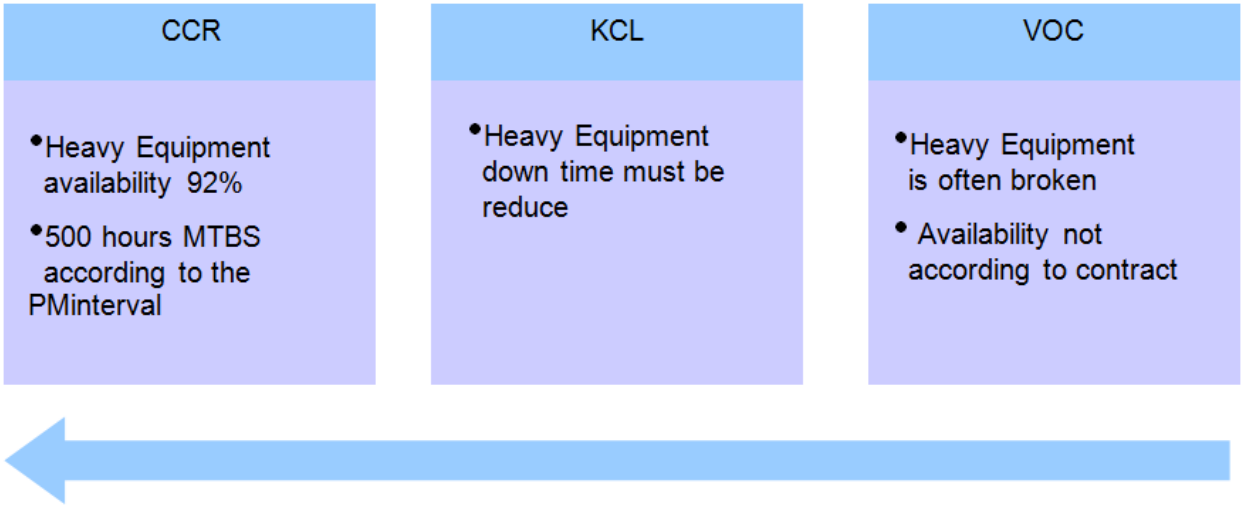

Fig 3:- Voice of Customer

From Voice of Customer, Critical Customer Requirements that are expected by customers are, the availability of heavy equipment reaches 92% as already poured into the contract, and no heavy equipment is down outside the scheduled ones like preventive maintenance.

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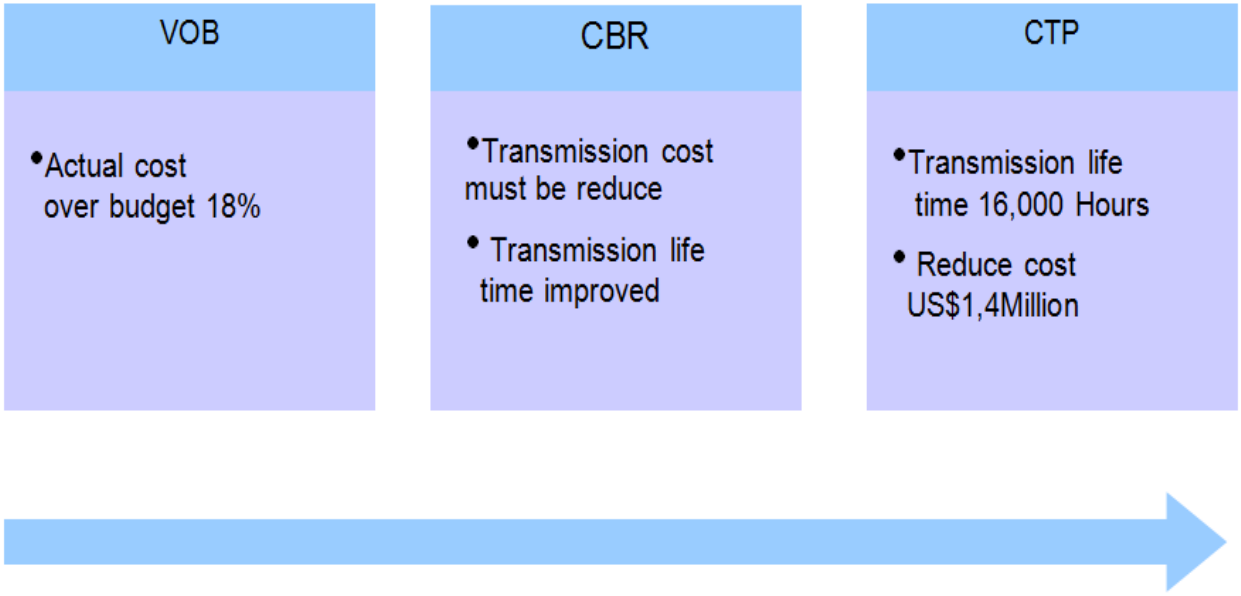

Fig 4:- Voice of Business

While from Voice of business, the Critical To Process is that the transmission age must reach a minimum of 16,000 hours so that there is no extra transmission during the contract period, and the cost variant between the budget and actual must be minimized.

B. Measure

Measure is the second operational step in the Six Sigma quality improvement program, there are several main things that must be done, namely:

- Carry out and develop a data collection plan that can be carried out at the process level, and / or output.
- Measuring current performance (current performance) to be set as a performance baseline at the start of a Six Sigma project.

COMPONENT	QUOM	Change-out Principle	Current Projection Life	Weibull RRX B50 (Last 3 Years)	Weibull RRX B50 (Contract To Date)	Rolling Average (Last 10 PCR)	Rolling Average (Last 30 PCR)	Projection Recommendation	# Data
3030 - Transmission - Original	Hrs	0	15,500	17,998	15,070	17,327	16,512	16,500	36
3030 - Transmission - REMAN	Hrs	0	15,500	16,119	14,784	13,162	15,873	14,500	36
3030 - Transmission - RC Rebuild	Hrs	0	15,500	15,903		15,990	15,947	15,500	11
3030 - Transmission - WS Rebuild	Hrs	0	15,500	13,347		13,454	13,401	13,000	11
							AVERAGE	14,875	

Table 2:- Transmission Age Based on the Type of Repair Performed

As a baseline, the current transmission age is 14,875 from various sources, both original heavy equipment, factory remanufactures, Rebuild Center rebuild, and Work Shop (Site) rebuild. Calculation of data using Weibull Analysis.

C. Analyze

A third operational step in Six Sigma quality improvement program.Actually the target of Six Sigma programs is to bring industrial processes to conditions that have stability and capability, so as to achieve zero defect-oriented.

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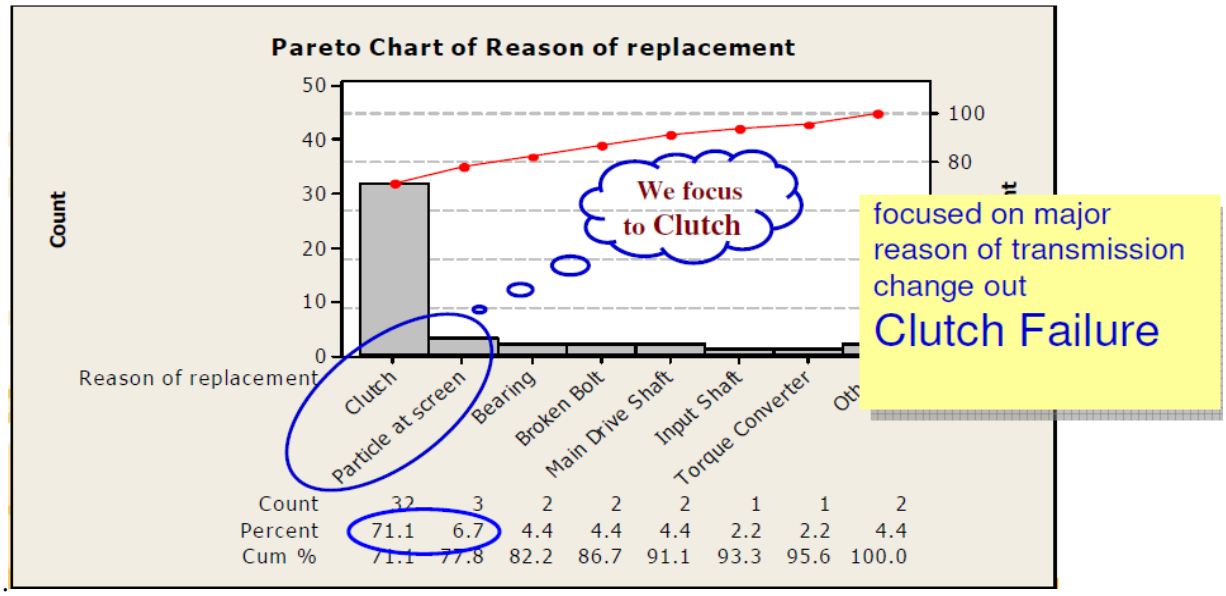

Fig 5:- Pareto Diagram

Of the 45 unscheduled transmission replacements, there are 32 transmission replacements caused by clutch failure. This accounted for 71.1% of the total unscheduled replacement. Therefore, in this project the clutch problem becomes a focus to be able to increase the transmission life.

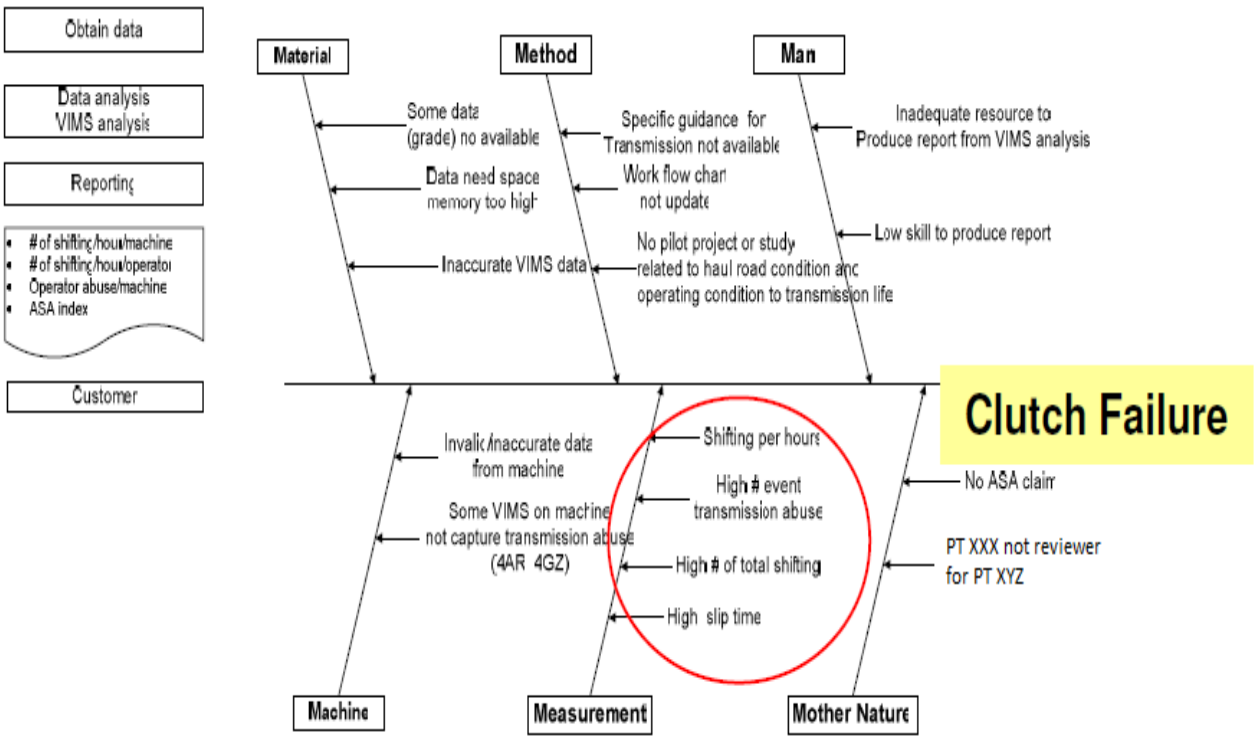

Fig 6:- Ishikawa Diagram

From the Ishikawa diagram, the root cause of damage to pre-premature transmission is excessive shifting, inaccurate transmission gear usage, and the slip time between clutches in too long a transmission caused by the calibration of the hydraulic valve in an incorrect transmission.

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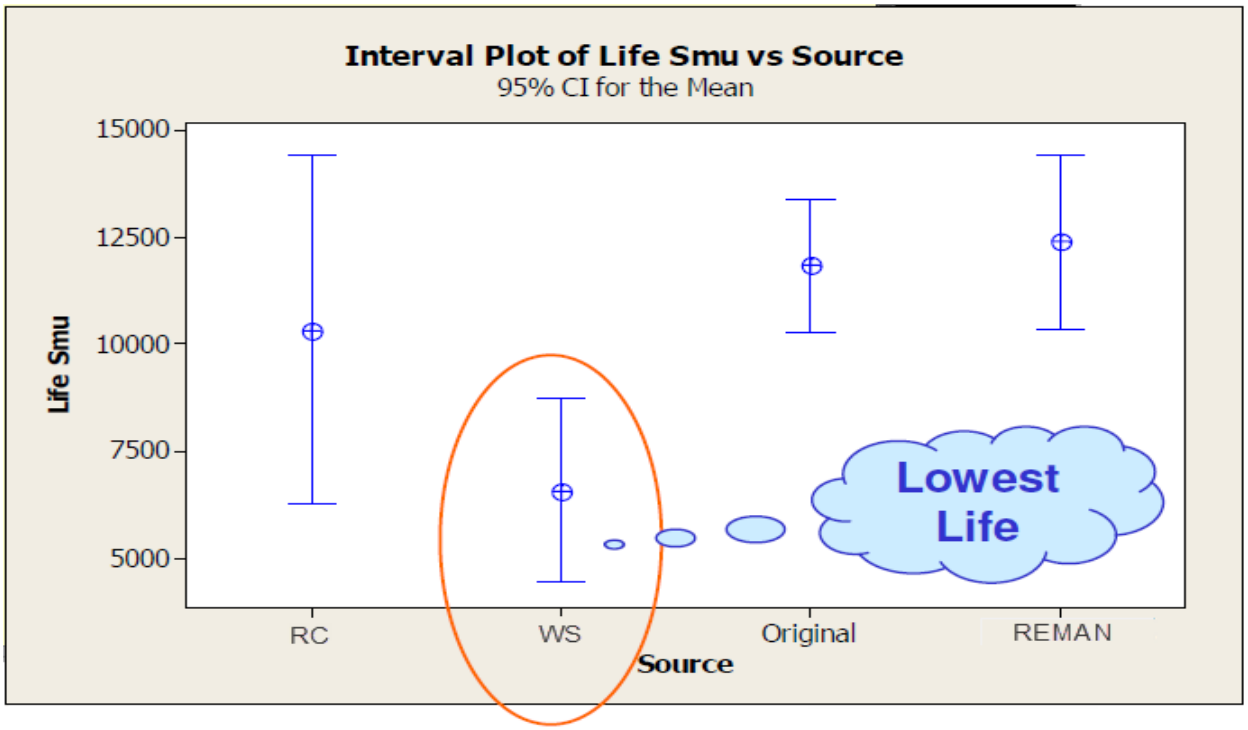

Fig 7:- Transmission Age Based on Source

From the data available, the lowest transmission age comes from the Work Shop (Site) rebuild. As for the original transmission, and factory Reman, it has a pretty good and consistent power. Whereas Rebuild Center rebuild has a fairly long lifespan, so the reliability is doubtful.

D. Improve

After the sources and root causes of quality problems are identified, an action plan is needed to implement Six Siqma's quality improvement, namely by tools: Failure Mode and Effect Analysis (FMEA) which describes the allocation of resources and priorities and or alternatives made in the implementation of the plan.

	ROOT CAUSE	SOLUTION
1	Transmission life time after overhaul < 16,000	Standardization BOQ
2	Truck operator not follow the rule of transmission operation	Refreshment training and held a contest operator with minimization of # of abuse alerts on transmission
3	Inconsistent reporting of applications and truck operations	Automatic generated report
4	Prognostic data is incomplete	Report the number of shift
5	Inconsistent maintenance strategies	Repair based on transmission conditions
6	Slip Time Clutch out spec	Making a schedule adjustment for the hydraulic control valve in the transmission

Table 3:- Root cause & solution

E. Control

It is the last operational stage in Six Sigma quality improvement projects. At this stage the procedures and quality improvement results are documented as standard work guidelines to prevent the same problems or old practices from happening again, then ownership or responsibility is transferred from the Six Sigma team to the person in charge of the process, and this means the project Six Sigma ends at this stage.

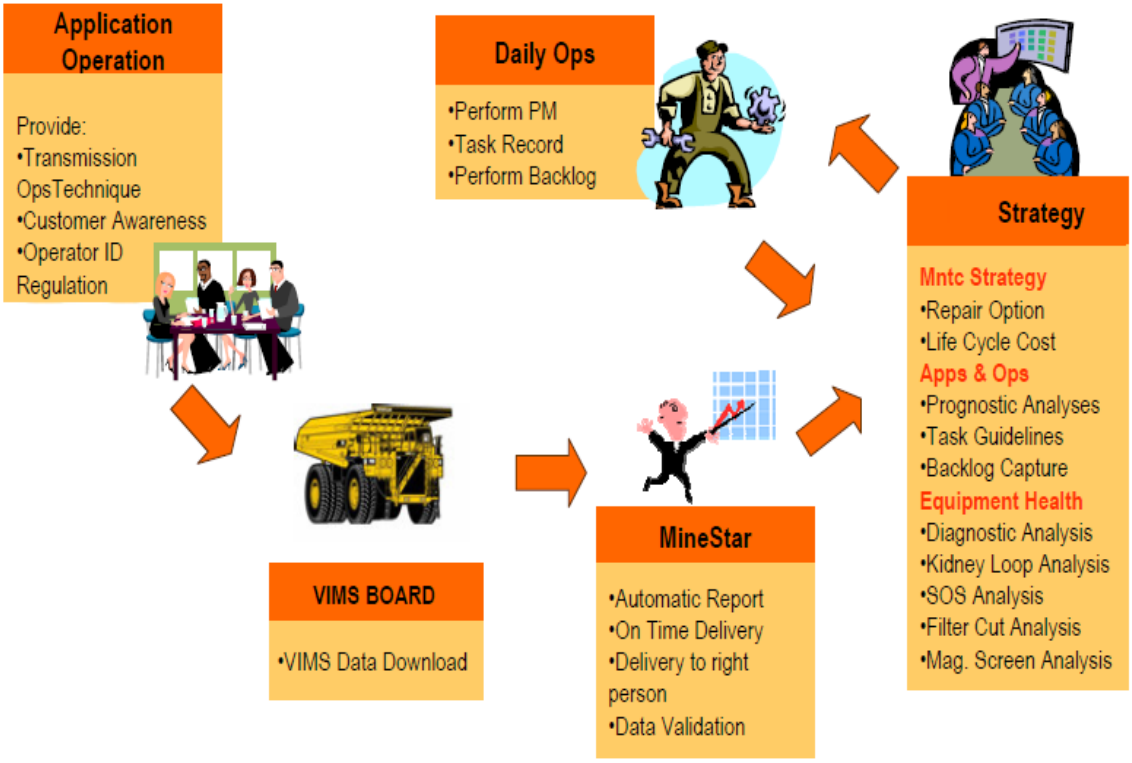

Fig 8:- Process Control System

In this final stage, a continuous system is created, so that existing processes can survive so that the final goal of getting the transmission age that is in accordance with the budget is reached and continues continuously. Some important things that are in the spotlight and must be controlled are:

- Report the number of shifts for each unit and operator
- Continuous preventive maintenance
- Increased operator basic knowledge of the operation of the tool
- Analysis carried out by the strategy group

V. CONCLUSION

The conclusion of the research process that has been carried out it can be concluded that:

- The transmission age can be increased by using component remanufacture from the principal, currently reaching 15,500 hours
- Variation in costs can be reduced
- Can be applied at other sites
- Further monitoring is still needed to ensure the transmission age reaches 16,000 hours

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