

Chapter 4 – Conclusion and Interpretation

4.1 Introduction

From the previous discussion in Chapters 1 & 2, a clear picture of where an organisation should be going towards the effective management of its assets, are defined. This sketches a picture of the desired future state that wants to be achieved. In order to define the present state of an organisation regarding the aspects involved in effective asset management, the principles defined in Chapter 3 can be utilised in order to assess of the current state of asset management. The gap defined by the comparison between these two states reveals the opportunities of improvement.

4.2 Decentralised Structures vs. Centralised Maintenance Management Structures

Both the centralised and decentralised maintenance management systems have some advantages and disadvantages relevant to this study.

Centralised Management Systems:

- Maintenance management system and different aspects to be managed can be controlled more easily (centrally).
- No resources are wasted by different decentralised management units in order to improve the same aspect.
- Improvements are effective over the whole area of maintenance management.

- Change management process to be followed regarding the implementation of changes and initiatives are much more involved than in a smaller group.
- Standards regarding engineering and management aspects across the whole business can more easily be defined. The problem faced here lies with the effectiveness of the deployment of these standards.

Decentralised Management Systems:

- Resources can easily be waited if assigned to improve the same aspect of management.
- Different sets of standards regarding the field of engineering and maintenance management can be developed.
- Implementation of improvement initiatives can more easily be implemented if focused on a smaller group of people.
- Improvements are localised and not effective over the whole group of the different departments.
- Ownership of the maintenance department over equipment, housekeeping etc. is better established if they report directly to a production unit.

From the results of the empirical study it can be seen that some departments are performing better to other regarding different aspects. This is however a comparison between different departments in a decentralised environment and not between a centralised and decentralised management system. As expected, the more resources available for improvement initiatives, the better the specific department will perform in the assessment.

If managed correctly, lots of benefits can be gained from a decentralised maintenance management system regarding improvement initiatives. Seeing these maintenance systems as stand alone businesses, will not promote the culture of a learning organisation within the overall business. A central panel, preferably the different maintenance managers, should:

- Constantly benchmark themselves against each other to identify areas they (and their people) can learn from each other.
- Set standards (especially regarding safety, policies, practices and engineering) to be adopted by all departments.
- Identify areas outside of the departments for improvement and benchmarking.
- Effectively allocate resources to improvement initiatives inside the different departments in order to prevent work duplication.

Following the approach described above, rapid improvements can be gained by adopting the local best practices within the organisation. Once all departments are on the same level of the identified local best practices, resources should be applied to continuous improve other aspects after prioritising.

4.3 Developing a Maintenance Strategy

In order to develop an effective strategy for maintenance teams, the overall mission, vision and core values must be considered. These are defined as follow:

Mission

Metalloys Manganese is in the business of supplying Manganese units in a form and manner that delivers optimal value to its customers, while ensuring maximum profitability to itself

Vision

Maximise return to shareholders by being the most reliable and lowest cost converter of ore to quality alloys in a safe, socially acceptable and environmentally friendly operation.

Core values

Simplicity

Continuous Improvement
Industry- & Internal Leadership

The above needs to be reflected in terms of management aspects own to the maintenance environment. This also includes aspects like training, value chain decision making, reliability centered maintenance (RCM), root cause analysis of failures (RCA), equipment conditioning monitoring and work load distribution. Developing a strategy around these aspects will in the end ensure that the focus will shift from the current of separate production and maintenance functions, to an integrated team focused on the benefits to the organisation. This can be demonstrated by a quick evaluation of the eight major losses as defined by The Japanese Institute of Plant Maintenance (JIPM).

Loss	Driver	Responsibility	
		Production	Maintenance
Shutdown Losses	Planned Maintenance	Shared	Full
Production Adjustment Losses	Change in supply and demand of markets	None	None
Equipment Failure Losses	Unplanned Breakdowns	Shared	Full
Process Failure Losses	Operating errors and defective raw materials	Full	Shared
Normal Production Losses	Startup, shutdown or change over of product	Full	Shared
Abnormal Production Losses	Under performance of plant due to malfunctions	Full	Full
Quality Defect Losses	Final product price downgrading	Full	Full
Reprocessing Losses	Passing of materials back through the process	Full	Shared

Table 4.1: Illustration of the responsibilities shared between production and maintenance departments.

By focusing on loss elimination and the overall equipment efficiency (OEE) the goals of production and maintenance teams can easily be aligned. From Table 4.1 it can be seen that the responsibilities defined to each loss category is not solely the responsibility of either the production or the maintenance department. In most cases there is a shared responsibility between the departments. Making some of the categories the sole responsibility of one of the departments opens the doors for conflict in the case of the occurrence of a loss. It is thus important to ensure that all parties are aware of the higher goal of the two departments as defined in the polarity matrix in Table 1.1 namely *delivering optimal business benefit from effective asset management*.

Not losing track of the core values of the organisation, aspects like simplicity, continuous improvement and leadership, the following is considered.

- **Simplicity**

Adhering to basics by minimising the tolerance for failure repetition and minimising 'patch-up' jobs and temporary quick-fix repairs. Focusing efforts on measuring equipment condition and planning ahead for effective preventative measures to be taken.

- **Continuous Improvement**

Annual internal benchmarking identifying strong points and areas of improvement. Closing the gap by adopting practices from each other. An increase in condition based maintenance (monitoring and execution).

After a satisfactory level of all departments in all areas is achieved, external benchmarking needs only to be considered.

- **Industry Leadership**

Establishment of an integrated holistic approach regarding the performance of maintenance and production as a unit.

With the compiling of a maintenance strategy the target group is seen as one of the most important aspects. Compiling a strategy to complex will result in an ineffective implementation and no buy-in from the people on the shop floor. It needs to be simple, short and understandable to the artisan who is rather comfortable working with equipment than long term future strategies.

An important function from management includes their full support towards the strategy, demonstrating their involvement by driving the implementation process and ensuring that the necessary support structures are in place.

Applying these principles a simplified maintenance management strategy can be developed, understood throughout all levels of the organisation (displayed in Appendix A).

4.4 Defining maintenance as a profit business centre.

As result of the nature of the maintenance function it is not easy to define it as a profit center because only losses are usually measured by the department itself and top management.

In order to define maintenance as a profit center it is first of all necessary to understand the equipment capability and what it is able to deliver and under what circumstances. Chapter 2 explains the process of using overall equipment efficiency (OEE) in order to understand the condition, capability and expectations of equipment. Two aspects need to be considered in this definition. The first being losses and the other being the costs of maintenance.

For the purpose of simplicity only one loss will be mentioned in further discussion (it must be noted though, that this loss is the sum of the losses over which the maintenance department has either full or shared responsibility). The only loss not considered (according to the eight losses defined by the JIPM – Table 2.1) is the production adjustment losses, seen as outside the control of both the

maintenance and production departments as result of changes in the supply and demand of markets.

Maintenance cost include the total cost incurred in order to maintain, get a unit back into production or minimise any loss that might occur or is expected to occur in the future. This cost does not include the actual cost of the loss as this will be shown separately as discussed in the previous paragraph. Maintenance cost is seen as the sum of (Figure 3.2):

- Planned maintenance cost;
- Planned corrective cost;
- Unplanned corrective;
- Breakdowns.

The next step will be to set targets for the performance of the equipment considering the following:

- the equipment's original design (specifications according to the OEM);
- modifications and alterations to the equipment form original design;
- working environment of the equipment;
- quality of the raw materials being used in the manufacturing process;
- overall equipment age in terms of expected remaining lifespan of the equipment preferably the remaining units it is capable to produce compared to the total units it was designed, and modified to produce;
- overall condition of the equipment (how well it was operated and maintained in the past).

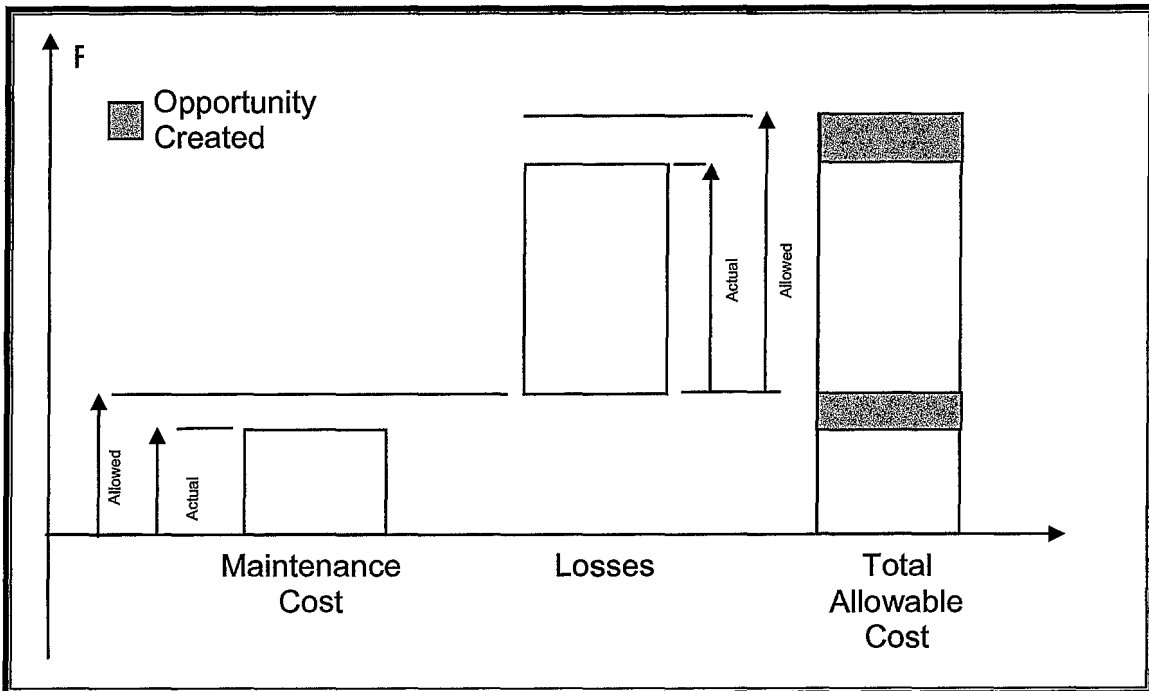


Figure 4.1 – Maintenance Cost and Losses in a healthy maintenance system

As can be seen from Figure 4.1 it is of great importance that the allowable maintenance cost and allowable losses are defined correctly in order to measure the profitability of the maintenance function. If the allowable maintenance cost target is set to high, the opportunity exists of over maintaining the equipment resulting in unnecessary waste of money. If the allowable maintenance cost target is set to low, equipment will be under maintained resulting in the increase of losses.

The profitability of the maintenance function can easily be calculated as the sum of the rand value *under* budget and the rand value calculated from the losses *under* the allowable losses target.

A factor increasing the dilemma of the maintenance manager lies in the ill definition of the maintenance budgets resulting in a continued overspending of maintenance funds. This is usually not defined correctly if a one sided approach to the budgeting process is followed not taking the loss reduction benefits into

effect. It is thus of overall business importance to see the maintenance function as a profit center rather than a cost center during the budgeting process. Defining the maintenance budget incorrectly (to high or to low) results in an increased conflict between maintenance managers and top management. It is thus recommended that with compiling the budget it needs to be done scientifically as described and from both a loss and cost perspective.

4.5 Maintenance Measurement Process

Referring to Table 3.2 and Appendix B (Question set for capability assurance) the overall ***maturity*** of the management abilities of the department can be defined and measured.

Regressive Maintenance (overall score of 0)

No indication of planning maintenance activities towards equipment capability concepts described in Chapter 2. No results or execution of an approach can thus be measured.

Reactive Maintenance (overall score of 1)

Approach of 'if it is not broken don't fix it'. No maintenance activities are planned in advance. Equipment is reactively fixed when it breaks.

Planned Maintenance (overall score of 2)

Maintenance activities are planned in advance on the short and medium term. Focus is given to areas for improvement but without a formal process of prioritising the importance of the focus areas. Areas of improvement are determined through experience of the workforce and not by using both experience and a sound scientific approach towards what the business benefits are.

Proactive Maintenance (overall score of 3)

A thorough understanding of the equipment's capability is established. All critical elements of equipment is identified and measured. A sense of urgency is established through to the lower levels of the organisation on the effects of equipment failure and what the estimated losses will be. Equipment maintenance plans for all critical equipment exists and is effectively and efficiently maintained. Little to no equipment failures occurs as the expected life of equipment is known and action can be taken before failure occurs.

Defect Elimination (overall score of 4)

Proactive maintenance is seen as a way of life. Maintenance activities are not only planned well in advance, but methods of how equipment can be improved when it breaks are investigated, implemented and measured.

Stable Improvement (overall score of 5)

Defects of equipment are eliminated and focus is given on improving the equipment's capability from a chain management point of view. The whole business pipeline is considered in the approach towards identifying and implementing improvement initiatives. Little deviation can be seen between the approach and deployment of improvement initiatives on the mentioned level above. Improvement initiatives are measured over the whole pipeline of the business. The management cycle is closed by proactively making changes to implemented initiatives if targets are expected not to be reached.

The maturity of the maintenance activities regarding approach, execution, results and improvement towards the management of equipment capability activities can thus be said to be as follow for the different departments:

- Engineering Services: Overall score of 2.3 - *Planned Maintenance*
- North and south Plants: Overall score of 2.9 - *Proactive Maintenance*
- West and Advally Plants: Overall score of 3.5 - *Defect Elimination*

The overall maturity of all the sections together, with an average score of 2.9 resulting in a state of *Proactive Maintenance*.

By applying the process described and followed in the empirical study (Chapter 3), the following goals were addressed:

- Key maintenance performance areas (from an equipment capability perspective) were defined and measured;
- These areas were measure and evaluated in the different business units;
- Internal benchmarking of these different areas, associated with key performance areas, was completed.

4.6 Recommendations and Steps Forward

With the steps followed throughout this study, the foundation towards the primary goal (to establish a culture shift form a reactive approach to maintenance, towards a more proactive approach of maintenance) is defined through a sound scientific approach. This approach is based on assessing the different departments on the principles of equipment capability, benchmarking, identifying the gap and initiatives to improve.

The polarity matrix defined in Table 1.1 is an important tool to be used in order to begin with the process of the desired culture shift of the approach towards maintenance. This can be used to give an understanding, and improve the interaction between operations, maintenance and top management to achieve the higher goal of business improvement.

Steps to be followed in order to complete the cycle of improvement will include:

- prioritise the areas of improvement (already discussed);
- recording the practices followed by the department with the highest score;
- development of action plans to close the already defined gap;

- establishment of a proper change management process to ensure the success of implementation throughout all levels of the organisation (including top management);
- assign sponsors and champions per department for the improvement of specific elements and practices;
- implementation of the action plans developed against a preset timeline;
- sustain the improvements implemented;
- continuous improve.

The aim of this study is to gain a quantum leap of improvement by tapping on internal sources of methodologies on how certain elements / practices / areas within the maintenance management field are approached and improved. The first phase is to close the gap that currently exists between the departments in order to get all different aspects of the different departments as close as possible to the highest score obtained from the question set. The final phase of this initiative is to continuous improve on the best scores obtained in order to create a world class maintenance environment and culture to the benefit of the organisation.

Care must be taken not to prioritise the initial areas of focus according to the areas with the largest opportunities as other elements with lower levels of opportunity may result in a larger benefit to the organisation. The priority setting must be seen as an exercise on its own due to the mentioned reason. Other aspects that need to be considered during the priority setting include factors like the effort to implement together with the time span of implementation.

As can further be seen from comparing the empirical study results to the literature study, the best intentions of management (approach) towards certain aspects of maintenance equipment management, is of little value without the proper resources to implement it and sustain the momentum. Setting the standard of how equipment should be managed is a trivial but important aspect in

the total view of managing equipment capability. This is clearly displayed in the results obtained from the empirical study.

The overall average of the three populations evaluated can be summarised as follow:

Approach: 3.2

Deployment: 2.6

The difference of 0.6 between these two evaluations can be as result of the following:

- The changes to current approach is not yet fully implemented;
- Insufficient buy-in of employees on whom the change is aimed;
- Insufficient resources allocated towards the implementation and sustaining of the changes;
- Too many changes effected in a short period of time resulting in confusion on what is expected from the involved parties.

As standards (the approach) are defined in the quest to improve the management of any equipment's capability, an equal effort should be made towards a proper change management strategy on how the changes are going to be implemented and sustained. This strategy should include what resources are going to be required especially to sustain the momentum of the newly implemented change and to drive future improvement initiatives.

The goals of this study were achieved as follow:

- a) A maintenance strategy could be developed by integrating the aspects of effective equipment capability assurance (Chapter 2) with the values, mission and vision of the organisation (Section 4.3) displayed in Appendix A.

- b) The understanding of the maintenance function and the contribution thereof towards achieving optimal business benefit from effective asset management were defined (Table 1.1; Sections 2.8 & 4.4).
- c) A maturity roadmap was defined in Section 4.5 in order to determine and plot the current state of maintenance departments and define a desired future state.
- d) Key maintenance performance areas together with their relevant drivers were identified (Section 3.5) from which elements of measure could be determined (Table 3.1).
- e) Different maintenance departments were compared against each other in order to determine the best practices within the organisation (Table 3.3 and 3.4). This was done for each of the dimensions of measure (approach, deployment, results and improvement).
- f) In order to compare different departments a credible, scientific method of measure was developed in Sections 3.4 through 3.8.

These steps then set the base for internal organisational benchmarking, gap analysis (and the closing thereof) and promotes the culture change towards a learning organisation.