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Identification of key performance areas in the southern African surface mining delivery environment

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Synopsis

The global resources and commodities market has become highly competitive. While southern Africa's abundance of minerals resources is still unrivalled, it has lost considerable dominance in terms of production output. The sustainability of southern Africa's mining industry is increasingly becoming dependent on its ability to manage the performance of its operations well. A valuable tool for monitoring and managing performance is the use of key performance areas (KPAs) – which are those areas of performance that are reflected explicitly or implicitly in the vision and strategies of an organization and reflect the critical success factors of the organization. This paper is a review of key performance areas in the southern African mining delivery environment. The KPAs discussed in this paper have been identified by comparing KPAs of the several mining houses engaged in surface mining operations in southern Africa and then extracting those KPAs that are common to most of them. Although the authors support the view that each organization should develop KPAs to specifically fit its needs, the study reveals that five KPAs – safety and health, costs, product quality, fleet management, and delivery should form a default list that covers the key areas that any organization should consider when choosing KPAs. KPIs are those subsets of KPAs that we measure in order to manage KPAs.

Keywords
key performance areas, delivery, performance measurement.

Introduction

The global resources and commodities market has become highly competitive. While southern Africa's abundance of minerals resources is still unrivalled, it has lost considerable dominance in terms of production output. The sustainability of southern Africa's mining industry is increasingly becoming dependent on its ability to manage the performance of its operations well. A valuable tool for monitoring and managing performance is the use of key performance areas (KPAs), which are 'those areas of performance that are reflected explicitly or implicitly in the vision and strategies of the organization' (Barker, 1997). The terms KPA and KPI (key performance indicator) are often used interchangeably – whether correctly or erroneously is debatable. KPIs are 'quantifiable measurements, agreed to beforehand, that reflect the critical success factors of an organization' (O'Neill, 2007). Each KPA probably has multiple KPIs associated with it. The state of implementation of that KPI will determine where the organization is measured. Mostly, an aggregation of all the KPIs for a particular KPA determines the final KPA measurement and status. It is the successful measurement and management of KPAs and their associated KPIs that will give southern Africa the ability to compete successfully in the current market and ensure its sustainability going forwards. KPIs are those subsets of KPAs which we measure in order to manage KPAs.

This paper is a review of KPAs in the southern African mining delivery environment. The KPAs discussed in this paper have been selected by comparing KPAs of several mining houses engaged in surface mining operations in southern Africa and then identifying those that are common to most of them. The study has relied on the judgment of the authors in deciphering the different usage of the terms by the different organizations in order to align them with the proposed definitions in this paper. Similarly, some of the KPAs are extracted by virtue of them being reflected implicitly in the vision and strategies of the organization.

Performance measurement

There are essentially three reasons to measure performance:

- To learn and improve
- To report externally and demonstrate compliance
- To control and monitor people (Marr, 2014).

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The common focus of mining operations has been on measuring performance to control and monitor people. While this is an important reason for measuring performance, the primary reason and therefore focus for any performance measurement system should be to learn about current performance and inform management on how to improve on it. Another reason for collecting performance measurements is to inform external stakeholders and to comply with external reporting regulations and information requests (Marr, 2014).

While there are many things that are measurable in a mining operation, that does not make them key to the organization's success. Measurements should be limited to those quantifiable factors that reflect the organizational goals and are essential to the organization reaching its goals. It is also important to keep the number of performance measures small just to keep everyone's attention focused on achieving the same goals.

Developing key performance areas

The authors support the view that each organization should develop KPAs that fit its needs. These may be a direct extract from vision statements if these have been recently developed or re-validated. It sometimes helps to agree on a long-term objective for each KPA, a sort of a mini vision statement. For each KPA three to five KPIs (specific measures) can then be identified. This is usually done by the senior management team of the organization. It typically takes several sessions to agree on a final list. After generating some candidate KPIs for each KPA, the senior team members will typically take these around to their teams and/or convene cross-functional breakout sessions to review the list, add to it, and select the most appropriate set of KPIs. This improves the quality of the resulting measures and also increases buy-in.

Case studies

The KPAs discussed in this paper have been selected by comparing KPAs of several mining houses engaged in surface mining operations in southern Africa and then identifying those that are common to most of them.

Case study 1 – Palabora Mining

Palabora is committed to the following strategic imperatives:

- Providing a safe and healthy work environment for all employees and contractor employees
- Practicing sound environmental management to ensure the sustainable biodiversity of the natural environment within which it operates
- Acknowledging and respecting stakeholder interests and concerns; and striving to be a leading corporate citizen within the mining industry
- Supplying a high standard of quality products and services – reliably and responsibly.

Case study 2 – Kumba Iron Ore

Kumba Iron Ore has what it refers to as 'four strategic pillars', which are:

- Delivering on growth projects
- Capturing value across the value chain
- Optimizing value of the current operations
- Organizational responsibility and capability.

The company performance is measured against the following seven measures, or KPIs (KPAs):

- Safety and health
- Our people
- Corporate governance
- Footprint management
- Corporate social investment
- Innovation research
- Production and sales.

The operational KPIs are:

- Zero harm
- Produce according to plan
- Mine waste effectively
- Containing our costs
- Securing our logistics.

Case study 3 – Anglo American

Anglo American has the following KPAs, which it refers to as 'Pillars of Value':

- Safety and health
- Environment
- Socio-political
- People.

Below follows a brief discussion of the identified KPAs, which may form a default list that covers the key areas that any organization should consider when choosing KPAs.

Identification of KPAs and KPIs

The case studies above reveal that the five KPAs are safety and health, costs, product quality, fleet management, and delivery. These are discussed in the following sections.

Safety and health

There is a strong cultural drive in Southern Africa to adopt a system of 'zero harm'. This goal reflects an eventual target that the industry has set and taken a stepwise approach to achieving. This is reflected in the current targets which, despite the implied target of 'Zero', are in fact not zero. The most common measures of safety in the southern African surface mining environment are the lost time frequency rate (LTFR) and the fatality frequency rate (FFR).

Matters of health have been identified in the Mining Charter, which includes measurement of new cases of noise-induced hearing loss (NIHL) and lung diseases.

Fleet management

With load and haul contributing to approximately 46% of total mining costs on some operations (Accenture, 2009), fleet management has been identified as a KPA in the southern African surface mining environment. The costs can be categorized into firstly, equipment costs, made up of fuel, tyres and tracks, ground-engaging tools, and repairs and maintenance, and secondly into operating labour costs. Fittingly, research into this KPA has shown it to contain the largest number of KPIs in the surface mining environment (Appendix A). The KPIs to be measured may be maintenance-related, where it is important to minimize downtime (planned and unplanned) and increase availability.

Availability is the measure of the time the equipment is ready to produce and is normally only minimized by downtime and/or non-utilization. It is also important to measure equipment efficiency in terms of the entire cycle of spotting, loading, travelling (loaded and empty), and dumping time for haulage equipment and cycle time of digging, swinging (loaded and empty), and dumping for excavating equipment. Relocation time, which is the average time spent in relocating equipment (*e.g.* the time it takes to move a dragline from one cutting position to the next) is often included. KPIs should also be in place to measure how effectively the equipment is used (utilization) and how efficiently it is used (matching equipment size and numbers – measured by number of dumps to fill and machine waiting time) to ensure equipment optimization. Logistics would not be complete without haul road management and this may be another focus of a KPI within the fleet management KPA.

Product quality

In today's increasingly competitive market it is important to ensure that the quality of the product meets the requirements of the client. This is particularly the case for a large number of South Africa's surface mining producers who, due to the unique characteristics of the mineral deposits being mined, serve niche markets and have to meet stringent client specifications.

Mines need to ensure they meet market demand at the correct product specification, which normally includes not only volumes or masses to be delivered but also limiting or quality criteria. In coal the proximates and the ultimate elements or constituents of the coal, which is a fuel mineral, made up of lithotypes (for example vitrain) and macerals (for example vitrainite), is placed under the spotlight. (Dougall, 2010)

Quality will involve the type of coal, the rank of coal, and often its grade or purity (ash content) or potential chemical energy value (calorific value). The application or use of the coal is critical and the dilution (such as moisture content) or problematic qualities (abrasiveness) need to be controlled. Fine coal is a production-related problem.

Quality influences the price attained for the delivery. Penalties may be incurred if specifications are not met to specific tolerances, having cost implications for the supplier. The supplier's reputation is also at stake. Middelburg Mines use a system on their surface mining operation known as CAVITY, which is focused on product specification on qualities and acceptance or rejection by the customer (Calorific value; Ash; Volatile matter; Index of Abrasivity; Total moisture; and Yield). Middelburg also uses the A to G Principle (Appendix B) to ensure they mine the correct quality and do not contaminate it afterwards (Area; Barrels; Contaminating triangles; Distance; Edge; Flow; and Geological factors). Both 'CAVITY' and the 'A to G' are 'aid to memory' acronyms to help reduce abrasiveness and contamination, and hence improve control quality. (Dougall, 2010). Typical KPIs for metalliferous mines are grade, degree of purity and physical characteristics, and ore dilution.

Costs

The sustainability of a mining operation is heavily dependent on the ability to contain the costs of mining. Measuring and reviewing costs against planned or budgeted spend will assist efforts to reduce the cost of mining. The cost of mining can be divided into the following categories: maintenance, labour, operational and sundries. The major contributors are, however, maintenance and labour cost, power and water costs (Dougall, 2010). The maintenance costs will be made up of equipment spares, fuel, tyres and tracks, ground-engaging tools, and repairs. Labour costs will take into account employees, contractors, and consultants. Operational costs can be monitored by how effectively the mining of waste is done so as to not negatively affect NPVs and can be measured in tonnage or volume of waste mined or by using stripping ratios. The cost variance against budgeted should be minimized to improve the sustainability of mining.

Delivery

A mining operation must be managed to meet the planned production targets. Delivery is the ability to meet the required production. It is the volumes or tonnages that need to be produced to satisfy demand (Dougall, 2010). Production is the KPI that measures if the operation is producing to plan, which may be measured as mass of rock in terms of ROM tons or volume of rock in bank cubic metres (BCM) produced over a specified time period, *e.g.* BCM per shift or tons per month (tpm). Productivity is also a useful measure of how efficiently the planned production targets are achieved and should be included as a KPI. This may be measured in terms of unit output per employee, *e.g.* tons produced per man-hour, or cost per unit mined *e.g.* rand cost per ton milled. Important measures may be blast gains and dozer gains as depicted in Figures 8a and b – Appendix C.

Other KPAs

The authors believe that the five KPAs discussed above should form a default list that covers the key areas that any organization should consider when choosing KPAs in a surface mining delivery environment. In line with the idea that the number of KPAs should be kept small, the KPAs have been limited to five. However, other KPAs for consideration, which will have varying degrees of importance in terms of delivery from one operation to another and may well be the concerns of corporate office, are:

- *Environment*—where it is important to monitor the organization's carbon footprint (CO_2) and water and energy usage
- *People*—measuring voluntary turnover, which is defined as 'the total of the number of employees who resign for whatever reason plus the number of employees terminated for performance reasons and that total, divided by the number of employees at the beginning of the year. Employees lost due to Reductions in Force (RIF) will not be included in this calculation (Sahu, 2007). Skills development, transformation, and leadership are equally relevant KPIs
- *Community*—CSI programmes such as housing and education, small business enterprise development *etc.*, with the Mining Charter setting clear targets. Some of these KPAs might have a lesser bearing on operational delivery but are becoming increasingly important to sustainability of mining operations. In recent

developments in South Africa's mining landscape, there has been an increase in sporadic community protests that have disrupted mining operations. Amongst the grievances being raised are demands for jobs, housing, and greater investment in community infrastructure. Mining companies therefore need to ensure that they effectively include the community as an important stakeholder in any mining operation.

The KPAs and related KPIs are summarized in Table I. A comprehensive list of KPIs is given in Appendix A.

Performance management

KPAs are essentially areas of interest due to their perceived importance in the success of a mining operation. KPIs are the identified factors that can be measured to determine how the operation is performing in those areas of interest. However, measurements on their own without the appropriate action and response become meaningless. This is the point at which performance management becomes vital with regard to KPAs. A large number of surface mines in southern Africa use contractors and subcontractors in their operations. Management and information sharing becomes critical and again KPAs can be used effectively in this regard. Frequently contractors and subcontractors are paid a set amount for a contracted time, which is not always based on productivity. KPIs can be built into their contracts in ways to get contractors on board for achieving KPIs on production targets. One way to do this is to involve the contractors in determining the KPIs from the onset.

Usually KPIs are based on tonnage, but this is not the only option – lack of incidents/breakdowns, or staff efficiency are other choices.

Conclusion

The research has identified five key performance areas, namely safety and health, costs, product quality, fleet management, and delivery, which should form the basis of any performance monitoring and measurement system on a mining operation. It is the successful measurement and management of KPAs and their associated KPIs that will give southern Africa the ability to compete successfully in the current market, and indeed ensure its sustainability going forwards. This research has been an attempt to identify KPAs and the authors are of the opinion that there is further research scope to develop appropriate benchmarks and benchmarking systems for the associated KPIs.

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Appendix A

List of mining KPIs

Average bucket weight
Average fuel use per machine
Average loading time
Average number of dumps per hour/day/week/month
Average number of loads per hour/day/week/month
Average payload

Table I

Key performance areas and their associated key performance indicators

KPA	Measure	KPI	Description
Safety and health	Zero harm	LTFR FFR	Loss time injury frequency rate Fatality frequency rate
	Occupational disease/ illness	NIHL	Noise-induced hearing lossa
Product quality	Degree of purity and physical characteristics	Grades	Quantity of metal in ore expressed as a percentage or ratio
		CAVITY	Calorific value; ash; volatile matter; index of abrasivity; total moisture; and yield
Cost	Maintenance Labour Operational sundries	Variance against budget	
Delivery	Production	Mineral production Waste mined Dilution Recovery Yield	
	Productivity	Unit output per employee	Ratio of outputs to inputs for any given activity
Fleet management	Maintenance	Availability Downtime	
	Production	Utilization Cycle time Relocation time	

Average swing time
Cash operating costs per unit produced
Change time (time between cycles)
Cycle distance
Cycle time
Degree of purity and physical characteristics
Dilution of ore
Dump time
Efficiency of metallurgical recovery
Empty stop time
Empty travel distance
Empty travel time
Fatality frequency rate
Fuel (*e.g.* litres/hour)
Incident rate (accidents, *etc.*) per x hours
Lifting costs
Loaded stop time
Loaded travel distance
Loaded travel time
Loading time
Lost time incident frequency rate
Number of equipment failures per day/week/month/year)
Number of holes drilled per day/week/month/year
Payload
Percent (metal, *etc.*) in ore
Percentage uptime (of equipment, plant, *etc.*)
Production rate – bank cubic metres (BCM)/ hour (cubic metres of material moved per hour)
Raw material substitution rate (percentage)
Reserve and resource replacement (percentage)
Tons of ore feed
Tons per hour
Tons per load
Total minutes lost per shift due to breaks
Unit variable costs
Utilization
Waste per ton
Waste recycling (*e.g.* tons per unit time)
Waste volume

Appendix B

A to G principle (after Middleburg Mine Services – BHP Billiton)

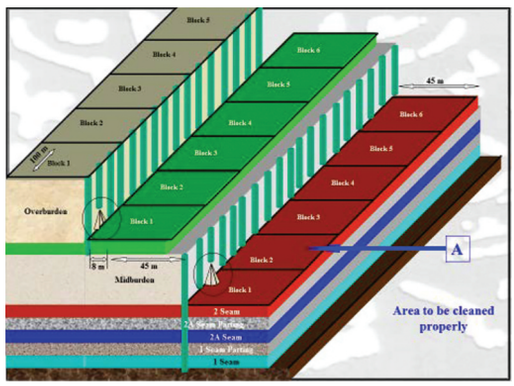


Figure 1—Area

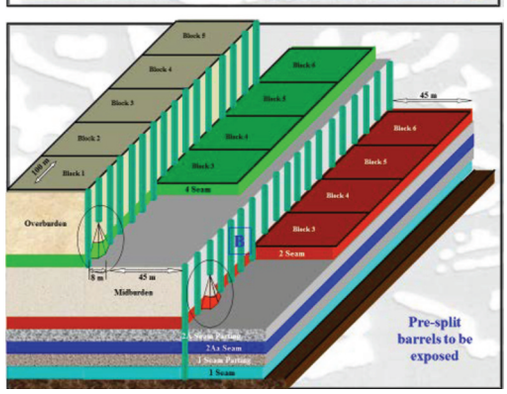


Figure 2—Barrels

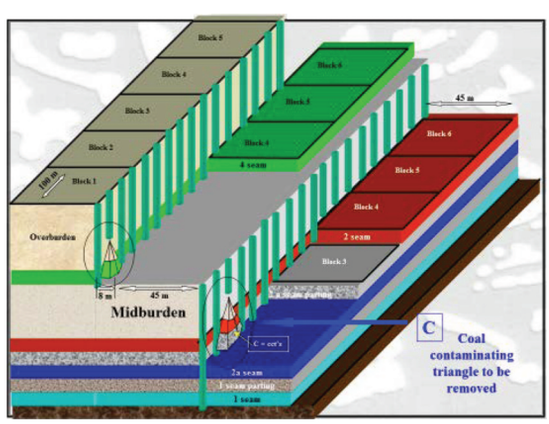


Figure 3—Coal contaminating triangle

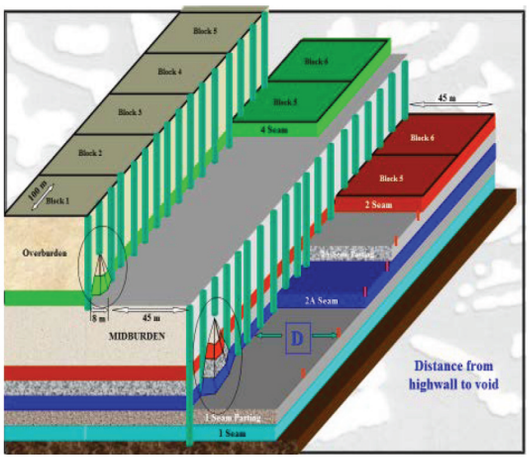


Figure 4—Distance from highwall to void

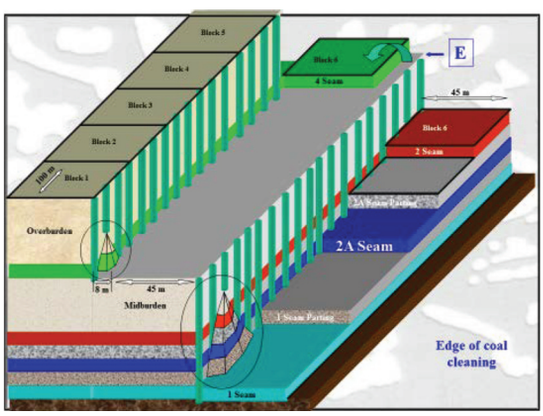


Figure 5—Edge of coal cleaning

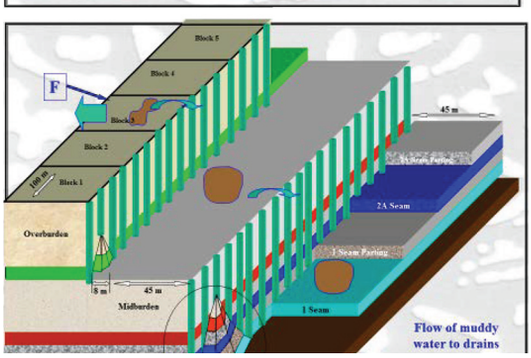
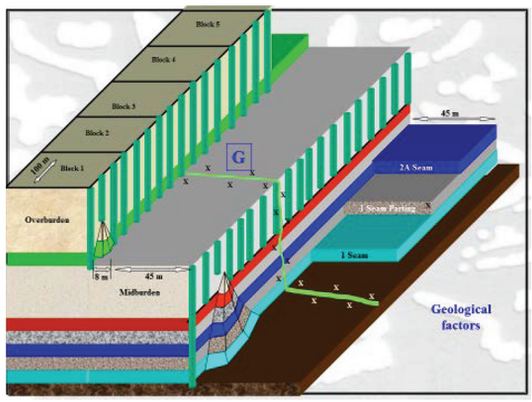


Figure 6—Flow of muddy water to drains



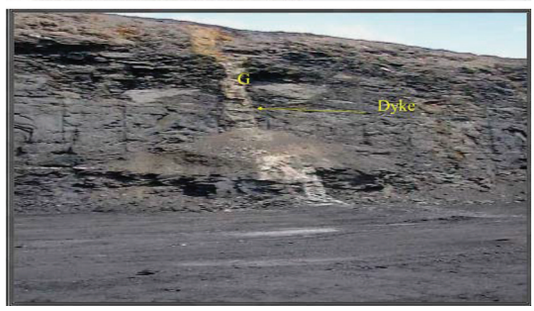


Figure 7—Geological factors

Appendix D

Blast gain and dozer gain (after Middleburg Mine Services – BHP Billiton)

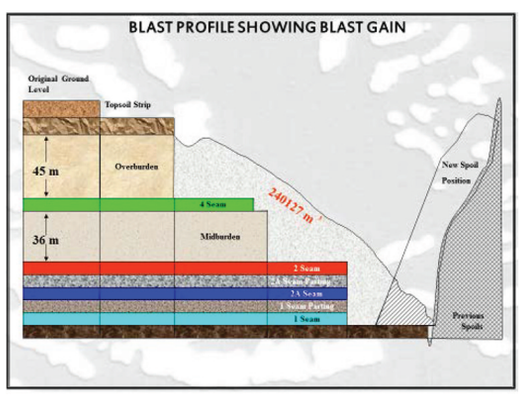


Figure 8a—Blast profile showing blast gain

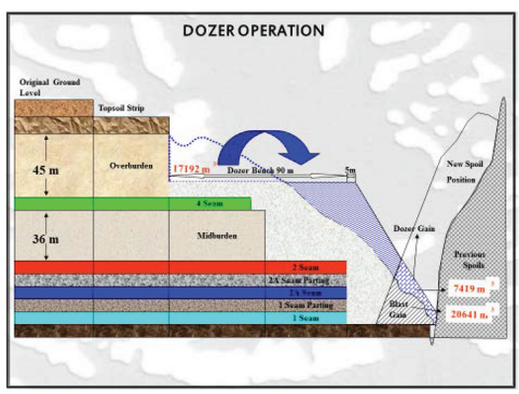


Figure 8b—Dozer operation resulting in dozer gain