

NINTH PLATINUM CONFERENCE

SA Institute Of Mining And Metallurgy

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

Presented by: Lefu Mohloki

TECHNICAL OPERATING FLEXIBILITY AND OPERATING COST
PERFORMANCE

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About The Authors

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This paper is a result
of University and
Industry
collaboration



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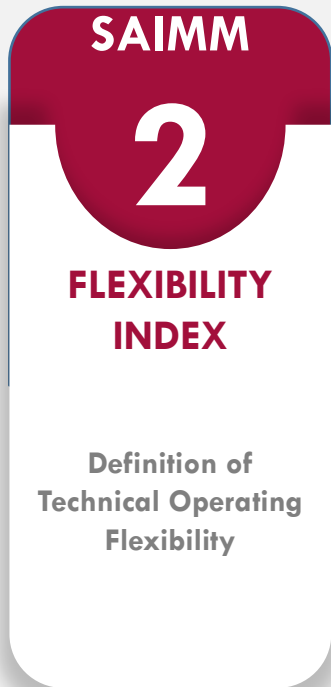
SPECIAL THANKS TO VALTERA PLATINUM FOR AVAILING THE DATA USED



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Technical Operating Flexibility – What is it?

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Key Principles And Key Considerations

Technical operating flexibility is a performance metric that is measured using a Flexibility Index (FI) which is undertaken in support of long-term operational viability through consideration of practices aimed at improving operating cost performance

- Key principles
 - long-term operational viability
 - Improved operating cost performance
- Key considerations/focus
 - Practices aimed at improving operating cost performance

Mining investments have long term time horizons in highly volatile market conditions

Technical Flexibility Index – Valterra Platinum

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**FLEXIBILITY
INDEX
CONCEPTS**

Valterra uses IMS
which is extended to
IMA and FI_extended

Technical operating Flexibility at Valterra Platinum

Valterra formerly known as Anglo American uses **IMS** – Immediately Mineable Stopes ' as a proxy for Flexibility Index (FI)

IMS is extended to Immediately Available (IMA) or FI_extended

Data from a few Underground Platinum Mines within the Valterra group was used in this analysis.

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Technical Flexibility Index - Objectives

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OBJECTIVES

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Objectives if this paper are two fold:

- to demonstrate that technical operating flexibility affects operating cost performance
- type of mining method affects technical operating flexibility

The presentation will conclude by recommending some practices for improving levels of technical operating flexibility which will inadvertently positively impact operating cost performance for long-term operational viability of PGM mines

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Technical Flexibility Index - Reasons

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**REASONS IN
SUPPORT OF
OPERATING
FLEXIBILITY**

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Reasons For Technical Operating Flexibility

Changes in business operating environment
unexpected potholes, sills, dykes faults, IRUP's e.t.c

Change in commodity prices

Black swan events and protracted labour unrest

Change in company ownership – mergers and acquisitions (different cultures merging)

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Industry Cost Curve As A proxy

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Reasons For Industry Cost Curve as Proxy

Operating cost performance of selected platinum mining operations derived from the position on the industry cost curve was used as a proxy for profitability and long-term operational viability determination because

The intention was to compare Flexibility Index to company profitability(proxyed by Industry Cost Curve).

In gradually declining commodity price environments

- mining Companies in the fourth quartile will be the first to be negatively affected



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Technical Flexibility Index Introduction

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FORMULAE TO CALCULATE FLEXIBILITY INDEX

Formulae for
strategic and
technical/tactical
operating flexibility

1. Strategic Flexibility - Kazakidis and Scoble (2003)

$$F = \frac{OV}{NPV \text{ passive (base case)}} \times 100$$

where

F = Flexibility Index

OV = option value or the additional net
present value (NPV) over the passive
(or base case) NPV

2. Technical Operating Flexibility – Musingwini *et al* (2007)

$$FI = \frac{\text{Available fully equipped alternative stopes} + \text{Stopes already in production}}{\text{Stopes required to meet planned production}} \times 100$$

where

FI = Flexibility Index

FI < 1 Inflexible operation

FI = 1 Borderline

FI > 1 Flexible, flexibility degree depends on fraction

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Immediately Mineable Stopes

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DEFINITION OF IMMEDIATELY MINEABLE STOPES

The IMS formula
used in determining
the Flexibility Index.

The term 'Immediately Mineable Stopes (IMS)' is an indicator of the portion of Ore Reserves that has been completely developed and equipped and is ready for mining and is called Developed Ore Reserves (DOR).

IMS has been extended into an extended Flexibility Index (i.e., $FI_{extended}$) as another measure of technical operating flexibility called 'Immediately Available (IMA)' stopes.

IMS is classified as the portion of Proved Ore Reserve that can be mined at full production without requiring further development and equipping work to be undertaken such as ledging, equipping, ventilation, and other essential services.

$$IMS = \frac{\text{Equipped Panels Ready to Mine} + \text{Current Equipped Panels Being Mined}}{\text{Equipped Panels Planned to be Mined}}$$

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Valterra Platinum Mines Selected

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**THREE MINES
SELECTED FOR
COMPARISON**

Three mines selected
conventional,
mechanized and
hybrid mining
methods

Selected Platinum Mines For Comparison

Bafokeng Rasimone Platinum Mine (BRPM) – Conventional mining method

Mototolo Platinum Mine – Mechanised Bord and Pillar

Modikwa JV – Hybrid mining

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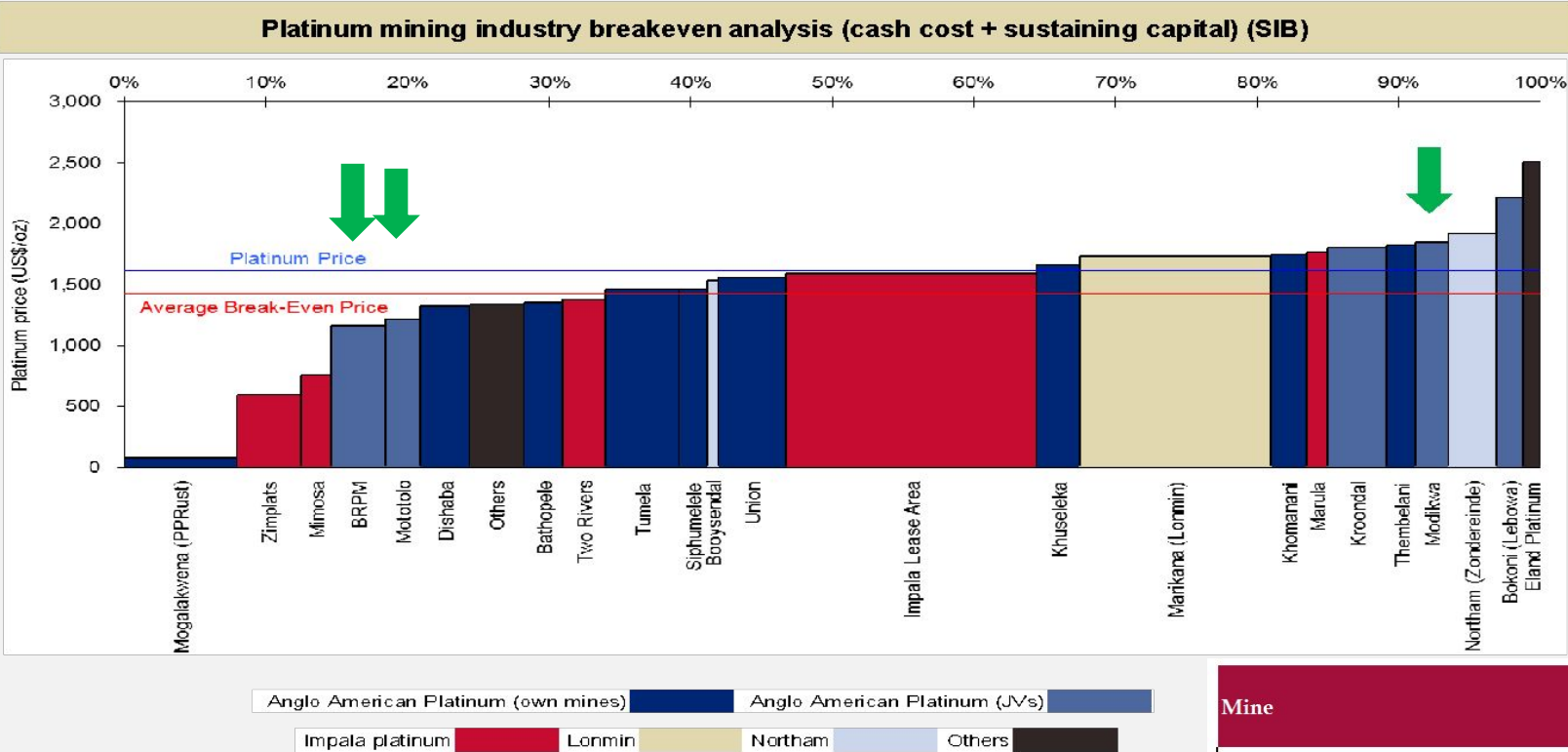
Platinum Industry Cost Curve 2012

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INDUSTRY
COST CURVE
2012

An interest was
sparked by the
apparent correlation
of profitability and FI



Source: Company reports, JP Morgan. Analysis is based on spot prices as at 10 January 2013

Mine	Mototolo JV	BRPM JV	Modikwa JV
	(TM ³)	(Convention all)	(Hybrid)
Flexibility Index (FI)	1.39	1.32	1.11
FI Status	FI>1	FI>1	FI~1



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Platinum Industry Cost Curve 2021 & 2024

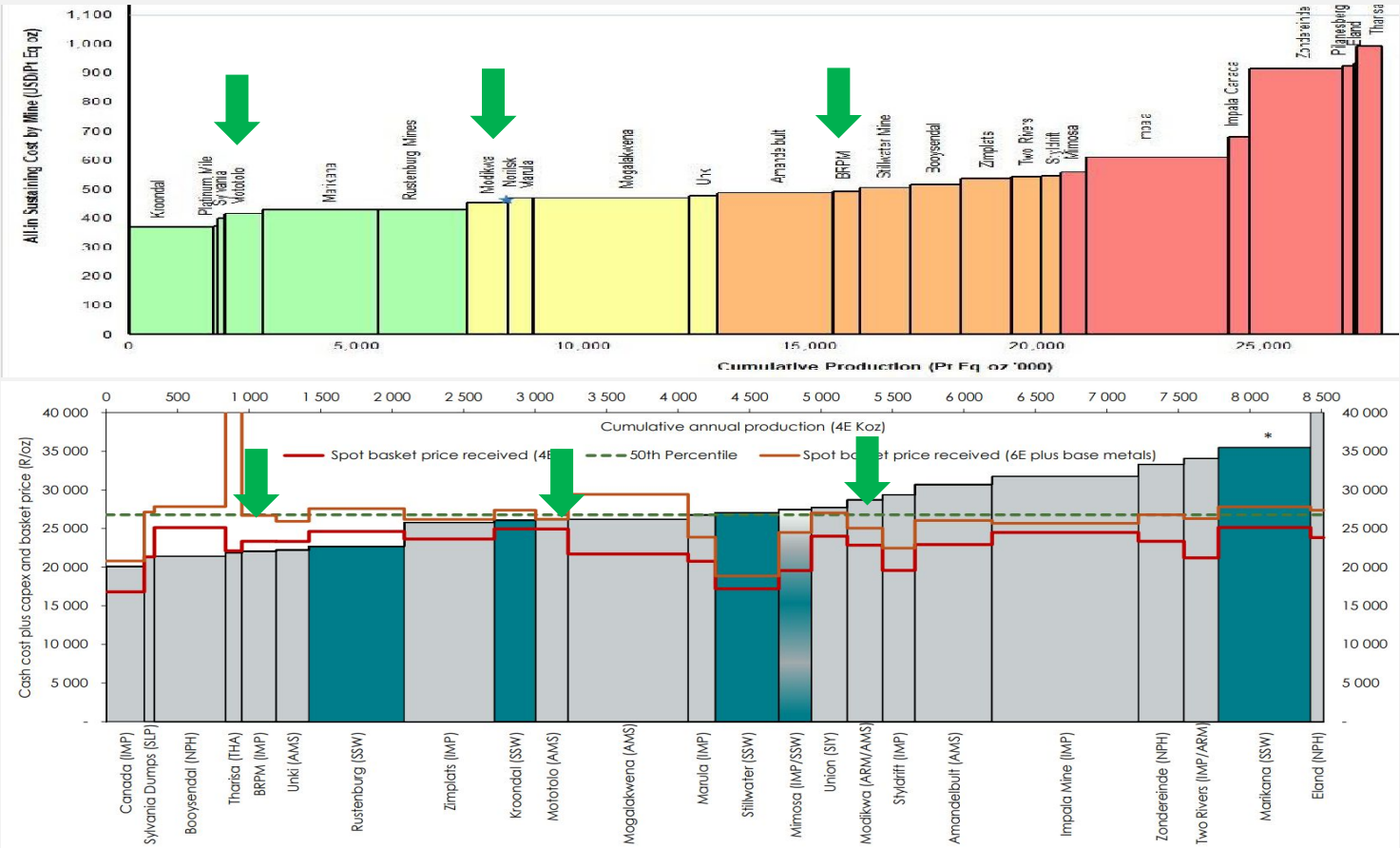
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INDUSTRY
COST CURVE
2021 and 2022

A comparison of the
selected mines
excluding BRPM
whose data was not
available.



Mototolo 1st to 2nd Quadrant

Modikwa 2nd to Third

BRPM moved back to 1st
From 3rd
No data to show why?

Year		2020	2021	2022	2023	2024
Mototolo JV (B&P)	IMS	2.57	0.27	0.26	0.81	1.71
	IMA	1.59	0.96	1.24	1.70	1.99
BRPM JV (Conventional)	IMS	N/A	N/A	N/A	N/A	N/A
	IMA	0.48	0.32	0.28	0.30	0.20
Modikwa JV (Hybrid)	IMS	2.57	2.05	1.69	1.34	1.09
	IMA					

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Technical Flexibility Index – Lost Blats

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LOST BLAST ANALYSIS

Lost Blast can be used as a proxy for inefficiency.

Attendance	Operational	Engineering	IMS Related	
Absent RDO	Labour:Medical	Winch Mechanical	Construction	Supply Air/Water Services
Absent Winch Operator	Labour: Shortage	Winch Electrical	Footwall Lifting	Vent: Holing
Absent Miner	Water Failure	Power Failure	Sweepings	Pillar Holing
Absent Loader Driver	Support	Breakdown: Vent Appliance	Startup: Geology	Clean Support Wbed
	Material Short: Logistics	Misfire: Engineering	Unit Move	Workplace Stop: Std Supp
	Cleaning gully. Pull+180M		Blast Winch Bed	Equipping
	Poor Cleaning		ASG Not Cleaned	Establish Workplace
	Roof Bolter		Misfire: Mining	Blast Drop Rse
	Drilling incomplete		Inst. Leding Roof Bolts	Instal service pipes
	Connect Winch		Construct Winch Bed	Startup: Ventilation
	Compressed Air		Support ASG	Transport material
	Breakdown: Loader		Ground Conditions: Unsafe	Startup Rock Engineering
	Box Full/Hanging Up		Flooded Workplace	Winch Install / Pin
	Support stop panel		Geology: Off Reef	Equip. winch bed
	Survey: No Pegs			Rehab: Set Installation
	Coaching Skills			Install Mono Winch
	Labour: Training			Workplace Stop: Geology
	Vent: Unsafe Conditions			
	Fixing Face Shape			
	Workplace Stop: Add Supp			

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Technical Flexibility Index - Impact

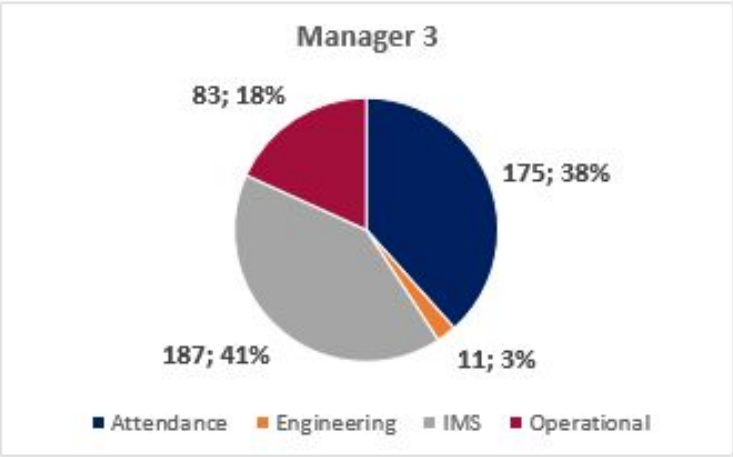
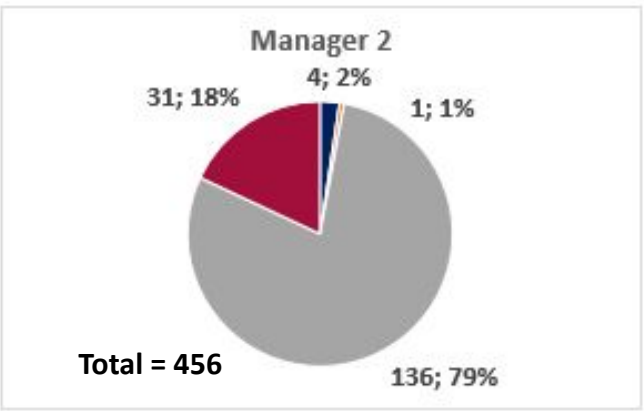
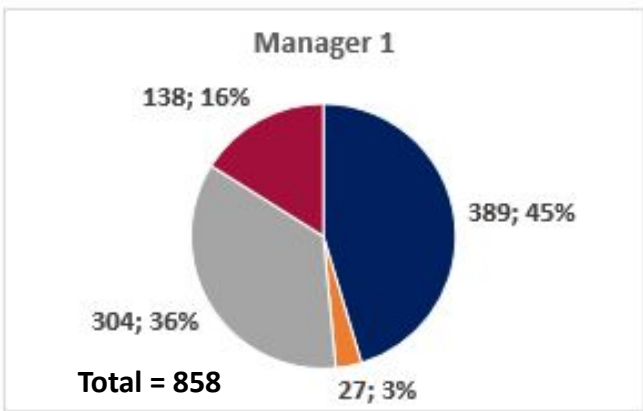
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MANIFESTATION
OF FLEXIBILITY
INDEX

Little or no flexibility
can have an adverse
impact on mining
operations



1486 Lost Blast
243 Panels

25m panel length
SG 4t/m³
Stoping Width 1m

100 tons per blast

10 000 tons/day
23 days per month
230 000 tpm

100 blasts per day

50% of call

50 Blasts Lost per day
1150 blats per month



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Conclusions

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- Technical operating flexibility is tacitly implied in the IMS definition.
- Technical operating flexibility affects a mining operation's position on the industry cost curve.
- Technical operating flexibility is affected by the mining method in use at a mining operation. In the case of underground PGM mining, TM3 tends to have the highest technical operating flexibility, followed by conventional (track-bound) mining and lastly, the hybrid mining method.
- Operations that set technical operating flexibility targets and implement governance structures and processes to achieve it (e.g., BRPM JV and Mototolo JV), tend to achieve better operating cost performance.

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Technical Flexibility Index - Recommendations

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Recommendations

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- Understand and recognise the significance of technical operating flexibility.
- Continually audit or monitor levels of IMS and IMA and keep track of corresponding positions of the mining operation on the industry cost curve relative to the IMS and/or IMA.
- Establish governance structures at executive and operational levels to drive the implementation of actions to achieve desired levels of operating flexibility.
- Achieving and maintaining operating flexibility targets must be non-negotiable and carry a higher weighting within the performance contracts for managers and executives.

**SPECIAL THANKS TO VALTERRA
PLATINUM**

QUESTIONS

