

Analysis of sustainability and the investment crisis in South African platinum mining using the A3 problem-solving process

S.M. ALI* and T.S. HATTINGH†

*School of Mining Engineering, University of the Witwatersrand, Johannesburg

†School of Mechanical, Industrial and Aeronautical Engineering, University of the Witwatersrand, Johannesburg

In August 2012 a wildcat strike took place at a platinum mine in the Marikana area, South Africa, which was followed by a wave of violent incidents. These unproductive episodes have affected the country's perception rankings, specifically regarding sustainability and investment concerns. To analyse this issue, this paper uses a structured approach of the A3 problem-solving process, a tool of the Toyota Production System, and makes use of publicly available data from January 2009 to March 2014. By using the A3 process, a picture is presented that places labour unrest at the baseline of problems. Further zooming unfolds the root causes under the ambits of socio-economic drivers, employment conditions, unions, and mine management. It reveals that migrant labour and rock drill operators are some of the most affected communities whose negative sentiments are not addressed at the right levels. The solution demands complete transformation of labour engagement forums, resolution of their social and economic needs, and elimination of feelings of depression. It includes reforms by all stakeholders, besides the improvements in safety assurances, educational progression, wage adjustments, working cycles, and housing conditions. The paper recommends that problem-solving techniques like the A3 process could be implemented in the mining sector to portray a unique and holistic view of current issues.

Keywords: South Africa, platinum, mining, sustainability, investment, A3, problem solving.

Introduction

Platinum group metals (PGMs) are the largest contributor in the South African mining sector in terms of GDP and employment. South Africa accounted for 53.4 per cent of global platinum supplies in 2013 (Baxter, 2014). Despite its significant role in the South African economy, the platinum mining industry is currently facing a major crisis. The wildcat strike at Marikana in August 2012 ignited a series of violent incidents and also impacted other mining sectors. The violent and unprotected episodes resulted in loss of lives, huge fixed costs, and a decline in export earnings. From the sustainability and investment perspective, such incidents tarnished the image of South African mining industry. The concerns of foreign investors resulted in a country credit rating downgrade by Moody's, Standard & Poor, and Fitch, with possibilities of further downgrades (Baxter, 2014). The weaknesses of the mining sector were also seen translated into declining economic prospects when the South African rand reached a multiyear low on 23 January 2014. The intensity of the problem necessitates that the issues be understood comprehensively, analysed deeply, addressed correctly, and sustained for long-term benefits.

The aim of this paper is to present the A3 problem-solving process to analyse the sustainability and investment crisis in the South African platinum mining industry. The paper is structured as per the guidelines of A3 process, and attempts to prove that such processes can be implemented in the mining sector to understand the current issues. It

takes a holistic view of the problem, and is not confined to a case study of Marikana. Other analyses of the problems arising from Marikana incident are, however, looked into to establish the relationships between causes and effects. The paper is based on a project work for the course 'Operations Management for Mining Systems' (Hattingh, 2014), and utilizes publicly available data from January 2009 to March 2014.

The A3 problem-solving process

Among various problem-solving techniques, the A3 problem-solving process is a powerful tool which provides alignment and cohesion as to the best course of action. It is more of a way of thinking than a report-writing methodology, which implements the PDCA (Plan-Do-Check-Act) or PDSA (Plan-Do-Study-Act) cycle (Deming, 1993). The A3 process with an underlying PDCA philosophy is the backbone of Toyota's product development system. The role played by the A3 problem-solving process in Toyota's rise to prominence is the primary reason for its popularity (Velaction Continuous Improvement, 2014). It is a practical technique for continuous improvement, which provides a framework of actions after getting to the root causes of issues. It checks that the changes are really effective, and identifies further actions to continue improving (Durward and Smalley, 2008).

Structure of the A3 problem-solving process

The A3 problem-solving process takes a systematic approach to ensure that a holistic view of the entire picture is obtained. It is like a storyboard leading logically from one section to the other while taking guidance from the PDCA cycle. The *Background* section clarifies the issue and adds context to the problem. It links the issue to the bottom line and the big picture, and creates a platform for tackling it. The *Current Conditions* section summarizes the current situation and establishes the lay of land. It shows an overview of the system, highlights problems, or presents the factors that help people understand the present conditions (Velaction Continuous Improvement, 2014). It also helps in understanding where the key drivers and issues might be found. Next is the *Goal* section, which determines where we should go and how long it should take to get there. This is followed by the *Root Cause Analysis* section, which takes substantial investigative time, being the most important section. This section uses appropriate tools to drill down to the actual root causes and establishes the link between cause and effect. If the root causes are not identified clearly, the wrong problem is likely to be solved (Velaction Continuous Improvement, 2014). It is only after the true root causes are understood that the A3 problem-solving process allows work to be done on the solutions. The *Countermeasures* section presents an action plan, in which the action items directly address the important root causes and add up to reach the specified goal. In the *Effect Confirmation* section, the effects of the countermeasures are confirmed, which is of particular importance for the PDCA cycle. It must check that the predicted changes are happening; otherwise the root causes are not being eliminated. In the latter case, it would require the repetition of previous steps (Velaction Continuous Improvement, 2014). The *Follow-Up Actions* section capitalizes on the opportunity to add further improvement and help spreading the knowledge. This section identifies steps to determine other issues and ensure that the solutions are sustained and shared.

To make a comprehensive visual reference, the abovementioned sections are summarized on a single A3 page (11 inch × 17 inch size) with use of graphics. The use of appropriate tools and graphical techniques helps in sharing solutions quickly and clearly (Durward and Smalley, 2008). The problem-solving A3 template with headings of the abovementioned core sections is shown in Figure 1.

Application of the A3 problem-solving process

The A3 problem-solving process can be adjusted to the needs and environment of application. It should, however, never stray away from the guiding principles, which are: adopting the PDCA cycle, back and forth communication, a deep understanding of the problem, following a team approach, taking decisions based on facts, and creating agreements about the goal (Velaction Continuous Improvement, 2014). This process is not intended as a tool for independent use. It involves several people and a variety of stakeholders who are affected by the outcomes. There must be people involved in data collection, analysis, and implementation of the solutions. It also requires consensus. If stakeholders are not bought in, the solutions are not likely to be supported.

This paper presents a practical example of how the A3 problem-solving process can be effectively utilized in the

platinum mining industry. The study can act as a guideline, which may require adjustments and improvements based on the facts and figures emerging through the meaningful engagements of all the stakeholders.

The evolved A3 solution based on the study in succeeding sections can be put on a single A3 page by combining the figures and tables and converting the essential text into graphical material. This will enable the solutions to be shared quickly and clearly, which is the real essence of a problem-solving process.

Background

This section not only links the issue of ‘sustainability and investment’ to the bottom line and the big picture, but also creates a platform to highlight its importance. It also clarifies the extent of problem.

The World Economic Forum (WEF) defines sustainable development as ‘the development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (WEF, 2013). It is not necessary that the rates of progress seen in the past may be sustainable going forward. To evaluate the competitiveness of a nation, it is now essential to question whether the prevalent growth model is sustainable over time or not. Sustainable development can be further subdivided into social and environmental aspects. Social sustainability evaluates the translation of economic growth into desired results for society, and environmental sustainability examines the pressures on the natural environment resulting from the economic activity. As a result, social and environmental sustainability influence economic policy decisions, thus affecting the economic performance of a nation (WEF, 2013). In the given scenario, it is necessary to check whether the South African mining industry is achieving a sustainable growth or not. And if not, what are the impediments?

The WEF carries out a competitive analysis of economies based on the Global Competitive Index (GCI). This is a comprehensive tool that measures the micro- and macro-economic foundations of national competitiveness (WEF, 2013). The sustainability-adjusted GCI as formulated by the WEF helps in analysing a nation’s sustainable competitiveness. In the Global Competitiveness Report

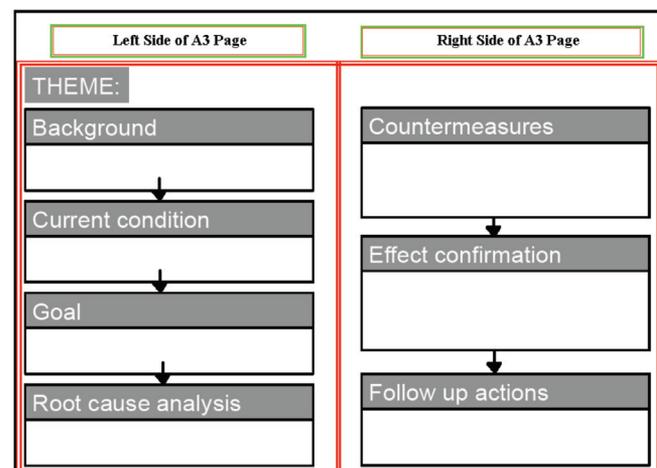


Figure 1. Problem-solving A3 template (Durward and Smalley, 2008)

(2013-14), South Africa ranks 53rd out of 148 countries, with a GCI of 4.37. As depicted in Figure 2, South Africa's GCI remained the same as of 2012-13 (WEF, 2012); however, the ranking dropped by one position due to an increase in the sample population from 144 to 148 countries. For 2013-14, both social and environmental sustainability aspects pulled the GCI down to 4.03. The trend remained similar to the previous year, where sustainability adjustment pulled the GCI down to 3.8 (in many European countries, sustainability adjustment pushes up the GCI).

Specifically for the mining sector, the Fraser Institute's Annual Survey (2014) includes national policies and mineral resources in the perception assessment of mining companies. Survey findings are influenced by experiences and sentiments of individuals having a significant impact on investment decisions (SA Mine, 2013). The investment attractiveness index for South African mining from 2009 onwards and related rankings (for 2013) are presented in Figure 3. The investment attractiveness index is calculated by taking into account 40 per cent of the policy perception index and 60 per cent of the best practices mineral potential index, in which South Africa stands at 64th and 37th position respectively out of 112 countries (Wilson and Cervantes, 2014).

Foreign direct investment (FDI) followed a decline after 2008 financial crisis, with lows reached in 2010 and then a subsequent recovery. However, in the second half of 2012 South Africa lost significant FDI due to Marikana and related industry-wide disputes. Despite the growth of total FDI in Africa in 2012, South Africa's inbound FDI decreased (SA Mine, 2013).

As the PGM sector is the largest component of the South African mining industry, its overall contribution to the mining industry and country's economy is significant. Despite its key contributing role, the sector is currently facing a crisis. South African share of global supply of three major PGMs decreased from 51 per cent (of the total) in 2003 to 39.8 per cent in 2013 (Baxter, 2014). The country's production of PGMs decreased annually by 0.4 per cent over the past decade, but more recently the production declined more sharply. The average platinum price in January 2014 was US\$1434 per ounce. If cash costs and sustaining capital expenditures are combined, 45 per cent of the platinum mining industry is either in loss or economically marginal (Baxter, 2014).

Current conditions

This section maps the ongoing situation to establish a base for the problem-solving. It breaks down the problem, which is of particular importance for identifying the key drivers and issues. Any form of solution or determination of root causes is avoided in this section.

As depicted in Figure 4, economies are categorized under various stages during a nation's progress along a development path. Currently South Africa, along with 30 other nations, is placed under efficiency-driven economies

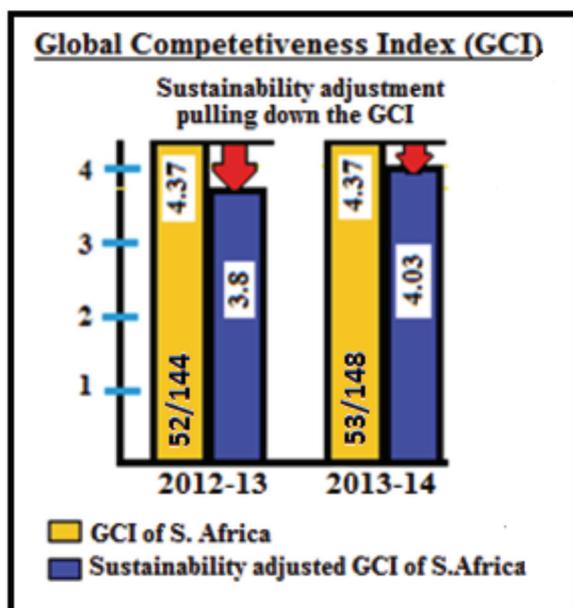


Figure 2. GCI and sustainability-adjusted GCI of South Africa (WEF, 2012; 2013)

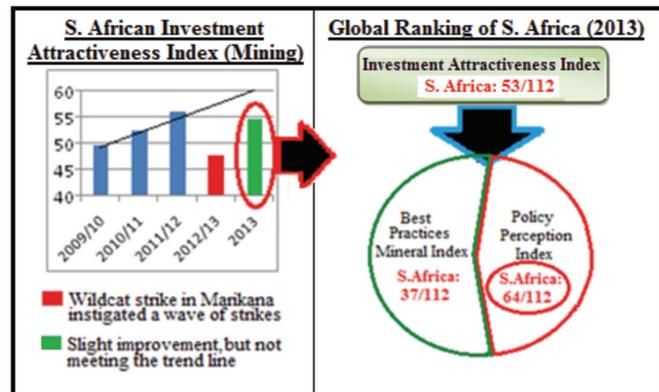


Figure 3. Investment attractiveness index and global ranking of South Africa (Wilson and Cervantes, 2014)

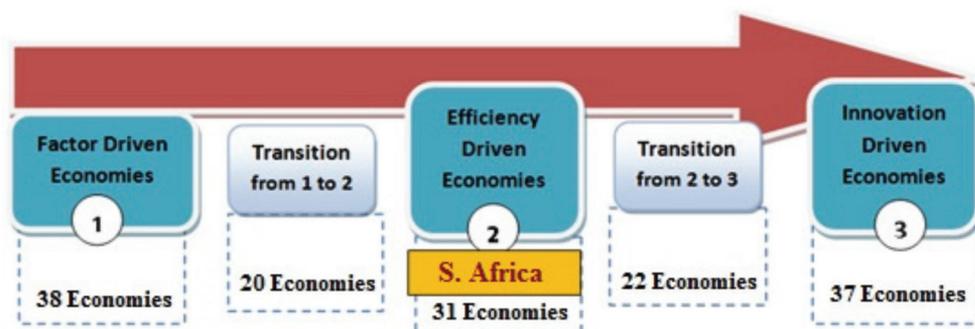


Figure 4. South Africa's position on the economic development path (WEF, 2013)

i.e. stage 2 (WEF, 2013).

For stage 2 economies, the efficiency enhancers comprising education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, and market size are the major pillars for GCI calculation. Figure 5 depicts the performance of South African efficiency enhancers, showing that 'labour market efficiency' in 2013/14 was at its worst, with a ranking of 116 out of 148 economies. The constituents of labour market efficiency with the worst rankings are labour-employer relations (148), wage determination flexibility (144), hiring and firing practices (147), and pay and productivity (142) (WEF, 2013).

As regards the mining sector, the Fraser Institute Survey (2013) determines the percentage deterrent to investment by assessing the policy factors of the policy perception index. Fifteen factors are considered, which are shown in Figure 6. The maximum percentage deterrent to investment in South African mining is for 'labour regulations, employment

Encourages investment	0%	
Not a deterrent to investment	19%	
Mild deterrent	34%	} 81%
Strong deterrent	30%	
Would not pursue investment due to this factor	17%	

agreements, and labour militancy/work disruptions' (81 per cent), with the country ranked 109 out of 112 countries (Wilson and Cervantes, 2014). The breakdown of 81 per cent is also shown in Table I. The proportion of respondents who are not likely to pursue investment in South Africa at all due to this factor is comparatively higher than for any other country.

The part played by labour unrest in the mining sector as the crucial deterrent to sustainability and investment is also confirmed by analysing the working days lost in industry. Figure 7 shows that working days lost in South African mining increased from 13 per cent in 2011 to 82 per cent in 2012 (Department of Labour, 2013). The labour unrest in 2012 resulted in a R12 billion fall in mine production (Leon, 2013). The South African platinum industry accounted for 5.7 per cent of GDP in 2011, while this contribution declined to 4.1 per cent in 2012 due to strikes and work stoppages (Baxter, 2014).

Goal

Based on the outcomes of the previous section, this section sets the target of solving the problem. The goal is required to be specific and clear in terms of: where improvement is required, how much improvement is required, and by what time.

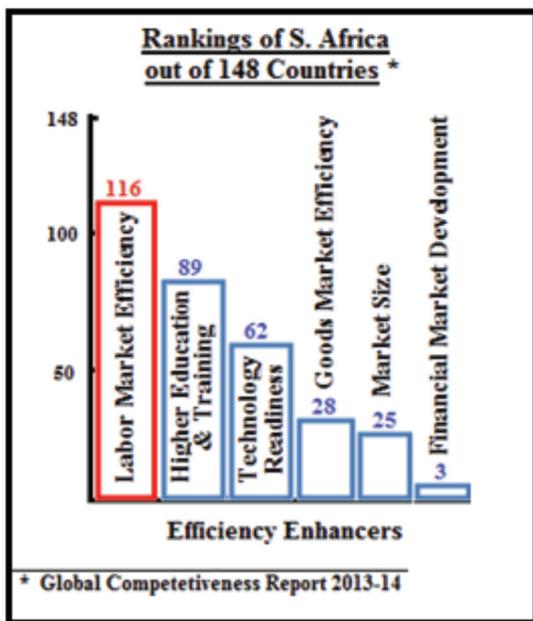


Figure 5. South Africa's rankings in the efficiency enhancer parameters (2013-14)

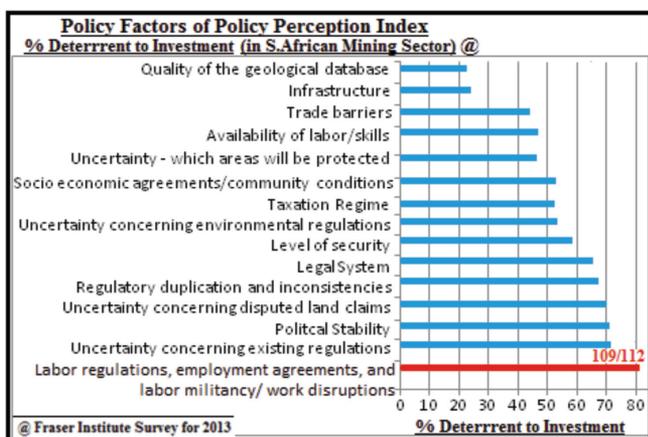


Figure 6. Policy factors of Policy Perception Index – percentage deterrent to investment in the South African Mining Sector

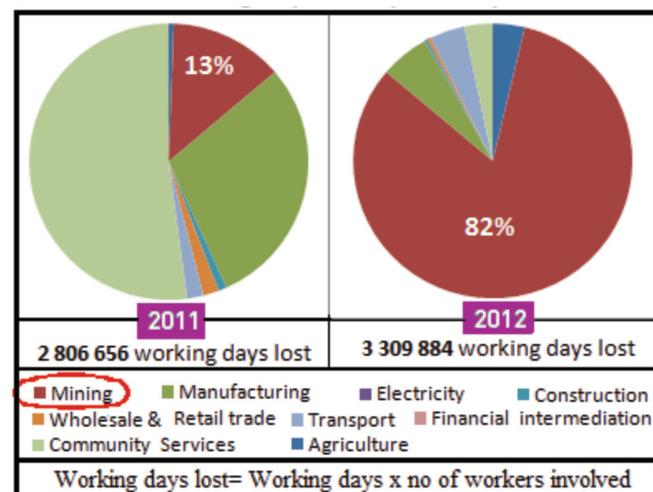


Figure 7. Working days lost by industry (Department of Labour, 2013)

The *Current Conditions* section showed that the sentiments of mining investors are becoming more negative due to massive unprocedural industrial actions and lost production. The preferred standard to check this is the percentage deterrent to investment for ‘labour regulations, employment agreements, and labour militancy/work disruptions’, as determined by the Fraser Institute surveys. The goal set in this paper is to reduce the percentage deterrent substantially from 81 per cent to a pre-determined, mutually agreed, and realistically formulated target level within 15 months from the effective date of execution. During practical implementation of the A3 problem-solving process, the 15-month time frame must be re-evaluated based on the consensus of all stakeholders. Also, the target level percentage must be clearly defined.

Root cause analysis

Root cause means an underlying reason or a ‘real’ problem, which is usually not obvious (Pelletier, n.d.). This section plays the most significant role in the A3 problem-solving process, as it separates the symptoms to uncover the real causes. To logically advance towards a realistic solution, the underlying real reasons (root causes) and not the apparent causes must be exposed. The identification of the correct root causes is essential so that relevant countermeasures can be applied to generate a sustainable solution. There are various root cause tools available for this purpose, which include 5 Whys, the fishbone diagram, affinity diagrams etc.

In this paper, the fishbone diagram is chosen as an appropriate tool to determine the root causes of labour unrest. Also referred as the ‘Ishikawa diagram’, it highlights the main causes and sub-causes leading to an effect or problem (American Society for Quality, n.d.). As illustrated in Figure 8, broadly five main causes are observed during the investigations and study of publicly

available data. Each cause has been questioned ‘why’ repeatedly till a reasonably true root cause has been determined.

Social drivers

The migrant labour system is identified as a long-term challenge for a sustainable mining industry, as the migrant mine workers are not permanently resident in their work areas (SA Mine, 2013). This aspect is more prominent in the platinum mining belts. The majority of the protesting labour is from the migrant population, and the motives of their dissatisfaction can be found under various reasons. The study of publicly available data and other analyses reveals the two major sub-causes of bad housing conditions and double family burden (Hartford, 2012, p. 1).

The living conditions of migrant labour are often not good. The improvements in housing conditions are not being addressed as per Mining Charter requirements (*root cause no. 1*), despite the commitment of meeting the same by 2014 (SA Mine, 2013).

In many cases, migrant labourers support their families in rural areas. Due to long work cycles (*root cause no. 2*), many of them are forced to keep second families in local communities near the mines. In South African mining, operations are planned on annual work cycles with only a Christmas and an Easter break (Hartford, 2012, p. 3).

There is a general feeling among mine labour on the lack of respect and concern for their issues. The major cause identified for such sentiments is the unsatisfactory manager-employee interface at shaft and mine level (*root cause no. 3*).

Economic drivers

A contracted underground sanitation assistant earns R1853 per annum, whereas in 2012 Lonmin’s chief executive earned R17.8 million (Forrest, 2013). The gross poverty

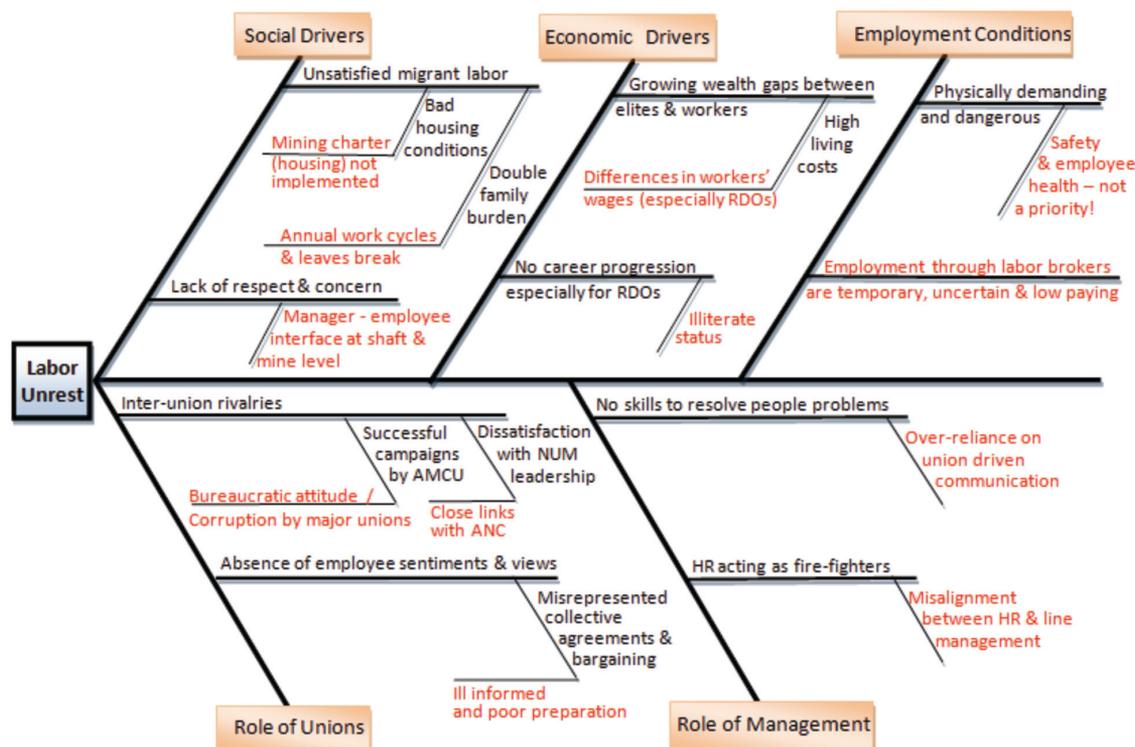


Figure 8. Root cause analysis

and inequality in South Africa (amongst the worst in world in respect of Gini coefficient measures) provides the context to heightened expectations of wage increases (Hartford, 2012, p. 6) (*root cause no. 4*). The rock drill operators (RDOs) of most of the mines have a long-standing perception of under-payment unmatched to their co-workers and work load (Hartford, 2012, p. 3).

The RDOs have a specific demographic pattern that distinguishes them from their colleagues. They are mostly migrant and functionally illiterate in comparative terms (Hartford, 2012, p. 3). The illiterate status of RDOs often causes hindrance in their career progression (*root cause no. 5*). The structure of the mining work team in respect of job categories requires basic academic training for advancement to blasting certificate status (Hartford, 2012, p. 3).

Employment conditions

The underground conditions are difficult to work in. RDOs are performing the toughest, most dangerous, and most production-critical functions (Hartford, 2012, p. 3). This feeling is enhanced due to the reason that required standards of safety conditions and employee health (*root cause no. 6*) are often not met by mining companies.

It has been noticed that workers employed through labour brokers are temporary, uncertain, and low paid (*root cause no. 7*). In many cases they pay a high registration fee to the broker but are uncovered in their stipulated rights. Labour brokers offer competitive rates to mines and make their own profit (Forrest, 2013).

The role of unions

The mining industry is the most unionized sector in the South African economy. The inter-union rivalry, particularly between the National Union of Mineworkers (NUM) and the Association of Mineworkers and Construction Union (AMCU), has caused an increase in violence and labour unrest (Leon, 2013). AMCU, as a new player, seized the opportunity to exploit the grievances of workers (Twala, 2012). It declared the bureaucratic attitude and corruption of NUM (*root cause no. 8*) as a reason for failure to address the grievances of the RDOs and migrant labour. On the other hand, NUM has lost 80 000 members since Marikana (Harvey, 2013). Among various reasons for this dissatisfaction, a significant cause is the close links of NUM with ANC (African National Congress) (*root cause no. 9*). A general feeling that the NUM is politicized is on the rise.

Unions are failing to probe and hear the rising discontent; as the collective agreements and bargaining processes are not representing the true sentiments of employees. With the passage of time, unions have gone into comfort zones, and they are generally ill-informed and poorly prepared (*root cause no. 10*) at the time of negotiations.

Role of management

In today's mining environment, the front-line supervisor has become a production and safety functionary, with little or no people resolution skills (Hartford, 2012). This is caused by the overburden of labour laws and (more importantly) overreliance on union-driven communication (*root cause no. 11*).

The HR department has emerged as a fire-fighting department, as they try to resolve the employees' conflicts on a shaft by shaft basis. This role of HR is a result of the

misalignment between HR and line management (*root cause no. 12*). Line management complains of not being empowered or consulted to deal with people issues; whereas HR maintains that line management is ineffective in addressing these problems (Hartford, 2012).

Countermeasures

This section entails a suggested action plan for how the root causes can be tackled to achieve the targets set. The aim is to suggest some of the many actions that emerged as a result of adopting the logical A3 problem-solving process. These can be taken as examples of how objective actions can be planned and implemented by establishing a rational link with the identified root causes. The suggestions corresponding to each identified root cause are shown in Table II, in which the colour coding represents the completion timelines for the combined reforms or stakeholders. Table II is further explained in succeeding paragraphs, which follows a chronological order as per the suggested completion timelines.

The educational and safety improvements must be executed as immediate reforms (completion within 3 months). These will address the root causes that fall directly within the mines' control. Focus should be retained on education and training of employees, and safety transformation programmes in terms of section 54 of the MHSA (SA Mine, 2013).

The energies must be focused on the reforms by line management to create synergy in language, culture, and ethnicity with the employees. Line management should be made accountable for resolution of people problem and rewarded for effective employee communication. Transformation in the people management interface at shaft level must be done by building work teams founded on respect, openness, information sharing, deep people problem solving, and leadership skills (Hartford, 2012). The target time suggested for these managerial reforms is 5 months from the effective date of execution.

Government and involved stakeholders must act to renew union structures, implement the constituency-based democratic representation, bring accountability for union leaders, and reduce political interference. Overall responsibility for reforms must be taken by labour unions (completion within 7 months).

The Department of Labour should come up with stricter regulations for labour brokers. These should encourage wage discrimination prohibition, compatible service conditions, and collective bargaining rights to the same extent enjoyed by full-time workers. The Department must also ensure sufficient representivity of employees in centralized bargaining structures (completion within 9 months).

Within 11 months, the Commission for Conciliation, Mediation & Arbitration (CCMA) and the mines should finalize and standardize wages, specifically addressing the RDOs concerns. The standardization must be done as per the acceptable formula across the board; accounting for mine profits, justifiable labour demands, and their work outputs. Mining companies should also re-orientate towards an increase in mechanization to balance their profits and curtail the unjustified labour protests.

Mines must introduce short work cycles of 4 months to help out the migrant labour (completion within 13 months). Deliberate planning should be done through overlapping of essentially required labour in order to ensure continuous operations.

Table II
The countermeasures

Suspected Cause	Action Item	Responsible	Target Condition
1. Conditions of Mining Charter on house improvements not met	Implement mining charter; convert all single-sex hostels into family units, attain one person/room occupancy rate	Mines & Department of Human Settlements (DHS)	Families of migrant labour accommodated and one person/ room occupancy rate achieved
2. Annual work cycles/ leave breaks	Short work cycles of 4 months (ensuring continuous operations)	Mining companies	Double family tendency curtailed
3. Manager-employee interface	Transform line management function to create synergy in language, culture & ethnicity	Mine Management	Comfortable communication of workers' problems direct to the management
4. Differences in workers' wages (especially for RDOs)	Standardize wages across the board vis-a-vis workers' justifiable demands, their work output, and mine's profits. Resort to increase in mechanization	Commission for Conciliation Mediation & Arbitration (CCMA) and Mines	Respectable living cost paid to the workers as per their work output share
5. Illiterate status of RDOs	Facilitation in education and on-job-training of workers (focus on RDOs)	Human Resource (HR) Departments	Equal opportunity of progression to all
6. Safety & employee health	Implementation of regular safety awareness campaigns and safety transformation programs	Health, Safety and Environmental (HSE) management	Achieve the goal of zero fatalities and injuries (as set up in 2003)
7. Employment through labour brokers	Stricter regulations on wage discrimination prohibition, compatible service conditions, and collective bargaining rights	Department of Labour	Equal opportunities and benefits for labour brokers' workers and full-time workers
8. Bureaucratic attitude/ corruption of major unions	Renewal of union structures implementing constituency-based democratic representation and accountability of leaders	Respective labour unions	Rightful, transparent and democratic representation of labours' concerns by the unions
9. Close links of NUM with ANC	Creation of peaceful and free union activity. Reduce political interference.	Respective labour unions/ Government	
10. Ill informed & poorly prepared collective agreements/ bargaining	Employees to participate/ ensure sufficient representivity in centralized bargaining structures	Department of Labour	Actual and genuine concerns should be addressed
11. Over-reliance on union driven communication	Increased focus on direct communication with employee	Mine Management	Grass-root issues should be communicated and resolved
12. Misalignment between HR and line management	Line management be made accountable (and rewarded) for people problem resolution and employee communication	Mine Management	

Completion (Color Codes)

 Within 3 months	 Within 5 months	 Within 7 months	 Within 9 months
 Within 11 months	 Within 13 months	 Within 15 months	

Within 15 months, the Department of Human Settlements (DHS) and mines should ensure full implementation of the Mining Charter conditions by converting all single-sex hostels into family units and attain one person per room occupancy rate.

Effect confirmation

This section accounts for verification of the effects achieved through the countermeasures, and determines whether the problem is eliminated or reduced as per the standard set in the Goal section. To implement this, the

survey details of the Fraser Institute and Global Competitiveness Reports should be accessed, and the discussed perceptions plotted in a similar fashion to that shown in Figure 9. A baseline curve is pre-plotted, with perceived effects for every reform and action.

The immediate reforms must develop a base of transformation in the mining industry, as anticipated in Figure 9 by the first four suggested reforms. These are expected to be slow in their response, but will provide time and create favourable environment for long-term actions to complete. The long-term reforms must be more

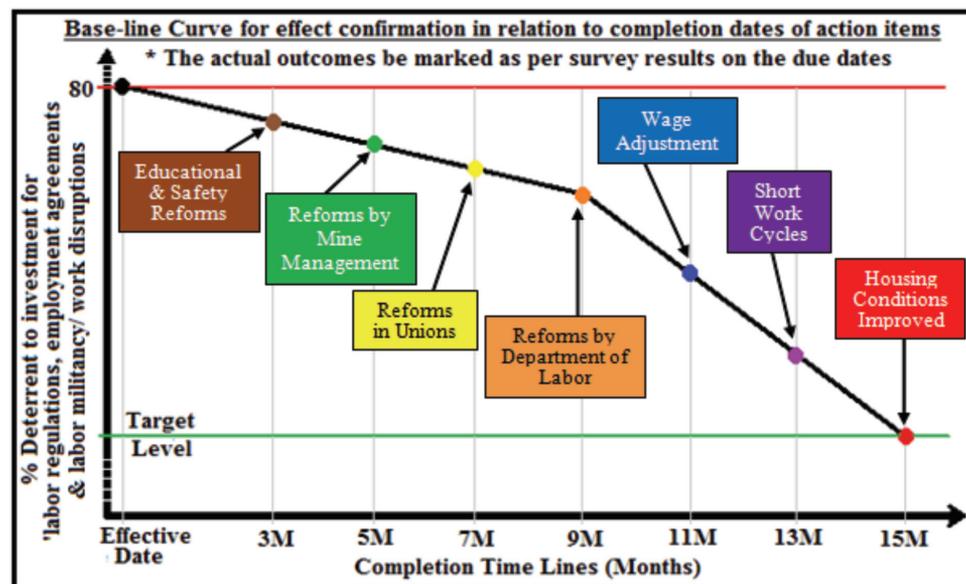


Figure 9. Effect confirmation

quantitative, well calculated, and physical in nature, as expected by the last three suggested reforms. These will support positive development of perceptions in sustainability and investment considerations. With an already created base of realizations, the successful implementation of wage settlements, short work cycles, and improvements in housing conditions are expected to greatly reduce deterrence to investment as per the Fraser Institute formulations.

With proper implementation of countermeasures, the percentage deterrent to investment for 'labour regulations, employment agreements, and labour militancy/work disruptions' is expected to be reduced from 81 per cent to the set target level. The target level and the completion timelines must be pre-determined before the practical implementation of A3 problem-solving process. For this study, the suggested timeline is kept at 15 months, which is flexible and can be modified with the consensus of involved stakeholders.

Follow-up actions

In light of the understanding gained, analysis performed, and countermeasures suggested, this section reflects what further changes can be made in the system and what remains to be done. If the logical linkages of A3 problem-solving process are adhered to properly, a set of significant follow-up actions must emerge to sustain the improvement cycle. Some of suggested follow-up actions (as a result of the study in this paper) are given in Table III, and are discussed briefly in succeeding paragraphs. For the implemented plan, the due dates for each action item must be identified on the basis of executed status of each countermeasure.

To sustain the continuous improvements in educational and safety reforms, HR and HSE departments should establish and revise their checklists in light of the implemented improvements. A system must be developed on each mine to study the functionality of the new techniques at international level, and recommend the feasibility of adopting them.

A feedback system must be put into practice to sustain

the transformations made at shaft and mine level, in which the mineworkers should provide feedback about their immediate supervisor and manager. The contents of feedback pro-forma must focus on the resolution of employee issues, labour respect, openness of communication, information sharing, and leadership skills.

All the stakeholders responsible for the improvements in the mining industry must be brought onto a single grid. This must be done by holding regular meetings of the representatives from mine management, unions, and government departments. Meetings should focus on maintaining the resolution of long-term issues, including improving labour brokers' engagement, improving collective agreements and bargaining structures, and creating conditions for peaceful and free union activity (Twala, 2012).

Contact must be constantly maintained with research centres and OEMs at the international level to ensure continuous improvements in mechanization of the mines.

Table III
Follow-up actions

Investigation item	Responsibility
Establish educational and safety implementation checks within companies	HR and HSE departments
Establish feedback system (on a pro-forma) of line management	HR department
Hold regular meetings of the representatives from management, unions, and government departments to discuss and improve upon labour brokers, collective agreements, and union structures	Department of Labour
Contact research centres and OEMs to increase mechanization	Mining companies
Invest in and resolve transportation for migrant labour	Mining companies
Establish labour housing maintenance teams and PM checks	DHS and mines

This will help in growing the production output (hence easing the wage burden), improving safety standards, transforming the technical skills of the labour force and curtailing future recruitment of low-paid bulk labour.

The short-term impractical measures for migrant labour are likely to have adverse repercussions. By introducing short work cycles, migrant labour is expected to visit their distant families more frequently and restrain from keeping second families. However, without organizing or investing in transportation facilities, the desired long-term results cannot be achieved. A well-coordinated plan must be formulated and implemented for the transportation of migrant labour.

The improvements in labour housing must be maintained and checked regularly through maintenance teams and systematic checklists. The preventative measures if incorporated, through timely maintenance of houses, will give a sense of dignity to the socially ignored labourer. The DHS and mines must work hand-in-hand to implement this essential follow-up action.

Comparison with other analyses and findings

Many studies and analyses have been done to date to investigate the crisis in mining sector, especially against the backdrop of the Marikana incident. All of these have contributed appreciably to a better understanding of the problem and offering of pertinent recommendations; however the techniques adopted were generally varied. In comparison, this particular paper is different due to its adoption of the A3 problem-solving process. It clarifies and adds context to the problem, maps the ongoing situation to establish the base, finds the key drivers, and then sets the target to solve the problem. The approach establishes traceable interconnections between what is happening in the industry and the identified issues so that the impact of changes can be linked back to the actual effects. It also suggests the method to track and confirm the reduction of the problem, and emphasizes continuous improvement. In nutshell, the A3 process ensures an objective- and data-driven approach with the inherent attribute of being shared quickly and clearly, while stressing comprehensive, realistic, and holistic answers. To offer a generalized comparison on the findings of this paper, a brief of some of the other analyses/findings on the topic are summarized.

President Jacob Zuma appointed a Commission of Inquiry on 23 August 2012, with a mandate to investigate matters of public, national, and international concern raised due to the Marikana incident (Marikana Commission of Inquiry, 2014). Different stakeholders have testified before the Commission, and the investigations are still under process.

The Department of Labour (2013) concluded that most of the strikes in 2012 were wage-related and for better working conditions. Recommendations to address the challenges included creating better communities between employers and employees; increasing capacity-building; accepting traditional bargaining structures; working together to develop a new roadmap; addressing poverty, unemployment and inequality; and government taking the control of situation.

Baxter (2014) analysed the economic contribution of PGM industry and the prevailing crisis. He recommended that all stakeholders should play their role in assisting the PGM mining sector through the short-term crisis and help in repositioning the sector for sustainability and future

growth. He stressed stabilizing the industrial relations environment and promoting peace and security in the platinum sector.

Twala (2012) analysed the Marikana incident by presenting a historical overview of labour unrest in the country. He recommended free union activity, active participation in centralized bargaining structures, renewal of union structures, improvement in living conditions, and national engagement on transformation of the mining sector.

Brand (2012) analysed the dynamics and facts of Marikana incident, and focused on the lessons for corporate South Africa. He suggested working on labours' living and working conditions, encouraging social dialogue, improving industrial democracy and collective bargaining skills, addressing union corruption, reviewing of labour laws, improving mediation, addressing illiteracy, communicating effectively, correcting media inaccuracies, and introducing moderators.

Forrest (2013) argued that Marikana incident was not just because of migrant labour concerns. Other related concerns, including implementation of Mining Charter, laws on labour brokers, and high pay gaps contributed to put workers under enormous pressure.

Leon (2013) analysed the challenges faced by the mining industry after the Marikana incident, and recommended working on the tripartite Framework Agreement signed by government, labour, and business on 3 July 2013. He stressed that all three parties must work together to ensure the sustainability of the mining sector.

Conclusion

The crisis of sustainability and investment in South African platinum mining is becoming severe, especially in the aftermath of the Marikana tragedy and the protracted strikes in 2014. Much is known about the issues within the industry, but it is not always easy to see how the issues are interconnected and what the relationships are between causes and effects. The A3 problem-solving process applies this unique approach by promoting logical, objective, and data-driven thinking.

References

- AMERICAN SOCIETY FOR QUALITY. Not dated. Fishbone (Ishikawa) Diagram. <http://asq.org/learn-about-quality/cause-analysis-tools/overview/fishbone.html> [Accessed 29 May 2014].
- BAXTER, R. 2014. Platinum – State of the nation. Chamber of Mines of South Africa. <http://www.platinumwagene negotiations.co.za/assets/downloads/fact-and-figures/platinum-state-of-the-nation.pdf> [Accessed 4 September 2014].
- BRAND, J. 2012. Marikana and its lessons for corporate South Africa. Bowman Gilfillan. <http://www.saccoconsulting.co.za/docs/STRIKE%20IMPACT%202012.pdf> [Accessed 20 April 2014].
- DEMING, W.E. 1993. The New Economics. MIT Press, Cambridge, MA. p. 135.
- DEPARTMENT OF LABOUR. 2013. Annual Industrial Action Report 2012. ISBN: 978-0-621-42003-6. <http://www.labour.gov.za/DOL/downloads/documents/annual-reports/industrial-action-annual-report/2012/industrialreport2012.pdf> [Accessed 3 April 2014].

- DURWARD, K.S. and SMALLEY, A. 2008. Understanding A3 thinking: A critical component of Toyota's PDCA management system. Chapter 2. A3 Thinking. pp. 11–27.
- FORREST, K. 2013. Marikana was not just about migrant labour. Mail & Guardian, 13 Sep. 2013, <http://mg.co.za/article/2013-09-13-00-marikana-was-not-just-about-migrant-labour> [Accessed 29 March 2014].
- HARTFORD, G. 2012. The mining industry strike wave: what are the causes and what are the solutions? <http://groundup.org.za/content/mining-industry-strike-wave-what-are-causes-and-what-are-solutions> [Accessed 2 April 2014].
- HARVEY, R. 2013. Marikana as a tipping point? The political economy of labour tensions in South Africa's mining industry and how best to resolve them. Occasional paper no. 164. South African Institute of International Affairs (SAIIA). <http://www.saiia.org.za/occasional-papers/marikana-as-a-tipping-point-the-political-economy-of-labour-tensions-in-south-africas-mining-industry-and-how-best-to-resolve-them> [Accessed 11 April 2014].
- HATTINGH, T. 2014. Lecture notes: 'Operations management for mining systems. Professional Development Hub, University of Witwatersrand, Johannesburg, South Africa, 3–7 March 2014.
- LEON, P. 2013. The mining industry after Marikana. Politicsweb, 21 October 2013. <http://politicsweb.co.za/politicsweb/view/politicsweb/en/page71619?oid=427549&sn=Detail&pid=71616> [Accessed 11 April 2014].
- MARIKANA COMMISSION OF INQUIRY. 2014. <http://www.marikanacomm.org.za/> [Accessed 25 August 2014].
- PELLETIER, L. Not dated. A3 – the basic problem solving tool. University of Massachusetts. http://www.umassmed.edu/uploadedFiles/fmch/Faculty_Resources/Fall11_PelletierA3.pdf [Accessed 25 June 2014].
- SA MINE. 2013. Highlighting trends in the South African mining industry. 5th edn, November 2013. PriceWaterhouseCoopers. http://www.pwc.co.za/en_ZA/za/assets/pdf/sa-mine-2013.pdf [Accessed 25 March 2014].
- TWALA, C. 2012. The Marikana massacre: a historical overview of the labour unrest in the mining sector in South Africa. South African Peace and Security Studies, vol. 1, no. 2. [http://www.saccps.org/pdf/1-2/SAPSS%20\(2\)%20Twala.pdf](http://www.saccps.org/pdf/1-2/SAPSS%20(2)%20Twala.pdf) [Accessed 7 April 14].
- VELACTION CONTINUOUS IMPROVEMENT, 2014. A3 Thinking. LLC. <http://www.velaction.com/a3-thinking/> [Accessed 20 June 2014].
- WORLD ECONOMIC FORUM (WEF). 2013. The Global Competitiveness Report 2013-14, Full Data Edition. ISBN-13: 978-92-95044-73-9. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf [Accessed 12 April 2014].
- WORLD ECONOMIC FORUM (WEF). 2012. The Global Competitiveness Report 2012-13, Full Data Edition. ISBN-13: 978-92-95044-35-7. http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2012-13.pdf [Accessed 13 April 2014].
- WILSON, A. and CERVANTES, M. 2014. Survey of Mining Companies 2013. Fraser Institute. <http://www.fraserinstitute.org/uploadedFiles/fraser-ca/Content/research-news/research/publications/mining-survey-2013.pdf> [Accessed 9 April 2014].



Syed Mohsin Ali

Postgraduate Student, School of Mining Engineering, University of the Witwatersrand

Syed Mohsin Ali is a Mechanical Engineer from the National University of Sciences & Technology (NUST) Pakistan. He is a selected faculty member from NUST for the capacity building program in mining engineering. He is presently doing M.Sc.Eng in Mechanised Mining Systems at the School of Mining Engineering, University of the Witwatersrand South Africa. The paper 'analysis of sustainability and the investment crisis in South African platinum mining using the A3 problem-solving process' is based on his project work for the course 'Operations Management for Mining Systems'