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A framework for developing social mine closure criteria

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Abstract

Mine closure criteria are a prerequisite for successful and sustainable closure of mine sites. However, the social mine closure criteria are not well developed across the world. While many International Council on Mining and Metals (ICMM) members and many other non-ICMM members recognise the benefits of closure governance, a corporate culture or mindset shift within organisations is required to integrate closure. Using the South African mining industry as a reference, an analysis of publicly available mine closure plans has shown that mine closure criteria mainly relate to environmental rehabilitation or mine reclamation. This approach does not fully address all relevant targets and global indicators of the Sustainable Development Goals (SDGs), which South Africa adopted in 2015.

South Africa has a long history of mining, which has contributed significantly to the country's economic development. At the same time, all mines contribute to the socio-economic development of mine-associated communities and labour-sending areas, as required by local legislation. They also undertake broad-based stakeholder engagement and address downscaling or retrenchment impacts in compliance with national legislation. However, social mine closure criteria and mechanisms for achieving an effective social transition towards mine closure are not legally required and are underdeveloped.

Major and mid-tier mining companies in South Africa undertake voluntary sustainable reporting. By effectively visioning their own long-term sustainability goals, such as the provisioning of economic and social development opportunities to host communities, mines have the potential to direct sustainable development policies, plans and programs within their area of influence. Developing suitable and sustainable social mine closure criteria should also ensure that this positive alignment to the SDGs set by the United Nations for 2030 continues beyond mine closure. In this context, the paper proposes a framework for developing social mine closure criteria and mechanisms. The social mine closure criteria have the potential to supplement closure plans and aim to foster sustainable social transitioning beyond mine closure.

Keywords: *mine closure, mine closure criteria, social transitioning, sustainable development, social impact, social performance*

1 Introduction

The concept of social transitioning is emerging as a central theme in the contemporary discourse around mine closure. This is mainly due to the International Council on Mining and Metals (ICMM) Planning for Integrated Mine Closure Toolkit, which was released in 2008 and updated in 2019 (ICMM 2019). Other documents, such as the ICMM Closure Maturity Framework (ICMM 2020), help operations understand their status and performance towards implementing sustainable closure in each phase of a mine's lifecycle.

Mine closure in the South African context has been neglected to a great extent (see Druten & Bekker 2017, p. 458; Watson & Olalde 2018). The South African mining industry makes a significant contribution to the country's overall gross domestic product. Consequently, any mine that closes without implementation of a practical social closure plan could negatively affect the surrounding communities and the wider socio-economic context of the country. Unfortunately, employment figures have been declining in the mining sector since 2012 (Chamber of Mines 2017). The Minerals Council South Africa (then Chamber of Mines)

reported that more than 67,000 jobs had been shed between 2012 and 2016 (Chamber of Mines 2017). Also, over the past 10 years (between 2010 and 2020), the gold mining industry has shed more than 50,000 jobs (Minerals Council of South Africa 2020, p. 30 and 2021, p. 37). This trend is especially upsetting in the context of COVID-19 and the ongoing retrenchments in the formal mining sector, with more than 2,260 jobs lost between January 2020 and June 2020. This period coincides with the pandemic's start and the subsequent economic lockdown (Parliamentary Monitoring Group 2020). Unfortunately, the effect of the ongoing COVID-19 pandemic on employment figures is expected to sustain this trend in the foreseeable future. Besides, gold mining companies, for example, have seen only two years of positive annual growth in the last two decades (in 2002 and 2013), with South Africa producing 83% less gold in 2018 than it did in 1980 (Statistics South Africa 2018). With the ongoing downturn in mine production that triggers mine retrenchments, the need to plan for mine closure is crucial. Incorporating social aspects into mine closure planning has the potential to develop alternative livelihood opportunities that are not dependent on the mining industry. For this reason, the need to consider social transitioning toward mine closure is critical within the development context of South Africa.

The South African mining industry has played an important role in the country's socio-economic transformation since democratic dispensation in 1994. Access to the country's minerals pre-democracy was intrinsically bound to land ownership, so mining also contributed to the unequal distribution of wealth (Twala 2012). However, the new democratic dispensation of 1994 has failed to bring about substantial improvements to the redistribution of mineral wealth in a way that benefits communities and individuals whose land was taken away for mining purposes (Action Aid 2008). Instead, "the structure of domination and control of South Africa's mineral resources created through the apartheid regime [has] remained largely unchanged" (Olaleye 2010, p. 24). Important to note is that poor mine closure and rehabilitation create dreadful environments, and this leads to issues within communities. Research explains that environmental degradation, such as mine waste, acid mine drainage and soil erosion, outlast the lifespan of a mine (Krause & Snyman 2014, p. 2). Such negative legacies pose a daily threat to the wellbeing and safety of communities (Krause & Snyman 2014, p. 2). Furthermore, high levels of illnesses like respiratory diseases and skin diseases have been reported in mine-affected communities. In addition, where mines have closed, like in the case of De Beers at Kleinzee, South Africa, communities were left in dreadful circumstances (see Cronjé et al. 2009).

What is of concern is that the estimated number of abandoned, ownerless and derelict mines across the country is close to 6,000 (Department of Mineral Resources 2015, p. 53; Druten & Bekker 2017, p. 458). According to the most recent data, 803 closure certificates were issued by the South African government for prospecting rights, mining permits and mining rights between 2011 and 2016 (Watson & Olalde 2019). The industry's decline, specifically the gold sector, has meant that unrehabilitated and abandoned mines' environmental and social impact is not being addressed. For this reason, the focus of mine closure policy and regulation has been narrow due to a general lack of policy and regulatory guidelines (Auditor-General 2009) and the focus of early legislation was primarily on surface rehabilitation (Van Tonder et al. 2009). In 2015, mine closure and rehabilitation appeared in South African environmental legislation. A key piece of legislation is the *National Environmental Management Act 107 of 1998* (NEMA) (Government of South Africa 1998). Historically, the Department of Mineral Resources and Energy (DMRE), through the implementation of the *Mineral and Petroleum Resources Development Act 28 of 2002* (MPRDA) (Government of South Africa 2002), was mandated to regulate environmental aspects associated with mining activities. This changed in 2014 when the NEMA was amended to delegate oversight of the environmental aspects of mining to the erstwhile Department of Environmental Affairs (now the Department of Forestry, Fisheries and the Environment). The DMRE remained the permitting authority. Amendments to NEMA in 2015 for the first time included aspects relating to mine closure and rehabilitation, with the promulgation of the Regulations Pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations (Regulation 1147) (Government of South Africa 2015).

Although the MPRDA does not provide clear guidelines for social transitioning into mine closure, it makes provision for a social and labour plan (SLP), which aims to ensure that mines contribute to the socio-economic development of the areas in which they operate. Also, the SLP aims to foster development and sustainability

during the life-of-mine (LoM) and after a mine has closed. This consideration is evident in the element of downscaling and closure as stipulated in the SLP guidelines. Through the MPRDA, a mining company is compelled to put the following mechanisms in place (Department of Mineral Resources 2010, pp. 21–23): the establishment of a future forum, strategies to save jobs or the provision of alternative solutions when job losses are inevitable, and the management of retrenchments and mechanisms to manage and improve the social and economic impact on communities when retrenchments or mine closure occurs.

Besides the national legal agendas that point to sustainable mine closure, South Africa adopted the international agenda for Sustainable Development in 2015 (Statistics South Africa 2019). To align with the country's overall Sustainable Development Goals (SDGs), the mine closure process must be supported by a consultation to gain a firsthand understanding of the socio-economic status quo of the community and their associated needs (Cole & Broadhurst 2021). While the SLP does not explicitly address the SDGs or impacts of social transitioning for closure, some of the provisions, as mentioned, aim to ensure that necessary processes are in place.

South Africa provides a unique backdrop to this research, as it has made significant progress in formulating national legislative responses to the social impacts of mine closure. Although it can be argued that the outcomes of the SLP have had mixed results (Centre for Applied Legal Studies 2018), the legislation serves as a good starting point and a step in the right direction for sustainable mine closure.

2 Barriers and challenges to incorporating social closure criteria

The social aspects of mining have always presented a challenge for the industry, with Owen & Kemp (2018) ascribing this to capability gaps around social performance. The Centre for Sustainability in Mining and Industry (Centre for Sustainability in Mining and Industry 2010) has reported that mines have historically struggled to fully comprehend how the management of social, as opposed to environmental, engineering, or other physical, risks should be managed. Social aspects of societies are generally complex, and this unpredictability makes it difficult to apply a one-size-fits-all approach to social performance.

The industry's strengths in environmental and engineering sciences tend to overlook or exclude social specialists (Owen & Kemp 2018, p. 14). Technical considerations dominate the closure planning process. Owen & Kemp (2018, p. 14) rightly remark that "by the time social specialists are brought in to the mix, their timeframes for studies, consultations and negotiations are compressed, and certain issues may have been neglected".

Despite the South African government's efforts to regulate some of these social obligations, mines have continued to view SLP implementation as an added administrative and tax burden (Centre for Applied Legal Studies 2018). Being a predominantly capital-intensive industry with high start-up costs, mines are constantly challenged to balance profit margins with the sustainable integration of SLPs into their core business strategy (Thambi 2019). Furthermore, legislation has put corporate social responsibility and sustainable development issues in the hands of the mining industry at a national policy level. Still, the MPRDA has not indicated what this means in practical terms (Cronjé & Chenga 2009).

One of the most significant barriers to incorporating social closure criteria is that mines and mine closure professionals tend to view closure as an isolated event that takes place at the end of the LoM (Dagva et al. 2015). Rather, it is a continuation of the mine lifecycle, and decisions are made during the LoM that will support or hinder successful social transitioning during mine closure.

Previous research has established that these gaps inhibit identifying issues and trends and the ability to conduct meaningful analysis and manage projects through complex problems and scenarios (Owen & Kemp 2018). The fragmented and siloed approach being taken toward social aspects of closure means that sustainable development objectives do not comprehensively deal with the post-closure scenario by considering current social impacts. For instance, communities are dependent on mining activities for employment, services, and a market for local businesses. In addition, mines have historically also fallen into the trap of industrial paternalism, providing mine employees with services such as housing and health care. A mine's contributions towards

community upliftment have been partly in response to a lack of government resources to provide municipal and social infrastructure instead of creating sustainable communities beyond the LoM.

Scholars such as Owen & Kemp (2018) and Hancock (2019) have noted that the absence of precise regulatory instruments to guide closure projects presents significant challenges for developers and stakeholders alike in the closing out of social and environmental impacts. The current vacuum in proper social mine closure criteria and guidelines results in ad hoc and unplanned approaches. Research indicates that developing the capacity of the mine management and governments and communities is also a key challenge (Edwards & Maritz 2019; Owen & Kemp 2018). As Owen & Kemp (2018, p. 12) state: "The capacity of these stakeholders to maximise opportunities, carry responsibilities, or absorb externalised costs, often exist independently of the company's maturity cycle. Different stakeholders require different lead times ...". Also, it is important to note that planning for closure is also ineffective if it occurs at the corporate level without considering the site-specific context.

The preceding sections of this paper have highlighted that no clear framework exists in South Africa for mines to adequately address social aspects of mine closure. A framework for developing completion criteria for mine closure and rehabilitation has been proposed by Manero et al. (2020). The framework focuses on post-mining land use and other environmental closure objectives. The framework considers social factors such as acceptability to key stakeholders and heritage, but a broader set of factors should be considered, such as the selection of post-mining land use, definition of aspects and closure objectives, the selection of reference(s), the selection of attributes, the definition of completion criteria, and evaluation of performance.

In addition, the framework developed by Vanclay & Smyth (2017) provides a valuable basis for elaborating on mine closure criteria. It includes factors relating to all three spheres of sustainability, namely environmental, economic and social, which can, in turn, be subdivided into seven subcategories (Figure 1). The environmental aspects focus on communities' reliance on land and natural resources, and the quality of their living environment. The economic aspects focus on livelihood assets and activities of communities as well as the infrastructure and services they rely on. The social aspects focus on people's capacities, abilities and freedoms to achieve their goals, social support and political context, as well as culture and religion.

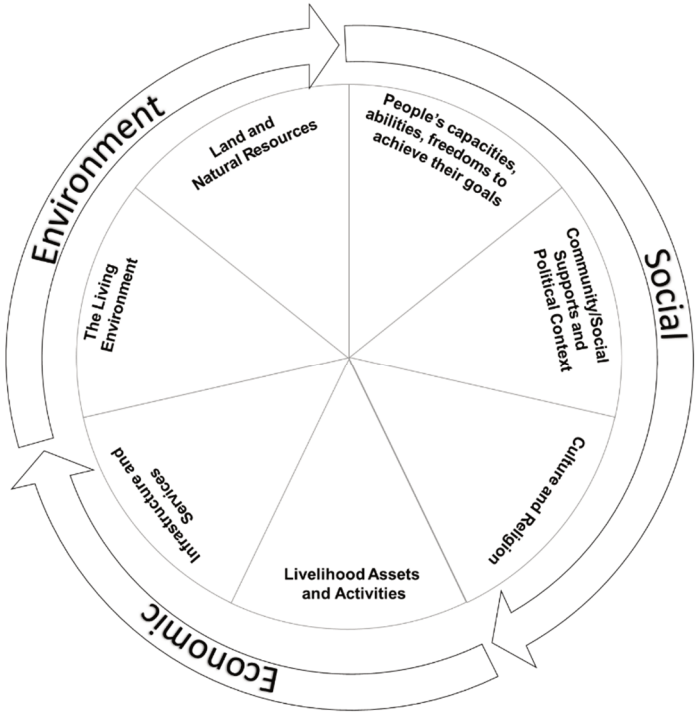

Figure 1 Social, economic and environmental aspects that should inform mine closure criteria (adapted from Vanclay & Smyth 2017)

This framework offers a broader perspective on developing social closure criteria that speak to social transitioning objectives. It should be used in the closure planning process, which involves setting objectives, closure vision, closure actions or mitigation measures, closure criteria, and accompanying schedule and cost estimate.

The inclusion of mine closure criteria is a prerequisite for the successful closure of mine sites. However, especially given the historical legacy of mining described above, and the significant focus on social licence to operate, there is a need to develop a new framework or update existing frameworks, including social mine closure criteria. Broad-based stakeholder engagement and addressing downscaling or retrenchment impacts are imperatives. Yet the necessary social mine closure criteria or mechanisms for achieving an effective social transition towards mine closure are underdeveloped.

Unfortunately, in the South African context, few frameworks or criteria with a focus on social mine closure are in development. For that reason, the paper's main research question is as follows:

1. What elements or aspects will contribute towards the development of social mine closure criteria?
2. What would a social mine closure framework entail?

Based on the research questions, the paper's main objectives are twofold. First, the paper aims to uncover what elements or aspects can contribute to developing a social mine closure criteria for the South African context. The second objective is to develop a framework for social closure. Many definitions of a framework exist within the literature. For this research paper, the definition by Miles & Hubermann (1999) will be adopted to define a framework. According to these authors, a conceptual framework "explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs or variables – and the presumed relationships among them. Frameworks can be rudimentary or elaborate, theory-driven or commonsensical, descriptive or causal".

The next section provides an overview of the methodology that was deployed for meeting the objectives.

3 Methodology

Content analysis was used to meet the paper's research objectives. For the content analysis, mine closure reports not older than 10 years were reviewed. Since mine closure reports often include sensitive information that mining companies would not wish to divulge, the researchers relied on publicly accessible documents published online.

Content analysis can be described as a technique for examining information or content in written or symbolic material. Neumann (1997, p. 31) further clarifies that the researcher identifies a body of material to analyse in content analysis, such as books, newspapers or film. In this case, the researcher analysed several mine closure reports from different mining companies. According to Neumann (1997, p. 31), the researcher then creates a system including counting how often certain words or themes occur. For this article, the researchers specifically looked for any social reference and amount of occurrence in the reports. Lastly, the researcher records what was found in the material. Also, specific questions and considerations were considered when analysing each report. Considerations include the following:

- Consideration of social aspects and impacts of mine closure.
- Inclusion of social transitioning considerations.
- Inclusion of a social baseline description.
- Collaboration with communities or stakeholders.
- Specific consultation regarding the post-closure land use.
- Inclusion of opinions and suggestions of the affected stakeholders and communities into the closure plan.

- Consideration of sustainability of social projects implemented through the SLP, and provision of mitigation measures for closure impacts on employees, suppliers, service providers, host communities or stakeholders who have become dependent on the mine.

Due to the limited number of South African mine closure reports available, all accessible documents were reviewed. A total of eight reports were reviewed, and these included:

1. Mine Closure Plan for the Delmas Clay Mine. Mpumalanga Province (Envass Environmental Assurance [Pty] Ltd 2016).
2. Rehabilitation, Decommissioning and Mine Closure Plan for the Thubelisha, Trichardsfontein and Vaalkop Mining Right Areas. Mpumalanga Province (Digby Wells Environmental 2017).
3. Rehabilitation, Decommissioning and Mine Closure Plan for the Leslie 1 Coal Mining Project. Mpumalanga Province (Kongiwe Environmental [Pty] Ltd 2018a).
4. Rehabilitation, Decommissioning and Mine Closure Plan for the Umsimbithi eMakhazeni Mining Project. Mpumalanga Province (Kongiwe Environmental [Pty] Ltd 2018b).
5. Decommissioning, Rehabilitation and Mine Closure Plan for Buffalo Coal: Aviemore (GCS Water and Environmental Consultants 2019).
6. Final Closure Plan for Voorspoed Mine. Free State Province (Redco and Uvuna Sustainability 2019).
7. Final Rehabilitation, Decommissioning and Mine Closure Plan for the Cygnus Mine (SRK Consulting 2019a).
8. Rehabilitation and closure plan for the Der Brochen Amendment Project (SRK Consulting 2019b).

The following section provides an overview of the content analysis findings, presented as themes.

4 Findings

This study set out with the aim of uncovering what aspects can be incorporated into a social mine closure framework, and second, as a culmination of the first objective's findings, the study puts forward a framework for social mine closure. The key findings that will be discussed in this section are as follows:

- Programs or projects that relate to social mine closure.
- Broadening social mine closure management objectives.
- Actions for determining the criteria for social mine closure.
- Towards the development of a social mine closure framework.

4.1 Programs or projects that relate to social mine closure

Overall, the findings of the study conducted by these authors indicate that mine closure criteria included in the reviewed reports were primarily related to environmental aspects, land use and safety. A review of the closure reports revealed that the closure objectives were almost exclusively focused on environmental rehabilitation and post-mining land use, clearly excluding social transitioning considerations. Three reports aim to achieve a sustainable environmental and social outcome in the long term, but very little guidance is provided on how this should be achieved. The overall key finding is that even though some reports refer to mines' SLP projects as potential ways to mitigate some of the social impacts, the sustainability of these programs is not assessed and the potentially enabling mechanisms of the future forum are noticeably absent. The role of the future forum is to encourage continuing negotiations and discourse between the workforce, worker representatives and the mine about the mine's future and any anticipated problems. Additionally, environmental management programs require environmental objectives and socio-economic goals for conditions identified in the SLP. Moreover, while there is no official regulatory body or legal obligation, the

growing acknowledgement of a social licence to operate provides additional incentives for mining companies to improve social and environmental results (Monosky & Keeling 2021, p. 32).

The phrase 'social licence to operate' developed from within the mining industry as an answer to social risk in the mid-1990s (Boutilier & Thomson 2011). A social licence to operate is a means to earn accountability, credibility, flexibility and capacity for both stakeholders and industry (Nelson 2006).

Moreover, a social licence to operate and the future of the workforce (e.g. decarbonisation) are among the three top-rated risks to the mining industry in 2022 (EY 2022), with mine closure being rated among the top five operating risks in mining (Brock 2019).

Mine closure criteria should incorporate detailed social criteria and be agreed to by the mining company, the regulator and other affected stakeholders. Since many mines will face closure in the next decade, the risks and opportunities associated with closure need to be prioritised across the various stakeholder groups, including industry, government and communities. Recognising this priority, the ICMM has published and recently updated its Integrated Mine Closure: Good Practice Guide toolkit (ICMM 2019). Its objectives are to provide support to developers, owners and companies in providing a positive, long-lasting legacy coupled with environmental protection and sustainable social wellbeing.

The ICMM toolkit (2019) states that closure activities are implemented to meet specific closure criteria. During the development and assessment of success criteria, the ICMM recommends the use of the SMART approach (i.e. specific, measurable, achievable, relevant, and timely). The ICMM further encourages early and ongoing engagement with regulators and other external stakeholders when developing and refining success criteria. Globally, there are several examples (Decipher 2020) where closure has taken place effectively from an environmental or biophysical perspective and a positive closure legacy.

When developing social mine closure criteria, the ICMM's (2019) SMART approach can assist in designing clear and concise descriptions of the proposed criteria. Once the criteria have been designed, it must be developed and shared with stakeholders, including regulators, employees, suppliers and affected communities. The ICMM (2019) also reiterates that engagement on the criteria should happen early in closure planning, with complete documentation of agreements on applicable criteria.

Even though South African mining companies recognise that their impact extends beyond closure and environmental rehabilitation, the significance of the social and economic impacts is still not considered in their planning processes (Digby Wells Environmental 2017; Envass Environmental Assurance [Pty] Ltd 2016; Kongiwe Environmental [Pty] Ltd 2018a, 2018b; Redco & Uvuna Sustainability 2019; SRK Consulting 2019a, 2019b). Consequently, there remains a need for closure to be integrated into the LoM planning. More specifically, it is vital to consider environmental, social and economic impacts while involving stakeholders and communities throughout the mining lifecycle (ICMM 2019). Factoring integrated closure into LoM planning will help create social and economic opportunities from mine closure, especially in emerging economies. More time is allowed to collaboratively plan alternative land uses or livelihood options, such as community and stakeholder values and needs. Communities within the South African context and other developing areas can be wholly reliant on a mining operation, establishing their livelihoods and economic activities around the mining activities. Therefore, successful planning for integrated closure and sustainable post-closure livelihoods must adopt a strategic approach at the outset of the project cycle, and proactively implement actions for the LoM. Thus, it is essential not to leave social closure planning until the mine is about to close.

4.2 Broadening social mine closure management objectives

A key finding from the content analysis is the need to have broader social mine closure management objectives. It is suggested that the following three social mine closure management objectives are key to defining effective mine closure criteria:

- Managing the effects of loss of direct employment.

- Managing the loss of local procurement.
- Managing the reduced contributions to community development programs.

Each mine has its context in which social transitioning beyond mine closure will take place and therefore the social mine closure management objectives will need to be adapted accordingly. The selected management objectives are likely to apply to most mines and have been selected. It is important to note that management objectives should not be left until mine closure is initiated. Ideally, they should be preceded by corresponding objectives implemented in employment, corporate social development, and enterprise- and supplier-development initiatives throughout the LoM.

The purpose of the management objectives is to document measures that could mitigate each potential risk and overcome threats to achieving the target social closure criteria. The mine should develop these management objectives in consultation with key stakeholders and host communities. Additionally, the management objectives should be used to refine the tasks required to implement, monitor and update mitigation measures needed to relinquish tenure and liability at the site.

Lastly, developing management objectives for social transitioning after mine closure will further assist the mine in developing the actions required for mitigating the risks associated with the social aspects of mine closure.

Closely linked to the issue of a lack of social criteria for mine closure is the importance of determining a social mine closure framework.

4.3 Actions for determining the criteria for social mine closure

Once management objectives have been developed for the specific mine, it is possible to generate a set of actions, interventions or activities to achieve the management objectives. Also, it will allow for developing criteria to measure the success of such actions. These actions should be practical and achievable within the context of the mine's location and estimated remaining LoM. Importantly, management objectives should ideally be put in place for the entire lifecycle of the mine – not just during the closure phase.

These objectives and associated criteria should be re-evaluated during the LoM to address contextual changes to variables over time. For example, changes in the demographic composition of an area or the cumulative impacts of other industries either entering or exiting the local market could lead to considerable changes in the baseline conditions. Upon formulating these activities and their desired social closure criteria, monitoring and review targets can be set for each action. To achieve the social closure criteria, each activity will have to be assigned to a champion for implementation.

It is acknowledged that some actions may be beyond the control of the mine, therefore a collaborative platform should also be available for actions that require support from other players, such as government, communities and employees.

4.4 Towards the development of a social mine closure framework

The research objectives around uncovering what elements or aspects will contribute towards developing a social mine closure criteria are discussed under Sections 4.1–4.3. The second research objective, namely to draw on this data to develop a social mine closure framework, is the visual (Figure 2) as well as the write-up, Table 1, followed by the visual.

Social closure criteria can be defined once the potential social impacts of mine closure have been assessed, and SMART management measures have been provided for each impact. These measures will allow the mine to outline the tasks required to implement, monitor and update mitigation measures needed for sustainable social transition post-closure.

Figure 2 depicts the social mine closure framework by outlining the main social closure impacts . Each social closure impact will have an associated management measure aligned with an action schedule and cost

estimation. Examples of social mine closure criteria linked with the sustainable development aspects illustrated here are included in Table 1.

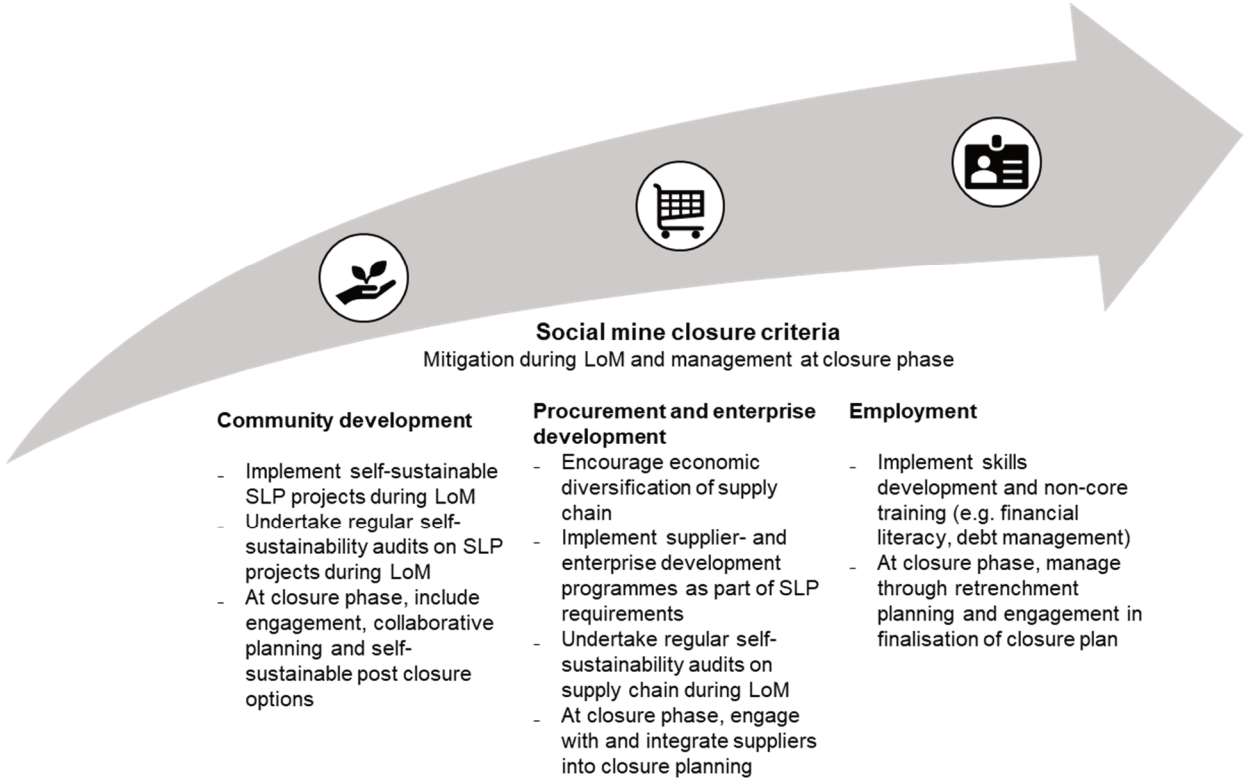

Figure 2 Social mine closure criteria during LoM and at closure phase

Once the mitigation measures (i.e. actions, interventions or activities) have been developed, it is suggested that mining companies develop their own site-specific social mine closure criteria. Companies differ in their approaches to mine closure, and some are also more advanced and mature in considering mine closure matters. For a mining company that is close to downscaling, the managing of the effects of retrenchments and the associated loss of income (e.g. mitigating activities may include developing and implementing a skills audit for employees) could be a priority. The objective here would be to improve their employment prospects elsewhere, whether in the mining industry or another sector of the economy. The data of the skills audit could also be shared with government authorities, such as the country's Department of Labour, or other mines in the region. Other sustainable measures that mines could implement include programs for employees to invest in their retrenchment packages to start businesses related to post-mining land use programs in the area.

In managing the loss of local procurement, mitigating activities may include a program to diversify the mine supply chain through supplier mapping. The social closure criteria would therefore reflect the desired outcome; they would identify the degree of dependence of key suppliers on the mine, define objectives for the empowerment of suppliers highly dependent on the mine, or define strategies to assist the mine suppliers in identifying alternative markets through the hosting of trade fairs.

Mitigation measures should be developed in response to reduced investment in development programs or infrastructure. Social closure criteria should outline the desired future scenario by applying self-sustainability criteria to all projects, implementing co-production projects at inception, or consulting with the regulator on sector-specific programs to address gaps in access to services and facilities.

Table 1 Examples of social mine closure criteria

Category	Preliminary closure plan (more than 20 years)	Draft closure plan (20 years)	Final closure plan (10 years)
People	An environmental, social and health impact assessment has been carried out at project commencement A social and human rights impact and risk analysis has been developed and maintained throughout the life-of-mine (LoM) The needs of employees and communities have been identified and appropriate mitigation measures developed Identified mitigation measures have been included in appropriate management plans Appropriate management plans have been regularly monitored and updated to address changes in the baseline A vulnerability assessment has been undertaken and has informed social and labour plan (SLP) projects Management plans have been developed to address impacts on vulnerable persons	Updated baseline indicators have been collected and incorporated into associated management plans Continuous monitoring of social baseline indicators has taken place and management plans have been updated Regular self-sustainability audits on SLP projects have been undertaken during LoM Skills development and non-core training initiatives have been reviewed and updated Economic diversification of the supply chain (e.g. trade fairs) has been encouraged Regular self-sustainability audits have been undertaken on the supply chain during LoM A vulnerability assessment and associated management plans have been regularly updated with monitoring results Skills development and non-core training (e.g. financial literacy, debt management) have been implemented Self-sustainable SLP projects have been implemented during LoM SLP projects focused on expanding education and skills beyond mining requirements SLP projects encouraged the empowerment of women and vulnerable groups Supplier- and enterprise-development programs have been implemented as part of SLP requirements	A closure environmental, social and health impact assessment has been carried out to inform closure mitigation measures A post-closure monitoring program has been established A program that allows for continuous improvement and adjustment has been developed to ensure the implementation of the social closure strategy Closure messaging (including communication channels and timing) has been designed Engagement, collaborative planning and self-sustainable closure options have been included in the final closure plan A retrenchment plan, including a retrenchment communication strategy, has been developed Engagement took place with local, regional and national stakeholders Engagement took place with suppliers and their input has been integrated into the final closure plan A vulnerability assessment and associated management plans have informed engagement processes during the final closure phase
Community, culture and religion	A site-induced migration management plan has been developed and integrated into the mine closure plan	Regular perception surveys have been conducted and used to inform the stakeholder engagement strategy	The community engagement plan has been updated to reflect changes in the LoM and road to final closure

Category	Preliminary closure plan (more than 20 years)	Draft closure plan (20 years)	Final closure plan (10 years)
	A cultural impact assessment, heritage impact assessment and Indigenous people assessment have been carried out at project commencement A community engagement plan, informed by the Cultural Impact Assessment and Indigenous People Plan, has been developed	A community engagement plan has been regularly reviewed and updated	
Livelihood assets and activities	Impacts on livelihood assets and activities have been identified and mitigated	The scale, viability, sustainability and project plans for a variety of socio-economic transitioning projects have been determined Livelihood restoration plans have been monitored and adjusted where needed Livelihood restoration obligations have been developed and tracked SLP and other social development obligations have been logged and tracked	SLP obligations have been fulfilled All social development obligations have been met Livelihoods impacted by the mine have been restored A governance body to oversee the implementation of socio-economic transitioning projects has been appointed Partnerships have been established to ensure the sustainability of socio-economic transitioning projects
Infrastructure and services		Infrastructure and services provided by the mine have met self-sustainability criteria Infrastructure and services have been developed in collaboration with local, regional or, where required, national government structures	A clear memorandum of understanding has been entered into with local government structures to take over mine-provided infrastructure or utilities Capacity building of local partners (private or government) has taken place
Living environment, land and natural resources			Landscape aesthetics, natural features and place attachment have been considered as part of the post-land-use design Trends in land and resource use have been incorporated into the post-land-use design Access to ecosystem services has been restored as part of the post-land-use design Land tenure and access have been restored to pre-mining levels

5 Discussion

The South African closure plans that were analysed considered the existing and proposed infrastructure at the mine and the associated cost to remove and/or rehabilitate the land as per their closure objectives. Although the environmental and social baseline description forms part of the closure plan, it was found that the attention is focused on environmental or biophysical rehabilitation and that the social side is absent or at best neglected. The plans lacked any measures to mitigate or reduce the impact of closure on employees, suppliers, service providers, host communities, or stakeholders who have become dependent on the mine.

The findings further indicated that the approaches to determining the closure risk and management objectives in South Africa vary, with all of the case studies focusing on the environmental aspects of closure. Although no clear structure or approach was provided, one case study considered collaboration with stakeholders. However, all the closure reports met the government-imposed requirement for stakeholder engagement as part of the EIA process. Although stakeholder engagement took place, the focus was primarily on the permitting process and not specifically on closure. The general approach is for these consultation processes to be delayed until the actual closure phase, as seen by the more comprehensive process followed by Redco and Uvuna Sustainability (2019).

The majority of the reviewed reports (five of eight reports) considered the loss of jobs and the potential that livelihood replacement opportunities will not be realised. However, the mitigation measures for this risk are not detailed or measurable. In five reports, specific consultation regarding the post-closure land use did not occur; the opinions and suggestions of the affected stakeholders and communities have not been incorporated into the closure plan. One report mentioned that stakeholder engagement would only occur at actual closure (Envass Environmental Assurance [Pty] Ltd 2016).

The content of the reviewed closure plans focused mainly on providing a baseline description of the mine's setting. A social baseline description was provided in seven reports. However, there is limited detail on communities surrounding and near the operations. The social baseline description is limited to a brief summary of the area's population size, average income, employment levels and access to services. The only report that included a comprehensive description of the social baseline was included in a final closure plan (Redco and Uvuna Sustainability 2019).

In four reports, the social aspects of closure are deemed to be sufficiently mitigated through the SLP, even though none of the reports investigated the sustainability of the SLP programs post-closure. Little mention is made of continuity between the SLP development projects, staff planning, enterprise and supplier development and the mine closure plan. Regarding mitigation measures, the mine's SLP is noted as a mitigation measure in all reports. Also, one report referenced the contractor social management plan of the mine (SRK Consulting 2019a) as an additional mitigation measure. In contrast, Redco and Uvuna Sustainability (2019) provided mitigation measures in the form of engagement, training and skills development policies. Finally, the case studies provided monitoring plans post-closure, but none included monitoring the post-closure recovery of affected communities and stakeholders.

6 Conclusion and recommendations

Mines have the potential to provide far-reaching opportunities for economic and social development by supporting the achievement of the SDGs. This positive contribution is currently not sustainable beyond mine closure when these positive contributions may be rapidly reversed. This is especially true where local communities have not been part of the development dialogue during the LoM. Therefore, acceptable and sustainable mine closure criteria need to be developed and formalised to address social aspects of mine closure in alignment with the applicable SDGs. A review of publicly available mine closure plans developed for South African mines revealed that, although mine closure criteria are being developed to ensure rehabilitation or mine reclamation at closure, social mine closure criteria are underdeveloped.

The literature review highlighted several key issues relating to social mine closure, including how mining still has the potential to improve the socio-economic conditions of people, even in closure.

While mining is associated with a range of negative impacts on the environment and society, responsible mining has the potential to improve the lives of thousands of people (Twerefou 2009). In addition to stimulating economic development through manufacturing, primary and secondary employment creation and upstream and downstream supply chains, mines also contribute to social development in their communities.

To conclude, within this vacuum, this paper has provided a framework for developing social mine closure criteria for inclusion in mine closure plans. Following Miles & Hubermann's (1999) definition of a framework, this framework explains the key aspects, such as what a mine closure criteria may entail and accompanies management actions or measurements, indicating the relationship between aspects within the framework.

By considering some of the major social impacts of mine closures at an earlier stage of the LoM, mines can proactively develop management objectives to consider social transitioning after mine closure. These tailored objectives, in turn, inform the actions required for mitigating the risks associated with the social aspects of mine closure. While social mine closure criteria can be defined and included in a mine closure plan, not all social or economic impacts of mine closure can be addressed through this mechanism. As with environmental impacts, there will be specific socio-economic impacts of mine closure that cannot be fully mitigated. Therefore, it is critical to note that successful social transitioning will also require community and government buy-in and cooperation throughout the LoM.

It is imperative to integrate social mechanisms for closure as early as possible. Mines should review their social mine closure objectives and criteria regularly. A collaborative framework for engagement is crucial when considering a post-mining landscape and socio-economic reality. Finally, self-sustainability criteria need to be applied when designing projects or programs to achieve the identified management objectives and social mine closure criteria.

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