

Evaluating the contribution of integrated mine closure and post-closure in realising community orientated Sustainable Development Goals

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Abstract

The focus of this study is to explore the contribution of integrated mine closure and post-closure initiatives in realising community orientated SDGs. The study makes findings that warrant integrated mine closure and post-closure's prioritisation as it can contribute to communities. Inadequate mine closure or the complete lack of mine closure planning is a serious concern for countries around the world. Australia has about 60,000 abandoned mines and in South Africa, it is estimated that there are 4,000 – 6,000 abandoned mines. There are several examples of disastrous mine closures around the world. In August 2021, a news website article highlighted the disastrous way in which a South African mine; Blyvooruitzicht Gold Mine near Carletonville was closed down. The liquidation of Blyvooruitzicht Gold Mine and its abrupt closure witnessed the collapse of an entire village and the subsequent collapse of electricity, water and refuse removal services. Mining Operations seized overnight and with it the environmental mitigation and management measures. Thousands of people lost their jobs as it was the only major local source of work. In another part of the world, Singkep Island in Indonesia witnessed its worst historic economic recession due to poor mine closure when the world tin price crashed in 1985. This resulted in 8- 25% of the Singkep Island population migrating to find work elsewhere. Much was lost as the tin mine operated and maintained 2 of the 39 primary schools, the hospital, the airport, piped water and power plant. The mine also directly provided employment to an estimated 2,452 out of 8,716 people.

The United Nations 2030 Sustainable Development Goals (SDGs) which are currently the most important goals as agreed upon globally may be the desideratum needed to prioritise mine closure and its ability to contribute to the interests of society. It is not hard to find points of intersection between the needs of the local communities and those of the mining industry. Examples that encapsulate such potential intersections is that both communities and miners benefit from healthy communities and an educated workforce, both need energy and infrastructure and both also need access to water. One key stage within mining that has the potential to house many of the benefits as far as the SDGs are concerned, is the mine closure stage. When done properly and adequately through integrated mine closure and post-closure techniques, each mining activity can then realise a number of the SDGs and create positive change to communities.

Keywords: *mine closure, integrated mine closure, post-closure, communities, sustainable development, sustainable development goals, social closure, creating shared value, linkages*

1 Introduction

Since the inception of the Sustainable Development Goals (SDGs), there has been a substantial increase in the volume of research that has investigated how the mine life cycle and all its stages can contribute to the SDGs (World Economic Forum (WEF) 2016). This has been beneficial for the mining industry to understand how they can play a positive role in the pressing matter of sustainable development. In the past, however, through the broadness of the mine life cycle characterised by many stages; many mining companies and countries chose to overlook and slip out of the specific and critical stage that is mine closure (Saul et al. 2022). In a malapropos manner; many companies risk appearing as good ambassadors by explaining their contribution to the SDGs through other stages of the life cycle whilst neglecting or glossing over adequate mine closure. Specificity with a particular focus on why integrated mine closure should be prioritised is

warranted here, as failure to realize adequate mine closure may counter all the other stages of the mine's life cycle in realising the SDGs.

While the terminology may differ; mine closure can be defined through the contours of general principles that are naturally applicable to various sites and conditions. The International Council of Mining and Metals' (ICMM) defines the general principles of mine closure as follows:

- **Safety:** mine closure includes the promotion of physical safety of a closed mine site by making sure that it is safe for humans and animals from pits and any potentially physically harmful structure;
- **Physical stability:** mine closure includes promoting and creating the physical stability and sustainability of a mine site by limiting the potential of long-term erosion and the long-term degradation of the environment;
- **Chemical stability:** mine closure includes preventing adverse impacts on the quality of the local environment through chemical contamination that may arise from the site;
- **Socioeconomic transition:** mine closure includes promoting a smooth transition from previous socioeconomic conditions that existed during the life of the mine to those that will be present post-mining activities. The aim here is that the net socioeconomic impact on the affected region must be positive as much as possible;
- **Ecological stability:** mine closure includes making sure that the post-closure ecosystem at the closed site remains in a sustainable state as desired in relation to its compatibility with the planned post-closure land use. This may entail goals for biodiversity and the viability of a self-sustaining ecosystem which does not need the support of the mining company in the long term and
- **Long-term care:** mine closure also seeks to minimise or eliminate as much as possible the need for long-term post-closure care and maintenance (ICMM 2019).

The "Integrated" part of mine closure or the progressive concept of closure essentially entails incorporating these characteristics and beginning the process of mine closure during the life of the asset (LoA) (ICMM 2020). Therefore, it is not necessary for a mine to have closed for certain mine-closure projects and post-mining transitions to take place. As supported by the ICMM, mine closure does not need to happen only when a mine is closed but is actually better to be "integrated" which ultimately means the socio-economic developments which have the future in mind can be realised while the mine is still in operation (ICMM 2020).

The most significant opportunities for mining firms to express their commitments to the SDGs is by proffering knowledge-sharing activities and conscientiously promoting economic spill-overs to other sectors within communities (Yakovleva et al. 2017). Mining companies have done this through Corporate social responsibilities (CSRs), social labour plans (SLP), corporate social investments (CSI), community programmes, Created shared value (CSV) and agreements with government etc. Whether it be direct monetary investments made by companies in the form of CSRs and CSIs or whether it is a SLP in compliance with regulations, this paper submits that these initiatives can form part of integrated closure, social closure and post-closure initiatives. All initiatives that are future orientated and have the social, economic or environmental sustainability and closure of an area in mind can be considered as the "Integrated" part of mine closure or the progressive concept of closure (ICMM 2020). This paper seeks to propose that integrated mine closure and post-closure initiatives are one of the most significant stages in mining when it comes to contributing to sustainable opportunities and economic spill-overs. In many jurisdictions, post-closure is regarded as forming part of mine closure plans as it forms part and parcel of sustainable closure initiatives (SRK Consulting 2019). Many jurisdictions also require that the intended post-closure land use be sustainable with the basis of the sustainability requirement being community benefit (SRK Consulting 2019). It is now beyond irrefutable that there is a surging pressure for mines not only to take ownership of the legal compliance facets of mine closure but in ensuring a transition into a post-mining reality that is sustainable (Edwards & Maritz 2019).

Mining companies are now being edged to transition into more sustainable operations in order to obtain their Social License to Operate (SLO) which goes beyond a mining company's legal compliance (Edwards & Maritz 2019). SLO is achieved when communities are involved in the planning of infrastructure development and municipal service delivery (Edwards & Maritz 2019). Allowing communities to be involved negates such disastrous examples such as the one of Blyvooruitzicht Gold Mine which controlled everything that was crucial for the community's survival such as water and electricity (Bega 2021). Integrated mine closure is intended to assist against such unwarranted incidents (ICMM 2019). Integrated mine closure works as a form of anticipatory mechanism to ensure communities become resilient and are able to live independent of the mine despite unforeseen circumstances such as experienced by Singkep Island in Indonesia (Syahrir et al. 2021).

When looking at the positives of integrated mine closure, one inextricably has to include social closure which entails involving the communities through a form of collaboration and co-production during a mine's operations (Edwards & Maritz 2019). This prudentially benefits the community to participate, learn and develop a future that does not solely depend on mining (Edwards & Maritz 2019). Integrated mine closure, therefore, helps to create a more sustainable future by building confidence and capacity in local partners who collaborate with the mine which results in the local partners taking ownership of their economic and social well-being (Edwards & Maritz 2019). When mining companies employ a Creating Shared Value (CSV) strategy which naturally comes with a socially sustainable form of integrated mine closure approach, this enables mining companies to deliver outcomes that support the priorities of local stakeholders and advance the SDG agenda (Fraser 2019).

As evident in the culmination that has led to the SDGs; it is clear that the SDGs are a priority according to the world at large and have the potential to affect every facet of the functioning world in a positive manner. Even so, a problem still stands, mine closure is not being done properly even though it is such an imperative stage in mining in terms of its potential to address many of the SDGs and mitigate the obstacles to their realisation. As acknowledged by the WEF (2014), despite mining having contributed to a lot of the problems that the SDGs seek to address, mining is also positioned uniquely to contribute to the sustainable development agenda. Therefore, the problem statement of this study is why mine closure is not taking place in a correct manner and not being prioritised.

The aim of the research is to illustrate why integrated mine closure and post-closure should be prioritised. Mine closure can largely contribute to what is currently and globally the most important goals that we should be seeking to achieve as a global village- the Sustainable Development Goals. If one understood how important mine closure is in terms of the SDGs and in transforming communities, one would then come to an understanding of why it is imperative and should be prioritised. This study seeks to examine how integrated mine closure and post-closure can contribute to community orientated SDGs and ultimately to draw conclusions regarding the contributions of integrated mine closure and post-closure towards community orientated SDGs and whether these conclusions warrant for adequate mine closure to take place and for its prioritisation.

2 Methodology

This research study is based on a grounded theory approach which entails "a set of systematic inductive methods for conducting qualitative research aimed toward theory development" (Charmaz 2009). Grounded theory dually refers to a method that consists of flexible methodological strategies and secondly the products of this type of inquiry (Charmaz 2009). The resulting analyses rely on strong empirical foundations which provide abstract, focused, conceptual theories that explain the studied empirical phenomena (Charmaz 2009). A comprehensive list of sources has been utilised for the literature review. Academic publications and articles based on real lived experiences within the extractive industry have been utilised to analyse the previous and current state of mine closure whilst conducting a parallel study on the SDGs and how their realisation can positively benefit communities.

The study has further analysed how mine closure converges with the SDGs and how successful mine closure can contribute towards the realisation of these community orientated SDGs. The study also investigates and calibrates some of the successful mine closure examples and how they have effectively contributed to communities through the lens of the SDGs. Essentially, the study follows a structured and systematic analysis. This grounded theory approach makes sure to thoroughly explore how mine closure can possibly contribute to each of the community orientated SDGs.

The literature investigated in this study is to a large extent contextual to a certain geographic area and/ or a particular time. This means that certain mine closure cases may emphasise certain goals over others depending on the context of that relevant community. For example, the ICMM Planning for integrated Closure Toolkit elucidates this point by saying:

“a target closure outcome for an industrial city in Western Europe might include such phrases as best practice environmental compliance and sustainable urban land use, whereas a target closure outcome for a rural area in sub-Saharan Africa might include concepts such as community development and health care. It may be as conservative or as ideological as the company wishes, but it should, at a minimum, portray the elements of lasting community benefits locally” (ICMM 2019).

However, this research has been approached in such a manner that one is able to see the positive contribution of mine closure to various communities as the research will address mine closure’s possible contribution towards community orientated SDGs. What will be made clear by this study is that as far as communities and the SDGs are concerned; it is better to do adequate mine closure than not to do it.



Figure 1 The United Nations Sustainable Development Goals (SDGs)

3 Potential intersections between mine closure and community orientated SDGs

The SDGs pertinently offer the mining industry an avenue to rebuild trust in the mining sector by realigning mining’s endeavours with the values of society (Fraser 2019). Imperatively, the SDGs offer mining companies an opportunity to benefit from improved relationships with communities and governments as well as greater access to financial resources if the mining companies commit to the SDGs. Therefore, being orientated

towards realising the SDGs is likely to help mine companies obtain their SLO from the communities in which they operate in as mine companies will be more aligned with the values of society. However, those that fail to meaningfully take part in realising the SDGs will consequentially put their operations in jeopardy in the short and long term.

The SDGs are likely to offer more sustainable outcomes as they are likely to influence more stakeholders to be willing to be part of collaborations as they resonate with the goals (Fraser 2021). This is accentuated by the fact that the SDGs have been agreed upon by a wide range of stakeholders such as national governments of UN member countries, civil society groups, development agencies, business and industry and ultimately reflects a shared agreement from a diverse group of stakeholders (Fraser 2021). By parity of reasoning, community stakeholders may be more willing to collaborate with mining companies if the SDGs are the projected outcome as they present more tangible benefits to the community due to the fact that they are widely known and clear (Fraser 2021).

As an important cog, local context is a salient matter when it comes to mine closure (ICMM 2019). Mine companies need to analyse each relevant community and strategize with relevant stakeholders in order to sustainably develop each relevant community in its context. This is in essence what integrated mine closure is about and the SDGs are broad enough to bring forth some form of positive sustainability change whether the mine company finds itself in a developed or developing country.

In a bid for greater clarity, an example of how integrated mine closure and post-closure initiatives have realised the SDGs is the example of Ivanhoe's Kamoia-Kakula mine in southern DRC which started operations in 2012. Ivanhoe established a sustainable livelihoods project around 14 communities (SDG 11) surrounding the Kamoia-Kakula mine (Edwards & Maritz 2019). To illustrate integrated mine closure in practice, Ivanhoe had early engagements (SDG 17) and began mine closure planning during the early development phase of their Kamoia-Kakula mining operations (Edwards & Maritz 2019). In the early stages, Ivanhoe had already handed over a number of the initiatives to the communities who have been operating them without the assistance of the mine (SDG 8) (Edwards & Maritz 2019). Ivanhoe only makes sure to monitor the implementation progress (Edwards & Maritz 2019). The design of this programme by Ivanhoe has witnessed environmental conservation through resource-efficient agriculture (SDG 12) and rehabilitation through tree-planting to combat degradation (SDG 15) (Edwards & Maritz 2019). Farmers were taught to build resilience against eventual mine closure through irrigation techniques and market gardening (SDG 9) for an all-year round food production (SDG 2). Furthermore, solar-powered dryers (SDG 7) are being utilised for the storage of vegetables and fruits (Edwards & Maritz 2019). This example serves as a highlight of how integrated mine closure can contribute to community orientated SDGs.

4 Findings

The objective of this chapter is to examine how integrated mine closure and post-closure can contribute to community orientated SDGs. Therefore, the following sections will discuss how mine closure initiatives can contribute to realising these community orientated SDGs by way of analytical discussions and the use of case studies.

4.1 The contribution to SDG 1—no poverty

When it comes to integrated mine closure and post-closure's ability to aid in "ending poverty in all its forms everywhere", it then becomes critical not only that a mine has closure and sustainability in mind by hiring locally when it comes to employment but that the mine assists employees and residents in alternative employment and skills once extraction and mineral processes cease (Syahrir et al. 2021).

As explicated in ICMM's Closure Maturity Framework "detailed reskilling and training" programmes are important in eradicating poverty within a community as it can be a way of building economic resilience against mining being the sole source of income (ICMM 2020). The goal and aim in closure is for local

procurement and local employment strategies as well as training development programmes to be designed in such a way that they support the diversification of the economy beyond extractive sector dependent industries (ICMM 2020).

In order to forestall and eradicate poverty within communities, integrated mine closure has to give its residents assurance of alternative employment, or at a minimum, the skills that are required to work in other industries after mine closure (Syahrir et al. 2021). This is an important way to sustainably end poverty as it improves the functional literacy of the mine labourers whilst ensuring that they will be marketable in the job market. The goal here essentially becomes ensuring that the post-mine land use supports each other with the social and economic transition (ICMM 2020).

A case in point is the Picadilly mine in Sussex, Canada, which found itself closing due to a crash in the world potassium prices in 2016 (Syahrir et al. 2021). This case illustrates how to create strong and resilient communities by transforming finite resources into more sustainable human capital (Syahrir et al. 2021). The mining company did this by significantly improving the skills of the local workforce and ultimately benefitting Sussex (Syahrir et al. 2021). The mining company developed mechanical and electrical skills applicable in other industries, like welding, renewable industry, surveying, land rehabilitation and mechanics (Syahrir et al. 2021).

The mine company created a work time table by which the mine workers worked for four days and then took four days off, allowing them to engage in other economic activities such as mechanical and agricultural activities (Syahrir et al. 2021). This inevitably helped diversify their skillset and diversify the economy which resulted in the mine workers being hired by other businesses in the region after closure (Syahrir et al. 2021). An example that shows this, is how a local bakery and distribution business has benefitted by employing 80 people with an excellent work ethic which has resulted in its growth by 50 per cent since the closure of the mine (Syahrir et al. 2021).

4.2 The contribution to SDG 2—zero hunger

Mine closure and post-closure initiatives can accord with the register of ending hunger, achieving food security and improved nutrition (Ramdoo 2013). Ending hunger can be achieved through promoting sustainable agriculture by supporting the development of local entrepreneurship in agribusiness (Ramdoo 2013). Zero hunger can also be achieved by developing programmes that encourage value chain activities in farming activities that already exist (Ramdoo 2013). Another way in which mine closure and post closure initiatives can contribute to SDG 2 is by strengthening the linkages between smaller farmers and the larger farmers, strengthening linkages to more market-oriented farming operations to grow staple foods and ensuring that they are able to sell their surpluses on the local, national and regional markets (Ramdoo 2013).

An example of such initiatives is Barrick Gold's project in Cuncashca Peru which trained the community by integrating modern farming, livestock and dairy practices with the fundamentals of business development (Ramdoo 2013). A new water management infrastructure was installed to help cultivate grasslands for cattle grazing and to improve irrigation which resulted in a significant increase in the crop production (Ramdoo 2013). The cattle herd was strengthened by way of genetic improvement as local dairy cows were cross-bred with Brown Swiss bulls and this has resulted in 250 cattle being genetically improved and further resulting in the significant increase in milk production (Ramdoo 2013). Furthermore, to create a more conducive environment for animal breeding corrals were installed for the livestock. A new dairy plant owned by families in the village was also built in order to manufacture milk and dairy products such as milk, cheese, butter, ice creams and yogurt (Ramdoo 2013). The result of this project has created new markets in a variety of areas and the average monthly household income leaped from \$46 in 2002 to \$166 in 2008 (Ramdoo 2013). Production increased so much that 4,200 litres of milk was produced per month in 2008, and between 2005 and 2007 the cheese production increased 400% (Ramdoo 2013). These initiatives form part of post-closure initiatives as the water management infrastructure will be present beyond the life of the mine and will

continue to bolster and encourage a more sustainable way of living. Furthermore, the community has been equipped with modern farming practices and skills which can be transferred to future generations.

4.3 The contribution to SDG 3—good health and well being

To improve responsible mining practices, more companies are implementing Social and Environmental Management Systems to manage negative impacts on community health and well-being (De Beers Group 2001). These systems combined with integrated mine closure are able to contribute to improved community health and well-being (De Beers Group 2001). There are also instances in which effective mine closure planning enables community members to realise enhanced levels of well-being beyond the life of a mine through various ways (Morrison-Saunders et al. 2016). Mine closure and post-closure initiatives can help fund and improve health services and infrastructure and this can contribute to the health and well-being of a community over a long period of time (EQUINET 2021). Integrated Closure initiatives can bolster community health activities by combating communicable diseases and reducing the mortality of non-communicable diseases which also impacts the health of communities in the long term (EQUINET 2021).

An example in point is De Beers disease management programme which addressed a need of society through its created shared value approach and contributed to sustainability through integrating a disease management programme in its operations (De Beers Group 2001). De Beers did this through a voluntary HIV/AIDS study in 2001 which indicated that 35% of Debswana (Joint venture in Botswana) employees had tested positive for HIV with the actual infection rate possibly being much higher (Fraser 2019). This was the first comprehensive disease management programme in Southern Africa and it offered free anti-retroviral treatment to the employees of the company and their spouses (De Beers Group 2001). De Beers managed to positively utilise the intersection between the needs of society and the needs of the company as it collaborated with NGOs, health care providers and community organizations (Fraser 2019). The programme can be regarded as a form of social closure as the programme managed to curb long-term, adverse social impacts within the communities and continues to be a great aid in the region post-closure (Fraser 2019).

4.4 The contribution to SDG 4—quality education

Integrated mine closure and post-closure initiatives have played a strong role of ensuring inclusive and quality education in the recent past (South32 2018). Mine companies can contribute to quality education and ultimately sustainable development by assisting people within communities with vocational programmes and higher education opportunities such as scholarships as well as building schools and other forms of educational infrastructures (Bizcommunity News 2021). Educational and skills development programmes can offer broader and more equal access to local communities by systematically transforming finite mineral resources and accelerating human capital (Bizcommunity News 2021).

A good example of how integrated mine closure and post-closure initiatives can contribute to quality education can be seen in South32 Hotazel Manganese Mines' Social labour plan (SLP) in South Africa where they handed over the newly-built Rearata Primary School to the Northern Cape Department of Basic Education in Vergenoeg Village (South32 2018). The school comprises of 14 newly-built classrooms with a total capacity of 500 learners, a learning centre dedicated to Grade R, a fully-equipped computer centre, a library, an administration block, ablution facilities and a nutrition block that provide meals for the learners (Bizcommunity News 2021).

South32 Hotazel Manganese Mines in the Northern Cape also supports other education projects such as a robotics programme which is currently rolled out through 12 schools and also facilitates a Science and Maths programme offering extra lessons to high school learners that are within the district (South32 2018). Such initiatives are imperative as they ensure sustainability beyond the mine by improving the quality of the lives of host communities through education.

4.5 The contribution to SDG 5—gender equality

Integrated mine closure and post-closure initiatives can contribute to the sustainable development goal of gender equality by accelerating the progress of those that are furthest behind and in this case that being women and girls (WEF 2016). Mine companies can take on various initiatives that empower women and girls within communities whilst conversely combatting discrimination and violence whether in the workplace or in social settings (Goldcorp 2015). Mine companies can assist through post-closure initiatives by systematically empowering women into decision-making positions in their local spheres (Goldcorp 2015).

A case from Cerro San Pedro in Mexico has seen New Gold's mine implementing an Integrated Closure Program designed on the basis of a Social Impact Assessment (SIA) which contributes to gender equality (Everingham et al. 2020). The company has to a large extent focused on the much needed and fragile economic environment through economic diversification by empowering the vulnerable which mainly includes the women of Cerro San Pedro (Everingham et al. 2020). New Gold's Cerro San Pedro mine achieved this by collaborating with five organisations and providing about 429 skills-training hours in eight local communities (Everingham et al. 2020). These programs involved 384 people in total and 90% of the people were local women (Everingham et al. 2020).

Another instance is Goldcorp's Professorship in Women in Engineering program in Canada which aimed to level gender disparities and accelerate the progress of those that are behind in terms of gender equality through the mining and engineering fields at university level (WEF 2016). Goldcorp launched this program by donating CAD 500,000 in 2014 to the University of British Columbia (UBC) with the aim of setting up the Goldcorp Professorship in Women in Engineering (WEF 2016). The programme involved increasing the female proportion from 20% to 50% in the engineering faculty within the next five years and the programme also aimed to promote women in engineering through recruitment strategies and marketing women in engineering to parents and high school students (WEF 2016). Although UBC did not meet the "aspirational" 50 per cent goal it was, however, able to mobilize people, mobilize resources and elevate female enrolment as a priority (The Ubysey 2023).

4.6 The contribution to SDG 6—clean water and sanitation

Integrated mine closure and post-closure initiatives can contribute to clean water and sanitation by way of building clean water and sanitation infrastructure and setting up programmes which will continue to operate and aid lives post-closure (Fraser 2019). The United Nations highlights that "For each dollar invested in water and sanitation, on average there is a return of eight dollars in costs averted and productivity gained" (United Nations Global Compact 2014). It is therefore pertinent for mine companies and governments to approach integrated mine closure and post-closure in a way that prioritises water and its sustainable management for the benefit of the community.

A case in point can be seen in Arequipa, Peru, where Cerro Verde managed to avoid a potentially catastrophic social and business dilemma by not competing for the already scarce water source (Fraser 2019). Through consultations with government representatives, regional officials, civil society groups and water authorities, Cerro Verde became au fait with the nuances of the situation and decided to invest in a water treatment plant (Fraser 2019). The wastewater treatment plant which was integrated during the operations of the mine continues to be a sustainable initiative and has brought sustainable development to Arequipa's municipal water treatment which used to treat only less than 10 per cent of its municipal sewage but now treats 95 per cent of its municipal sewage (Fraser 2019).

The sewage treatment plant has managed to reduce faecal coliform counts which had exceeded the World Health Organisation (WHO) standards at five spots along the river for safe agricultural irrigation and water consumption by livestock (Fraser 2021). This has resulted in the reduction of incidents of water illness and has improved agricultural outcomes as attested by water authorities who confirm that the higher biological oxygen demand (BOD) per litre has improved drastically (Fraser 2021). Previously, the untreated water would

be discharged directly to the river that serves as the principal water source for the area but due to the intervention by Cerro Verde, an opportunity that met both a social and a business need was identified (Fraser 2021). The mine has navigated through a critical social and sustainability issue in the community by using created shared value by firstly obtaining a guaranteed volume of water for their own operations from the treated water which does not bring the mine in competition with the farmers who use the fresh water supply and have assisted the farming industry with more clean water for their utility through the water treatment (Fraser 2021).

Another instance is that of Canadian company, Erdene Resource Development Corporation which created a post-closure solution and advanced the sustainable development agenda in Mongolia by offering to assist Shinejinst community which is 90km away from the Bayan Kundi exploration camp (Fraser 2019). Erdene engaged with stakeholders and became aware of the town's need to improve its access to potable water as prior to 2017; potable water was trucked into Shinejinst from the regional capital which is about 270 km away (Fraser 2019). Whilst commissioning hydrogeological work to source a water supply in Bayan Khundi, Erdene offered to expand the investigation area to include Shinejinst and embraced CSV resulting in the discovery of a potable water source 3 km away (Fraser 2019). Erdene personnel then worked together with the municipal officials to drill the new water well which now provides drinking water to the local residents in a more reliable and cost-effective manner when compared to the trucking method (Fraser 2019).

4.7 The contribution to SDG 7—affordable and clean energy

As the transition to clean energy accelerates; mine companies can play their part when possible by utilising the previously mined areas as an opportunity to facilitate renewable energy initiatives within communities.

Sokhulu (2016) states that “What is attractive about abandoned mines is often their proximity to electricity infrastructure such as substations and transmission lines, as well as road and transport infrastructure. The existence of infrastructure can lower renewable energy project costs”.

A representative case is that of a German coal mine in Leipzig which managed to utilise its post-closure initiative on an open-cast operation and realised SDG 7 by taking advantage of the exposed and expansive area when it decided to deploy solar energy in the area (EPA 2011). The German coal mine of Leipzig built a solar power plant with 5 megawatts (MW) of installed capacity which was one of the largest at the time and this solar plant is able to supply power to 1800 households (Sokhulu 2016).

4.8 The contribution to SDG 8—decent work and economic growth

Once again, mine companies and in this case through integrated mine closure and post-closure initiatives can utilise CSV approaches as a way to develop profitable business strategies that have parallel goals of improving business performances whilst delivering tangible benefits to communities (Fraser 2019). Local procurement and tourist strategies can propel economic diversification and aid in providing much-needed employment to the local communities.

The Llechwed Slate Caverns in Wales is an example of how a mine has been repurposed into a tourist attraction as a way of contributing to economic growth. From extracting half a million tonnes of slate per year by the end of the 19th century to being voted the Go tourist Attraction for the year 2019/2020; Llechwedd's Slate Mountain Adventure provides an experience through the historically significant quarry and provides a ride through an ex-military truck to the highest peaks of the 2,000 acre site (Llechwedd Deep Mine 2022).

4.9 The contribution to SDG 9—industry, innovation and infrastructure

Integrated mine closure and post-closure initiatives can contribute to major infrastructure projects within a community such as road and rail development, and the construction of infrastructure that makes a

community more sustainable (Everingham et al. 2020). As much as possible, a system of infrastructure-shared use or open-access use should be integrated into a community with closure in mind. An integrated and shared-use regional economic approach in regard to infrastructure can be seen as a social capital investment by a community and can lead to the acceptance of a mining project (Syahrir et al. 2021).

It is also important to note that a lot of infrastructure can remain valuable to a community once production ceases and a mine company can utilise this as an opportunity for a post-closure initiative by helping a community to self-mobilise and become independent of the company (Everingham et al. 2020). Iron Ore Company in Labrador, Canada managed to do this by selling a railway at a nominal sum to a company owned by three aboriginal groups and the company that bought the railway now operates a passenger and freight service on the railway line (Everingham et al. 2020).

4.10 The contribution to SDG 10—reduced inequalities

The best way to reduce inequalities through closure initiatives is to implement social investment and capacity-building programmes that target marginalised and disempowered people within communities with the goal of empowering them to be able to live independent of the mine. This point is well articulated by the Centre for Social Responsibility in Mining (CSRMI) when it says:

“Mining companies routinely invest in communities and have increasingly moved from random sponsorships and donations to more strategic investment. A key consideration in determining whether investments are strategic or not is the extent to which they create dependency or have the potential to eventually provide benefits independent of the mining company” (Everingham et al. 2020).

Mine companies should tailor their closure initiatives in a context-sensitive manner with the goal of empowering the under-represented and the vulnerable within communities in such a way that they are not dependent on the mine.

Another reason that helped the Picadilly mine in the Sussex region cope with sudden mine closure and maintain sustainable development was the mine’s integrated closure strategy of maximising its local contributions to the community by buying more than 52% of its services and supplies locally such as truck and auto parts, basic machinery, equipment, and contract labour (Syahrir et al. 2021). These linkages managed to reduce inequalities by triggering other economic and social activities such as the hospital, the local agricultural sector and the schools that served 25 000 people within the region and therefore managed to mitigate the impacts of mine closure (Syahrir et al. 2021).

4.11 The contribution to SDG 11—sustainable cities and communities

It normally takes 10 to 20 years in order to build “sustainable, alternative livelihoods to mining” hence the need to integrate mine closure planning well in advance during the life of the mine (Edwards & Maritz 2019). It is important for mine closure initiatives to contribute to sustainable cities and communities through both physical rehabilitation and socioeconomic considerations and that these initiatives ensure the future safety, public health and beneficial use of the site to the affected communities in the long term (Edwards & Maritz 2019).

An example is how sustainable growth was realised at the former Hydro Aluminium Kurri Kurri Smelter site in Australia and the surrounding buffer lands through the Hydro Kurri Kurri Redevelopment Project; the project involved community members and local government in a redevelopment plan which utilised the local government Kurri Kurri District Strategy (Everingham et al. 2020). A sustainable approach was utilised for the 2000 hectare site which resulted in about 65% of the land being utilised for conservation, 15% for industrial use, 15% for rural land and the final 10% for residential utility (Everingham et al. 2020). This strategy has proven to be sustainable and long-term orientated; making sure that the community and city at large has a sustainable future which has been well prepared for and well planned (Everingham et al. 2020).

4.12 The contribution to SDG 15—life on land

There are many sustainability issues that can emanate from negatively impacting the environment because negative environmental impacts can limit land use options and ultimately result in a lack of realistic economic diversification options (Syahrir et al. 2021). This was one of the problems faced by Singkep, in Indonesia where local communities were not able to diversify into the agricultural and fisheries sectors due to the land being contaminated by corrosive water from the abandoned former mining sites (Syahrir et al. 2021).

The ICMM emphasizes through principle 7 of its Mining Principles Performance Expectations that mine companies must “contribute to the conservation of biodiversity and integrated approaches to land-use planning” (ICMM 2022) as land is the foundation of development and human well-being and, in some cases, may be irreplaceable (Nerini et al 2018).

An example of how mine closure can contribute to SDG 15 is how a Gold mine was turned into botanical garden in Southeast Minahasa, Indonesia (ICMM 2019). PT Newmont Minahasa Raya (PTNMR) planted hundreds of thousands of trees on a former mine site in Southeast Minahasa and delivered 443 hectares of revegetated land to the Government of Indonesia which is now a thriving forest of mahogany, nyatoh, sengon and teak trees (ICMM 2019). This reforestation strategy was incorporated into PTNMR’s closure plan and Sustainable Development Program very early in the mine’s lifecycle and the forest now serves partly as a botanical garden in collaboration with the Ministry of Forestry (ICMM 2019). The botanical garden and the reclaimed forest are capable of creating positive environmental conditions and economic benefits for local inhabitants (ICMM 2019). This integrated mine closure and post-closure initiative further contributes to SDG 15 by ensuring the habitats of hundreds of species of birds, plants, insects and other animals (ICMM 2019). The reclaimed forest now serves as a model for carbon absorption as the first of its kind in Indonesia and due to the rich biodiversity, the forest and the garden are expected to serve as a laboratory and outdoor classroom for education and environmental research (ICMM 2019). This case clearly illustrates how responsible mining and closure can actualise into long-term benefits to local communities (ICMM 2019).

4.13 The contribution to SDG 16—peace, justice, and strong institutions

As has been the case before, failure to do adequate closure can precipitate a furore among the communities and can lead to unpeaceful environments filled with dissatisfaction and a possibility of spiralling into violence. Conversely, adequate closure through integrated and post-closure initiatives can make an environment more peaceful, more willing to adhere to the rule of law and can encourage stronger institutions within an environment than was previously the case.

An example of community consultation can be seen in the case of Pasminco’s Broken Hill Mine in Australia, where closure has been addressed in a systematic manner by which proper communication and consultation has taken place with the community whilst the mine still had another five years to go (Laurence 2006). The mine approached community engagement and consultation in such a way that it has been “a life-of-mine principle”, being transparent and honest with its dealings with the community and this has resulted in mining at Broken Hill proceeding without serious interruptions for almost 120 years (Laurence 2006). When consultation and communication are integrated into operations with the end goal of closure in mind, this often results in little to no issues and paves way for sustainable peace within that community. It is also important to provide adequate notice of closure as much as possible as that also increases the chances of peaceful transitions.

4.14 The contribution to SDG 17—partnerships for the goals

Integrated mine closure and post-closure is an archetypal stage to realise co-production and cooperation in collaborative endeavours as a way of achieving SDG 17. Co-production that involves the community results in increased community satisfaction, a greater sense of local ownership, increased innovation and increased efficiency which all leads to more resilient and cohesive communities, however, in order for this to actualise,

coproduction must be integrated in mining processes well in advance of actual closure (Edwards & Maritz 2019).

Partnerships have proven to be important in aiding the handing over process. CSRM questions the “in perpetuity” term usually associated with post-mining obligations as a lack of ability to define end points as the term fails to address companies that are no longer active in an area, no longer have a presence in the relevant jurisdiction, or have ceased to exist completely (Everingham et al. 2020). Newmont- lead-zinc Woodcutters Mine in Australia which was decommissioned in 1999 illustrates the importance of partnerships in avoiding such horrible predicaments; as the partnerships by Woodcutters mine lead to agreements with the traditional owners of the land by which the actions taken (decommissioning, rehabilitation and monitoring activities) supported proper handing over (Everingham et al. 2020). Newmont’s lead-zinc Woodcutters Mine was able to realise SDG 17 through the pursuance of adequate mine closure.

5 Conclusion

As highlighted in the study, integrated mine closure and post-closure initiatives are important stages for empowering a workforce with the skills that are required to work in other industries (Syahrir et al. 2012). Mine closure, therefore, strengthens the functional literacy of a community which ultimately works in eradicating poverty and zero hunger. Not doing adequate mine closure means losing out on the opportunity to have resilient and sustainable communities. By not doing mine closure, a country and a particular region can miss out on the benefits that come with repurposing, such as tourism and other post-closure initiatives which are able to inspire societies to become socially healthy.

Closure initiatives are also important in the sense that they can create new markets in various areas as already indicated by Barrick Gold’s impact in Cuncashca, Peru (Ramdoo 2013). It has also been highlighted that integrated mine closure and post-closure initiatives can help strengthen networks among suppliers and therefore create more resilient societies (Ramdoo 2013).

Health-related infrastructure can help alleviate well-being issues that societies may be facing and create a healthier workforce by curing and/or minimising the impact of diseases that may have caused havoc to societies in the past. Therefore, integrated mine closure and post-closure initiatives can help reduce the mortality rates in communities and this would not have been the case if closure initiatives had not taken place. Integrated mine closure and post-closure initiatives also have a strong positive influence on the educational front as many pupils have benefitted from scholarship programs and the building of much-needed schools by mine companies (South32 2018). Mine companies through post-closure initiatives can contribute to gender equality through various women empowerment initiatives, whether through education, skills programmes, or other means- what has been made clear is that mine closure initiatives can contribute to the gender equality agenda. Integrated mine closure and post-closure initiatives can reduce inequalities through capacity-building programmes that target disempowered and marginalised people in communities.

The lack of integrated mine closure and post-closure initiatives can be detrimental to society as these stages can be fertile ground for collaborations that contribute to more satisfied communities, and a greater sense of local ownership and efficiency. Furthermore, as explicated in the study; collaborations may be the only way to solve complex issues in societies and closure initiatives create such opportunities for collaborations.

Clean energy initiatives can pertinently drive economic development and create thriving societies. These energy initiatives can end up supplying power to communities that never had power before. Realising integrated mine closure and post-closure initiatives can go a very long way in creating decent work and economic growth and this is largely due to the linkages. Post-closure initiatives have the potential to contribute to economic diversification, negating doing adequate mine closure may result in an area missing out on economic growth within communities.

Infrastructure is one of the key means of bringing about sustainable development. Post-closure initiatives often contribute to the building of much infrastructure which an area may have lacked in the past. Such infrastructure may help a city or an area to be more functional, creating a better life for people. Not doing adequate closure may result in missing out on such development to communities.

One crucial form of sustainable development that countries and mining areas can miss out due to adequate closure initiatives is the ability to create sustainable cities and communities. A lot of economies and cities are under strain due to the lack of economic diversification and beneficiation in an area. As crucially explained, a company and an area may lose out on financial investment from financial institutions and fail to create sustainable cities and communities.

Furthermore, the lack of integrated mine closure and post-closure initiatives can be extremely detrimental to the environment and communities may miss out on valuable opportunities to create more healthy and sustainable environments. Through development strategies brought about by integrated mine closure and post-closure initiatives such as increasing the accessibility to potable and clean water, livelihoods may become more bearable, and communities may be able to function more efficiently.

Therefore, closure planning plays an essential part as a mitigating factor for many potential sustainable development problems. Integrated mine closure and post-closure are vital in making sure that the land is chemically and physically stable. This is a salient matter as integrated mine closure and post-closure initiatives are often the processes that restore flora and fauna, creating much-needed habitats for life on land. Not doing adequate closure unfortunately means one loses out on such opportunities to contribute to sustainable development.

The relevance of this study could be that due to the nature of the study addressing and evaluating mine closure's contribution to community orientated sustainable development goals, this study could therefore assist mine companies and relevant stakeholders to broaden their horizons on how mine closures, tailored to their unique context, could assist in making the world more sustainable. This research could also help assist policymakers, mine companies and other relevant stakeholders with a honed understanding when it comes to evaluating their economic, social and environmental dimensions as well as determinants for success in relation to mine closure. This study can also assist by critically exploring and providing much-needed clarity on mine closure's contribution towards the SDGs and communities.

The study could make community stakeholders more motivated to engage and collaborate with mining companies due to the fact that the projected outcomes present more tangible benefits to the community in the form of the SDGs. Furthermore, by showing how mine closure could address community issues through the realization of the SDGs; mining companies could potentially earn more trust in order to be viewed as more of a valuable partner in the sustainable development goals and a valuable partner in potential projects.

As evident from the history of sustainable development, the core objectives of what the world has been trying to achieve from the MDGs to the SDGs has not fundamentally changed. Basal Human rights, economic influences and environmental concerns have continued to remain a priority. Bearing this in mind, this study may largely remain relevant for future development goals in relation to the extractive industries and its contribution to communities in the future.

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