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# Sustainability and Circular Economy in Mining

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## ABSTRACT

Sustainability and Circular Economy in Mining is the new generation way to take responsibility in mining to reduce the environment effect through mining after mining operation is completed and upgrading to new age technology for Mine operations which will be beneficial in terms of profitability and environment. This book chapter is written to make sure that every individual understands the importance of environmental concerns in mining, along with the importance of the mining industry and how to be the best entrepreneur in the mining industry. The context of this article includes the Sustainability and circular economy objectives of mining in environmental policy, the methods and ways for companies to become sustainable mining companies, and different case studies to help understand why reclamation is important. Three companies are used as examples in the case study. British Coal Mines, Appalachian Botanical Company, and Singerini Colleries Company Limited. Each case study is related to the "Reclamation" procedure of a project. In the conclusion part, it is explained why it is important to reclaim mine land, what are the various procedures to reclaim mine land, and why, as an entrepreneur, it is important to consider reclamation in mining.

***Keywords:*** *Sustainability, Circular Economy, Mining, Reclamation , Entrepreneur*

## Introduction

Sustainability and Circular Economy is representing an Economic Model where the objective is to produce goods and services in a sustainable way, by limiting the consumption and waste of resources (raw materials, water, energy) as well as the production of waste (Berg, 2019).

Sustainability is the model of representing the Economy through Reducing Green House Emissions like Carbon Monoxide, Sulphur Oxide etc. For sustainable development to be achieved, it is crucial to harmonize three core elements: economic growth, social inclusion and environmental protection. These elements are interconnected, and all are crucial for the well-being of individuals and societies.

Sustainability is a societal goal that broadly aims for humans to safely co-exist on Earth

over a long time. Specific definitions of sustainability are difficult to agree on and therefore vary in the literature and over time.

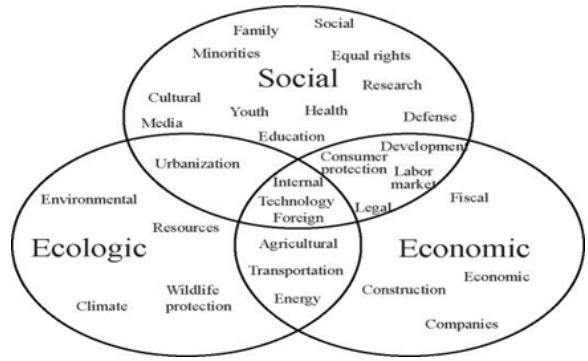


***Figure 1: Sustainability Representative Model by Circular Chart***

The concept of sustainability can be used to guide decisions at the global, national and individual level (e.g. sustainable living). Sustainability is commonly described along the lines of three dimensions (also called pillars): environmental, economic and social. Many publications state that the environmental dimension (also referred to as “planetary integrity” or “ecological integrity”) should be regarded as the most important one. Accordingly, in everyday usage of the term, sustainability is often focused on the environmental aspects. The most dominant environmental issues since around 2000 have been climate change, loss of biodiversity, loss of ecosystem services, land degradation, and air and water pollution. Humanity is now exceeding several “planetary boundaries”.

According to Berg (2019), "Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources. Sustainability is not just environmentalism. Embedded in most definitions of sustainability we also find concerns for social equity and economic development".

Circular Economy (CE) is the model of representing the Economy through Recycling the Waste, Using Product's which are Reusable and Ecofriendly which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products if possible. In this way, the life cycle of products is extended.

Circular Economy is the way to tackle global challenges as climate change, biodiversity loss, waste and pollution by emphasizing the design-based implementation of the three base principles of the model.

The three principles required for the transformation to a circular economy are:

1. To eliminate waste and pollution.

2. Circulating products and materials.

3. The regeneration of nature.

The "circular economy" is defined in a completely different manner to the traditional linear economy. The idea and concepts of a "circular economy" (CE) have been studied in a framework of three principles driven by design: eliminate waste and pollution, keep products and materials in use, and regenerate natural systems. It is based increasingly on renewable energy and materials, and it is accelerated by digital innovation. It is a resilient, distributed, diverse, and inclusive economic model (Reuter et al., 2019).

Sustainopreneurship (entrepreneurship and innovation for sustainability) is an idea that emerged from the earlier concepts of social entrepreneurship and ecopreneurship. The concept aims to use creative business organization in order to solve problems related to sustainability. With social and environmental sustainability as a strategic objective and purpose, sustainopreneurship aims to respect the boundaries set in order to maintain the life support systems in the process. In other words, it is "business with a cause" – where ideally, world problems are turned into business opportunities by the deployment of sustainability innovation (Abrahamsson, 2006).

**Sustainability and Circular Economy prospective in Mining**

All people know that one of the major factors for pollution and all other effects on Earth and Environmental is mining. So, it is important to see or make way for possibilities for Sustainable and Circular Economy prospective for mining to encourage Mining Companies across the Globe to move towards the Goal set by UNITED NATION.

Sustainable development in coal mining is taking effective action on both environmental and social fronts. Ministry of Coal (India) has come up with an action plan to move forward with a comprehensive Sustainable Development Plan and has initiated its speedy implementation.

The Ministry of Coal Primary focus is on making an immediate social impact through Out of Box measures besides regular environmental monitoring and mitigation during mining operations. Sustainable development was first in attention in 1987 with the publication of "The Brundtland". The Context of the Publication at that time clearly explained the concept of Sustainable Development indicating a warning of the negative environmental consequences of economic growth and globalization.

Today, most of the challenges faced by humankind, such as climate change, water scarcity, inequality, and hunger, can only be resolved at a global level by promoting sustainable development: a commitment to social progress, environmental balance, and economic growth.

The United Nations approved the 2030 Agenda on implementation of a new sustainable

development roadmap, which contains the Sustainable Development Goals, The Sustainable Development Goals should be considered global goals. This is an important call from the United Nations to all countries around the world to address the great challenges that humanity faces and to ensure that all people have the same opportunities to live a better life without compromising our planet (UNESCO, 2015).

Government of India under various Ministries has set a massive capital expenditure for developing and planning activities related to sustainable development for next 5 years. The future goals of India are very high and will set benchmark as world's second highest populated nation is heading towards sustainable future.

**Objectives of Environmental Policy for Mining**

Today the topics discussed are Sustainability & Circular Economy system in Mining. The Mining Industry will affect environment for years, but it is seen rapid change in New Age Mining Method. Where advance machinery and methods have been adopted by Mining Industry to tackle environment effects by the Industry. The Motive of Sustainable & Circular Economy is to reduce Air & Noise Pollution, Prevent Soil Erosion to adopt Sustainability activity and adopt new method which can eliminate the risk of Environment, Climate and Ecological Hazardous. Following are the various objectives of this policy.

- To take account of environmental concerns in planning and decision-making.
- To successfully complete conditions imposed by Environment & Forest department and other statutory clearances issued by regulatory agencies.
- To make sure and prevent pollution by continuous monitoring and measurement of Environmental parameters at surrounding Living Areas.
- Identifying the impacts of Mining towards Environment and prepare environment management system.
- To reclaim the mined out areas along with mining operations and making sure that suitable measures for conservation of adjacent forests, wildlife and bio-diversity.
- To follow “Zero waste policy” and promote recycling of materials, wherever possible.
- Optimize the use of resource i.e. Electricity, Oil and Water.
- To take up projects related to development of villages as part of corporate social responsibility.
- To provide the employees with proper training and information to take responsibility and implementing the best particles and work for organization and Environment.

**Methodology**

The Method of Working in Mining is done by two types

1. Underground Mining 2. Opencast Mining.

In Underground Mining environment hazard can be prevented by backfilling the extracted area. Sustainable Development in Underground can be developed by upgrading equipment's and machineries which are Sustainable & Effective to use for Mine operations. The Environment hazardous in Underground Mining is however lower has compared to Opencast Mines. However, there is an latest case study on this topic which will discuss below.

The Environment Hazards in Opencast Mines are occurred from starting time of a project. For an Opencast project to start the topsoil where through prospecting Minerals are done. If it occurs in Forest Area total forest area within Mine boundaries are cleared (Cutting of Trees), which natural destruct the Ecology of the Forest Area. Opencast Mining production is profitable than Underground in terms of production as there is no left over of mineral and complete extraction is possible. [ The process of recovering the effected lands due to Opencast across the way world is being tackle by various methods and latest technology which will discuss below and also it will discuss a case study related to Post Mining process (Reclamation).

1. Lower-Impact Mining Techniques – By Using Electric, Hydrogen or Hybrid Machineries like Electrical Dragline, Shovel, Dumper and all other machinery to reduce Carbon Footprint and Noise Pollution.

2. Investing in research and development of Green Mining Technology

3. Closing and reclaiming sites of shut-down mines

4. Accurate tallying of toxic mining waste- Mine Tailing Process

5. Improving environmental performance – By Reducing Air & Noise Pollution which occurs due to Mining

6. Better legislation and Regulations

**The steps taken by indian government for reducing environment impact by mining**

In the latest survey report for Fiscal year 2022. The Number of Mines in India are 1245. At present, the demand for Coal Consumption in India has increased from 900 Million Tonnes – 1200 Million Tonnes per year. The Ministry of Mines also expects the demand to be of Consumption of Coal to Improve by 1500 Million Tonnes by 2040. Also, in Metal Industry the present demand is around 86 Million Tonnes per year as of 2022 fiscal year, And Steel Industry is excepted to grow by 7-10%. It is also possible that steel demand

will reach 230 million tonnes per year by 2030.

Because the mining industry may see an increase in demand, it is critical to consider that the environmental impact of mining is reduced in the process. Hence Ministry of Environmental, Forest and Climate Change (MoEFCC) has taken decision on January 8,2020 after Supreme Court Order to implement Reclamation of mined-out areas to be now Compulsory.

Under "National Mineral Policy 2019" which guides mining activities in India, also talks about the importance of land reclamation once mining is complete.

For instance, If one can look at the official data (2018-19) regarding land restoration and reclamation of 52 opencast coal mines projects of Coal India Limited (CIL),The data shows that the total mine leasehold area is 671.44 square kilometers. Of that, the total excavated area is 255.43 sq. km. and of that 60.80 sq. km. (23.80 percent) of the land restoration has been planted (biologically reclaimed), 99.99 sq. km. (39.15 percent) is under backfilling (technical reclamation) and 94.64 sq. km. (37.05 percent) is under active mining. CIL is an important player in mining and is a public sector company of India it accounts for over 80 percent of India's total coal production and is also considered the world's single largest coal producer (Aggarwal, 2020).

Some government companies implementing environment reclamation and development.

***Figure 2: Eco in NLCIL, Tamilnadu: Boating facility***

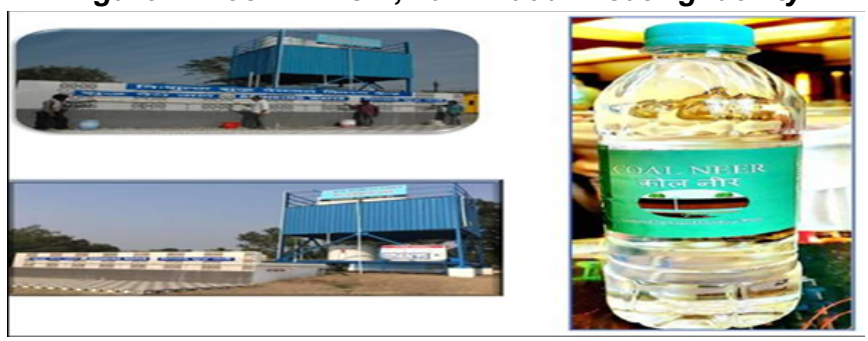


***Figure 3: Mine water purifier to Drinking water at Gondegaon, WCL, Maharashtra***

***Figure 4: Gunjan Park of ECL – An Opencast mine turned into a beautiful Eco-Park with water body***

***Figure 5: SCCL: Solar Power Plant at Manuguru (30 MW)***

Different Case Study for Why, What and How Sustainability Entrepreneurship is Beneficial in Mining: -

**(A) Why to introduce sustainability and circular economy: -**

British Coal Mines in Ghugus City, Chandrapur, Maharashtra, On August 27,2022 in Ghugus City of Chandrapur. House Collapse and Sink upto 50 feet down. The house suddenly collapsed and sunk 50 feet down in Ghugus town which is famous for the British coal mines. This incident has left the entire town in a state of shock. Gajju Madavi, a resident of the Amrai ward of the city was at home with his family when suddenly his house started to collapse. He rushed out with his family and within a moment his house collapsed to the ground.

***Figure 6: Sudden Collapse of a House in Ghugus City Due to Irregular Backfilling***

This happened because during the British era coal was mined from open pits. But as the city expanded, people built their houses near the mine. Today, the entire city of Ghugus is situated on top of an underground coal mine. At present, the residents of Amrai Ward are being demolished and shifted to a safer place to avoid a Major Accident (Ali, 2022).

**(B) A project which introduces sustainability and circular economy:-**

Appalachian Botanical Company is a start-up company owned by Jocelyn Sheppard-founder & president of Appalachian botanical company. The company started its journey from Boone country, west Virginia (USA), the role of the company is to transform sections of a Opencast strip mine into an beautiful lavender blooms and buzzing honey bees. Which transform the waste land by mining into Wonderful Farm-Land. This is economically profitable along with the land which has been polluted is with mine impurities (like shale coal , iron) which endangers the surrounding water bodies and may flow towards nearby water bodies during Monsoon season and also cause Acid Raining.

Lavender is a relatively easy to grow plant and depending on the variety, it (lavender) actually have minimal water to grow and attention demands, with some of the prominent variations only requiring watering once everyone to two weeks. Most of Appalachian Botanical lavender are produce during June and July and are harvested quickly thereafter to ensure premier quality oils.

The organization waits until after the “prime harvest” period to allow their honey bees to collect the nectar and pollen. Today, company boasts a wide variety of home and body products, all crafted with their own lavender and honey.

The company has seen great success since its foundation of three years (i,e:- 2019). They operate as a “zero waste company,” as they use ingredients each and every part to blend into outstanding products.

***Figure 7: Plantation of Lavender in Open pit Reclamation project in USA [12]***

As the company moves forward the plan for them is globalize the company and reclaim the land which are left over after mining, there revenues are increasing and profitable. The company concern with environment impact by mining is also making sure they involve in social cause too by providing jobs to those who are addictive to Drugs etc to make sure they have a proper rehabilitation.

**( C) Singerini colleries company limited- Telangana**

The SCCL Mining Company is a mining company from Telangana which has achieved milestone achievement in terms of mining company as per Production. It will be interesting to see how they have implemented sustainability and circular economy within the company as well as by assisting communities. The Reclamation Model for SCCL is bring various other models and figuring out the best model out of it.

1. Creation of Eco-parks
2. Mine Water Utilization
3. Plantation Reclamation
4. Processed Overburden
5. Bottom Ash Utilization
6. Promoting Renewable Energy

The Company with its various projects has not only Reduce Carbon Footprint But also have decreased there maintaining cost as company.

The Steps taken have being milestone achievement like

- Proposed Eco-Park at Gautham Khani OC on 23.07.2020.

- About 100 surrounding villages are being benefitted by excess mine water discharge with Mine Water Output of 993 LKL.

- Bottom ash is being utilized successfully for stowing in UG mines.

- Processed Overburden of around 3120091 Cubic Meter.

- By proposing to set up 299.5 MW capacity solar plants (in 3 phases) with capital outlay Rs.1361.5 Crores.

- By Using Roof Top Panel in Various Office's with Approximate Capacity of 240 KWp.

With this different Models SCCL has made sure that Company not only Switch towards Green Energy but also find way to implement the best suitable model for different locations for not only just Reducing Carbon Footprint also making sure to be profitable and helpful to Communities living by and helping Village's.

Companies like SCCL clearly benefit from implementing the Sustainability and Economy Model and set a good example for others. It is also Helping Companies like NTPC by using Bottom Ash Produced by Thermal Plants can be used for Stowing in Underground.

**Conclusion**

- Through this Case study, it is now known that it is possible to achieve Sustainability and Circular Economy in mining and to become a successful company with Net Zero Carbon Output.

- By looking at the Incident in Chandrapur British Coal Mines it has been focused on on proper and safe reclamation with commitment.

- It is known that after mining also income can be generated generated through mine land and also make the land fertility improve which is said that Circular Economy and Win-Win situation.

- It is seen that big players in coal Industry like Singerini Colleries Company Limited are also trying they level best to implement sustainability day by day.

- And Also that it is important for a all the mining industry to follow the Environment policy of government not only for the Country but for the better World.

- Not only it has let to implementing environmental policy for old giant companies like CIL, SCCL. It has also given birth to Net Zero Companies like Appalachian Botanical

Company which are making farmland possible in mining area with sustainability and economy of the Company growing in a good pace. Which shows a positive sign for all the other Companies around the World.

- The Carbon Footprint across the world is increasing day by day and it is important to act know for the future generations to be safe.

- The rules are made for Social Cause and not implementing it is indirect way of effecting yourself and world.

- In SCCL case Study we see that Waste Ash can also be used properly for Back Filling which in British Coal Mines Company did not implement and now, the result is seen.

- Also, through SCCL case Study it has been observed that if one think properly every waste can be made useful like mine water being used for Village supply after filtering and ash from Thermal Plants being used as Back Filing in Mines.

- Government across the globe along with United Nations is giving priority to implement sustainability in every aspect of life.

- It will definitely take time to completely be Net Zero or stop depending on fossil fuels for electricity and petroleum too.

Author's view towards sustainable entrepreneurship for mining

In a World , where backlash from Environment Protesters and Climate Activists for mining (which is a major cause of pollution) is becoming a sensitive issue, the reality is that everybody is dependent on natural resources like Coal, Oil for ourselves and even for country's economic perspective. Even Metal Mining Industry plays a vital role and will remain important to the World for variety of uses. As a Mining Student, it is known that the Fertilizer used by farmers for agricultural need required minerals which are also Extracted by miners ( Phosphate Mines). By Looking into actual facts, it has been understood that Mining and Agriculture will always remain Primary Industry for Human's.

To become a Good Entrepreneur in Mining Industry, one needs to ensure and reduce the effects of mining towards environment by following the government Policy. Even if there are no policy from government from few countries, since Environment and Climate Change are International issues, as an entrepreneur in mining goals need to be set in International Level to stay ahead for competition.

In the above case studies examples has been observed of various companies for understanding the way towards Sustainability and Circular Economy can be effective. As an entrepreneur it is important to keep in mind that profit doesn't mean just getting extra money in less time without caring environment in long run. The ideal company

must have a good reputation in terms of economical and management perspectives as well as a positive concern on environmental impact. A good start up should be a problem solver for the society.

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