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A GENERIC APPROACH TO ELIMINATE CHILD LABOUR IN MICA MINING

Sonia Mahendra Pol
ME Mechanical Engineering (CAD/CAM and Robotics), Fr. Conceicao Rodrigues College of Engineering, (Bandra West) Mumbai, Maharashtra, India
soniapol.11.pisces@gmail.com
https://orcid.org/0009-0008-8232-7635

ABSTRACT
Geologically, mica minerals are a category of phyllosilicate sheet silicate minerals that are created by an amalgamation of heat, pressure, and chemical reactions that occurs in the outermost layer of the planet's crust. India serves as one of the world's top exporters of mica, and the majority of the country's mica reserves are in its eastern and north-eastern geographical regions. Various industries utilize mica in a variety of ways. It serves as insulation for capacitors, wiring, and electrical apparatus in the electrical sector, as well as being used in construction materials as an additive to improve the durability and heat resistance of substances like paint, plaster, and cement. Mica is a mineral that is also used in the cosmetics industry to give beauty products shine and luster. In India, the illegal practice of mica mining frequently entails unregulated and risky procedures, including the employment of child labor, hazardous working conditions, and a lack of supply chain transparency. In this research paper, child labor elimination in mica mining can be aided by recommending companies and industry organizations practice ethical sourcing and encourage transparency across the mica supply chain with the help of appropriate technological solutions, i.e., cost-effective machinery that will eliminate child labor in mica mining.

Keywords: Mica Mining, Child Labor, Cost-effective machineries, Ethical Sourcing, Supply Chain Transparency

INTRODUCTION
Mica minerals are largely made of aluminum silicate or potassium aluminum silicate, with various proportions of additional elements such as iron, magnesium, and lithium. These minerals have a multi-layered or sheet-like structure with weak connections between the layers. (des hommes - Hilfe für Kinder in Not - Deutschland eV, n.d.). This structure allows mica to easily fracture into thin sheets or flakes. 60% of total mica minerals and the largest mica exporters are served in India.(Jain & Singhal, 2022). In 2021, at least 70% of India's mining output was illegal but profitable. (Chia, 2021). Mica deposits in India are predominantly found in the country's eastern and north-eastern areas. (des hommes - Hilfe für Kinder in Not - Deutschland eV, n.d.). Jharkhand is India's largest producer of mica, accounting for a sizable portion of total mica output (des hommes - Hilfe für Kinder in Not - Deutschland eV, n.d.). Mica deposits abound in the districts of Giridih, Koderma, Hazaribagh, and Nawada. Bihar, another state in eastern India, contains a lot of mica. Mica mines can potentially be found in the districts of Gaya, Nawada, and Munger. Rajasthan, in western India, is also well-known for its mica riches. Mica deposits abound in the districts of Ajmer, Bhilwara, Sikar, and Tonk (des hommes - Hilfe für Kinder in Not - Deutschland eV, n.d.). The southern Indian state of Andhra Pradesh is a major producer of mica (des hommes - Hilfe für Kinder in Not - Deutschland eV, n.d.). Mica deposits may also be discovered in Telangana, a bordering state of Andhra Pradesh. The Nellore mica belt is the largest mica-producing area, covering part of Nellore district in Andhra Pradesh, India (Tewari et al., n.d.). Child labour has been used in the mining of mica at these locations where mica minerals are found (des hommes- Hilfe für Kinder in Not- Deutschland eV, n.d.). Child labour in mica mining is a serious problem that impacts children's rights and well-being all across the world (Bliss et al. 2017; Das & Goel, 2021). Mica exports from India totaled $21 million in 1950–51. Exports reached $22 million in 1973–74, a slight increase. Exports were much lower in most years. Mica exports made up 1.7% of total exports in 1950–51. (Ramachandran, n.d.)Children are occasionally compelled to labour in mica mines, where they are exposed to hazardous working conditions such as dust and poisonous compounds, which increases their risk of developing lung and other respiratory conditions (Malathy, 2018) Furthermore, most kids mine for mica

with their bare hands since they lack the necessary equipment, which commonly leads to wounds and skin diseases, and the possibility of mine collapse sometimes leads to death (Illegal Mica Mining Continues Unabated in Jharkhand, Causing Death and Disease—The Wire Science, n.d.; Malathy, 2018).They labour long hours, sometimes in tight and restricted conditions (Malathy, 2018). Mica insulates cables, capacitors, commutators, hair dryers, and toasters (A Kate et al., 2016) Mica is in plasterboard, fibre cement, oil-well drilling fluids, plastics, shampoos, and conditioners (Kate et al., 2016). Mica is used in coatings, tyres, bitumen foils, brake pads, and clutches. Cosmetics, plastics, ink, and paint or coatings sparkle with pearlescent pigments (A Kate et al., 2016). 60% of Jharkhand and Bihar's exports and metric tonnes come from pearlescent pigment manufacturers (A Kate et al., 2016). Cosmetics were the 4th most common use of mica, accounting for 10–18% of the mica market, but this industry was easy to target because the ingredient is on every ingredient label (RMI - Approach & Strategy, 2021). This research paper presents a general mica mining child labour elimination strategy. Mica minerals are extracted using low-cost to high-cost machinery. This approach will certainly replace child labour, ethical sourcing of businesses and factories that supply mica to various industries, and supply chain transparency of factories that regulate mica supply chains.

PROBLEM DEFINITION

The ongoing, unethical problem of child labour in mica mining Despite prior efforts, child labour remains a problem due to social issues and a lack of mining strategies. The difficulty is in developing a long-term strategy that ends child labour and offers viable alternatives while taking into account economic, social, and environmental factors.

RESEARCH OBJECTIVE

This research paper intends to solve the crucial problem of child labor in mica mining by offering a workable and adaptable generic solution that combines ethical considerations, sustainable resource utilization, and economic viability. The primary objective of this research paper is to propose a generic approach to implementing technology that has not been utilized so far in the mica mining sectors in India. So, various cost-effective machines can be utilized to replace and eliminate child labor in mica mining. The mining firms practice unethical child labor because that is more affordable than the mining techniques, so the affordable, cost-effective machines can increase productivity and contribute to an ethical practice on mica sites, which possess transparency in mica excavation practices.

Legal and Policy Framework

The Indian government is dedicated to eliminating child labor in the nation. In the Fundamental Rights section of our Constitution (Article 24), we prevent children from engaging in work or hobbies that are inappropriate for their age. This commitment is reaffirmed in the Constitution's Directive Principles of State Policy. Article 24: Prohibiting the use of children as laborer in industries, etc. Children under the age of 14 are not allowed to work in factories, mines, or in any other hazardous employment (Article 24 of Indian Constitution, n.d.). Multiple parties, such as mining firms, regional communities, governmental organizations, and civil society organizations, are frequently involved in mica mining. Effective enforcement may be hampered by a lack of coordination and collaboration among multiple stakeholders (Bliss et al. 2017; Malathy, 2018; Schipper & Cowan, n.d.). Mechanisms for information exchange, teamwork, and coordination must be built to close this disparity. Mica, a global mineral, has complicated supply chains. Before reaching end users, mica mined in one location may pass through several intermediary companies, making it difficult to trace and ensure ethical sourcing. This complexity hampers supply chain enforcement.

Socio-economic Factors

The main cause of child labor in the mica mining industry is poverty. Mica mines are often in impoverished areas without access to healthcare or education. Poor families need extra income, and children often work dangerous jobs to support them. Lack of alternatives to mining for mica in certain areas leads to child labor, and due to a lack of diversified economic activity and few work opportunities, a great deal of money is derived from mica mining. Parents have few options but to involve their children in mining. Girls in particular may have extra

obstacles, such as restricted educational opportunities brought on by gender prejudices or cultural norms (Malathy, 2018). They frequently experience gender-specific kinds of exploitation and are more likely to be in danger in mining regions. Consequently, gender disparities also contribute to child labour in mica mining. To eliminate child labor in mica mining, cooperation between governments, industry players, and civil society organizations is essential (des hommes- Hilfe für Kinder in Not- Deutschland eV, n.d.). This involves encouraging ethical sourcing, working with key stakeholders to create child-free supply chains, and sharing best practices and information to solve the problem.

LITERATURE REVIEW

(Road-Map for Sustainable and Inclusive Mica Industry in Jharkhand, n.d.) (2018) This article guides Jharkhand's mica sector toward inclusive and sustainable growth. As the first mica industry documentation in India, this may be a good place for experts and organizations to start before taking further aggressive steps to ensure the sector's long-term viability. This paper can help governments, firms, and non-governmental groups set goals, targets, and strategies for environmental sustainability to restore and sustain the mica industry (NGOs). Mica production, availability, and industrial uses are covered in the paper [15].

Terre des hommes (des hommes - Hilfe für Kinder in Not - Deutschland eV, n.d.) (2008) intends to raise awareness of the supply chain's complexity and highlight key locations where businesses might look for child labor. This article discusses mica's characteristics, global production and exports, intermediaries' buyers and sellers, factories and processing facilities, the export of mica from India to Germany, the supply chain component, responsible mica initiatives, demands, and solutions [1].

(Schipper et al., n.d.) (2018) They studied mica supply and demand worldwide. Because demand drives production, the research identified the electronics and automotive industries that use mica the most. Risk-based due diligence in many sectors is also examined in this case study. Labor, output, export, and import statistics are examined for the fifteen largest non-western and five largest western mica-producing countries. This report advises corporations, NGOs, governments, the EU, and the public on mica mining and mica-producing nation risks [14].

(Sine, 2022)On January 31, 2017, L'Oréal joined the Responsible Mica Initiative to address mica supply chain safety. Cosmetic companies like mica because it's cheap and unique. Private investigations have shown inconsistencies between companies' customer messages and mining communities, bringing negative attention in recent years. As the biggest cosmetics company, L'Oréal affects these communities. A case study examines L'Oréal's approach to these issues and possible improvements [16].

(Ika Hidayani Harahap, 2021) examined L'Oréal's role in ending child labor in India, particularly in Jharkhand and Bihar. As one of the companies that uses mica from India, L'Oréal wants to help end child labor in illegal mica mines. Thus, this study uses the UN Guiding Principle on Business and Human Rights, which emphasizes corporate responsibility to respect human rights and access to remedies. To end child labor mica mining in India, L'Oréal and several multi-national cooperations founded the Responsible Mica Initiative (RMI), a non-profit organization. The Responsible Mica Initiative, L'Oréal, and child labor (RMI) [17]

Child labour at mica excavation sites is illegal, unethical, and lacks transparency in mica excavation sites, firms, and companies that use mica as an ingredient or key ingredient.

Statistical data of child labor in Mica Mining

The below table illustrates the No. of child labor in Mica Mining locations according to the available sources: -

Table 01 Statistical data of child labour in Mica Mining

Serial number	No. of child Labour	Destination	Source
1	20,000 and more	Jharkhand & Bihar	Dutch campaign group SOMO
2	23,000 and more	800 Villages where Mica is found	SOMO and terre des hommes: "Beauty and a Beast" in 2016
3	22,000 and more	Jharkhand & Bihar	(NCPCR) after a report by Terre Des Hommes
4	20,000 and more	Andra Pradesh	KSCF US Team

According to a reasonable estimate by the Kailash Satyarthi Children's Foundation, 10 to 20 people die in accidents caused by mica mining each month(*The Dark Secret Behind Mica Mining*, n.d.). Additionally, 45 children lost their lives in the mica mines between 2013 and 2018, according to a 2018 report by the NGO Children in Need Institute (CINI)(Child Labour, Mine Deaths — Rihanna's Fenty Beauty Brings Jharkhand Mica Back under Spotlight, n.d.).

It is vital to note that gathering accurate statistics on child labour can be difficult due to the concealed nature of informal and hazardous work. Furthermore, mica mining is frequently carried out in remote locations where monitoring and data collecting are challenging.

Sustainability Aspects in Mica Mining

Mica mining has been associated with terrible labor conditions, negative social effects, and environmental deterioration, particularly in some areas. Mica mining practices must take sustainability factors into account in order to be long-term, commercially feasible, environmentally sustainable, and socially ethical(Schipper & Cowan, n.d.).

To ensure mica mining sustainability, governments, mining companies, NGOs, community members, and other stakeholders must work together. Mica mining can balance economic growth, social progress, and environmental preservation by incorporating sustainability.

The Table below depicts various sustainability aspects in mica mining: -

Table 2: Sustainability aspects in mica mining

Sr.no	Sustainability Aspect	Explanation
1	Environmental Impact Assessment (EIA)	Assess mica mining's environmental impact through thorough EIAs. This entails assessing issues including soil and water quality, habitat damage, deforestation, other ecological worries mitigation and strategies into place to reduce adverse impacts (Namin & Bascetin, n.d.).
2	Child Labour Elimination	Suppress mica mining child labour by surveillance, education, livelihood support, technology, and mine-engineer employment.
3	Community Engagement	To improve community well-being, collaborate on mining decisions, benefit-sharing, and community rights.
4	Corporate Social Responsibility	Mining businesses should support infrastructure, education, healthcare, and life improvement.
5	Supply Chain Transparency	Verify transparency and traceability throughout the entire mica supply chain. Promote ethical manufacturing by working with manufacturers, suppliers, and customers.
6	Certification and Standards	Practise well-known standards set by the mining sector, certifications, and best practises, such as those developed by the Extractive Industries Transparency Initiative (EITI) and the Initiative for Responsible Mining Assurance (IRMA).
7	Technology and Innovation:	Investigate cutting-edge methods and technologies that can reduce the negative effects on the environment while improving the effectiveness of mica mining, processing, and utilisation. for, e.g., machines.
8	Legal and Regulatory Compliance	Mining firms must maintain all applicable laws and regulations governing mining operations, labour legislation, environmental protection, and community involvement.
9	Post-Mining Habitation	Develop comprehensive plans for land reclamation and site rehabilitation to return mined sites to their natural condition or use them for other sustainable land uses.

Enhancing Supply Chain Transparency to eliminate Child Labor in Mica Mines

End users of mica-based products may not know that illegal child labour is used to extract mica from the earth. Final consumers always want a product made ethically without injuring or violently harming humans during production or supply chain. Child labour for mica mining is illegal and shows the lack of supply chain

transparency. The visibility and traceability of products and information flows across the whole supply chain are referred to as supply chain transparency (Sodhi & Tang, 2018). Stakeholders may gain a thorough picture of the complete supply chain from raw materials to the final customer by collecting and exchanging data on the flow of commodities, processes, and circumstances under which they are created(Sodhi & Tang, 2018).

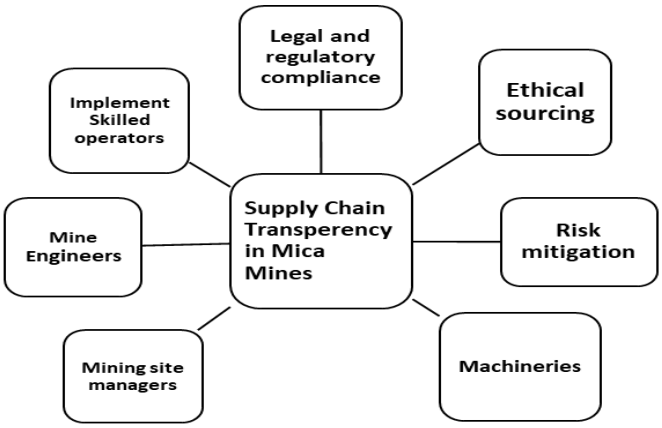

Fig.1 Supply chain transparency in mica mines

Supply chain transparency mainly deals with the ethical sourcing and risk mitigation. Identifying and lowering risks related to quality assurance, legal and regulatory compliance, and reputational impact are made easier through transparent supply chains. Companies that manage risks proactively can avoid interruptions and protect the reputation of their brands. Companies can buy products from suppliers who follow moral, environmental, human rights, and decent working conditions laws. Consumers want businesses to be more accountable and transparent. Because transparent supply chains allow customers to judge ethical issues, environmental sustainability, and product safety, confidence increases. Support mica supply chain certifications that ensure ethical sourcing, such as child labour prohibition. Businesses could prioritise mica from authorised mines and use ethical sourcing labels to provide transparency. Mining companies can hire experienced operators, engineers, and site managers. Their expertise in safe and efficient mining can improve productivity and responsibility. Professionals know how to prioritise worker safety, labour rights, and environmental sustainability in mining. They can create and enforce ethical processes to reduce child labour. Hire qualified staff to run comprehensive on-the-job training for miners. These programmes can raise awareness of child labour, promote ethical sourcing, and set mining standards. To ensure ethical sourcing, experts may audit and due diligence suppliers. They can inspect suppliers' child labour policies and take corrective action if necessary. Skilled professionals can build trust and collaboration with local communities around mining sites. This involvement allows community development, education, and other livelihood options, reducing child labour. Skilled operators and mine engineers using monitoring systems can detect and prevent child labour at mining sites. They can detect and address child labour through frequent site inspections, worker interviews, and paperwork verification. Businesses and trained professionals can share best practises, experiences, and new mica supply chain child labour reduction ideas. This shared knowledge could inspire industry-wide changes and build a responsible sourcing network. NGOs and industry groups dedicated to ethical sourcing can employ skilled professionals. These collaborations can use professional expertise, resources, and direction to end child labour and promote ethics. Skilled engineers and staff can help mica mining companies improve. Ethical sourcing, responsible mining, and collaborations can eliminate child labour and create a more transparent and sustainable supply chain.

A Generic Approach to Eliminate Child Labour in Mica Mining with the help of cost-effective Machineries.

In this research paper, the generic approach to eliminating child labour with the help of cost-effective machines has been identified. The intervention of machines automatically declines the use of child labour. Prioritising costs

according to the market, flexibility to the unique requirements of mica mining, and safety concerns is crucial when looking at cost-effective machinery for mica excavation and screening. Mining operations may become more productive and efficient by using inexpensive machinery. These machines can lessen the need for physical labour, including child labour, by automating some operations and expediting the mining process. The enhanced productivity makes it possible to collect more mica in less time, which lessens the need to use children for low-paying physical labour. Cost-effective machineries frequently have safety measures that are intended to shield users from potential risks. The danger of accidents and injuries can be considerably decreased by employing machines for jobs that were previously completed manually. This reduces the need for children to participate in hazardous mining tasks and helps establish a safer working environment.

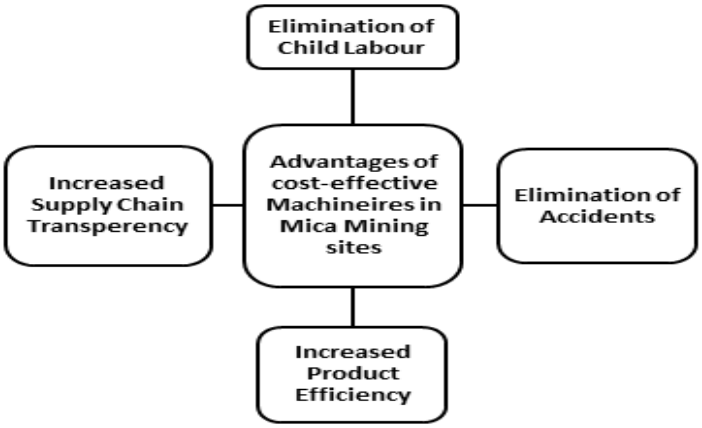

Fig. 2: Advantages of cost-effective machineries in mica mining sites

The following constitute a few cost-effective machines that can possibly be implemented in the mica mining process:

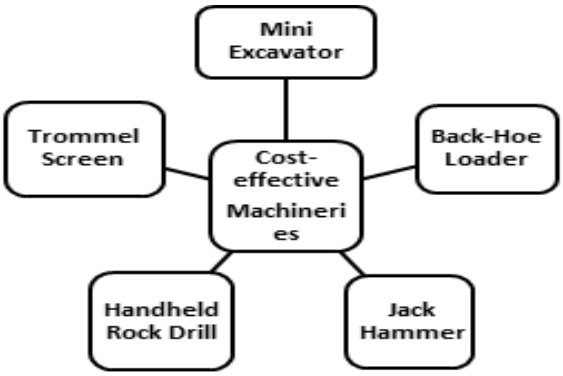

Fig.3: Cost effective machineries for mining purpose

Mini Excavator: It is capable of efficiently removing unwanted materials and gaining access to mica-bearing layers. Also, it is capable of digging and excavating the soil and rock layers to expose the mica deposits. (Prajapati et al., 2011) researched soil-machine interaction during mini-excavator digging. Parameters that affect soil-excavator interaction during digging were examined. Construction, mining, digging, and forestry utilise hydraulic excavators (Korucu et al., 2017). Once the mica-bearing rock is exposed, the mini excavator can load it into trucks or other transportation equipment for further processing or transportation to the designated processing area. It can work in limited locations, like pits or small mining tunnels. They can successfully mine mica-bearing materials in confined spaces, increasing mining efficiency. Mini excavators are frequently equipped with replaceable attachments like buckets, hammers, and grapples that may be used for various jobs. These accessories

help excavators extract mica more accurately and efficiently. A mini excavator can relocate mica material at the mining site. Mica-containing material can be transported to processing or stockpiles.

Backhoe Loaders: The backhoe loader features a digging bucket in the front and a backhoe arm in the back. The majority of backhoe excavators' work is below ground level (Kumar et al., 2015).For discovering the mica deposits, it can be used to dig the soil and remove sediment materials. A backhoe loader can be used for material loading and handling. Backhoe excavators can be used for building foundations, highway construction, gardening, forestry, digging holes, material handling, light demolition, urban works, river dredging, and hazardous environments (Kumar et al., 2015). The JCB loader can load it into trucks or other transportation equipment for further processing or transfer to the assigned processing area. The backhoe loader helps to move and relocate the extracted mica material throughout the mining site. It is capable of transporting mica-containing material to processing areas or specified stockpiles. Backhoe loaders generally have interchangeable buckets, hydraulic hammers, and grapples. These attachments can smash rocks, sort materials, and clean trash, improving the backhoe loader's mica mining capabilities. Backhoe loaders work well in pits and small mining tunnels. The backhoe arm can dig mica-bearing minerals in tight spaces, increasing mining flexibility. Backhoe loaders can also repair sites. They can grade, level, or fill trenches after mica extraction to restore the mining site. Offering a more efficient alternative can reduce child labour.

Jack-Hammer: In mica mining, a jackhammer, also known as a pneumatic drill or rock drill, can help extract mica-bearing rocks from the earth's surface. Mica is typically found lodged in rocks, and its removal requires the breaking down of these rocks. A jackhammer is strong portable equipment that delivers high-impact blows to rocks using pressurised air or electricity, efficiently shattering them into smaller pieces. This method makes it easier to access the mica deposits within the rocks. As opposed to human techniques, jackhammers are designed to produce quick and repetitive blows, making the operation of breaking rocks more efficient and time-saving. The jackhammer's high-powered strokes may swiftly break through hard rocks, enhancing the mining operation's total output. Jackhammers allow miners to precisely regulate the power and direction of their strikes, allowing them to target particular sections of mica-containing rocks. Jackhammers are often used for both surface and underground mining, as well as in locations where it would be impossible to utilise larger machinery. Because of their mobility and manoeuvrability, they are ideal for mining activities in difficult terrain. Jackhammers are versatile machinery for a number of mining scenarios since they are available in a range of sizes and accessories. One drawback of pneumatic rock drills in mining is noise. (Camargo et al., n.d.; Miller, 1963). Although digging can be hazardous, using a jackhammer can enhance safety measures.

Handheld Rock Drill: Mica is commonly found in deep subterranean rocks. Rotor-percussive hand-held rock drills Their drill-and-blast, anchor, and rock-splitting applications are influential, and these compressed air-powered devices are cheap and significant (Su, 2019). Miners can drill holes through the rocks with a portable rock drill, providing access points for additional mining. By estimating the depth, angle, and position of drill holes, miners may target specific places with mica resources, so drilling can actually be done precisely using handheld rock drills. Because they are compact and portable, handheld rock drills are perfect for use in mining activities. The extraction procedure is more productive because of its precision. Due to their mobility, miners can reach parts of the mine that larger drilling machinery would find challenging to reach, such as confined spaces or rocky terrain. Handheld rock drills are adaptable machines that may be implemented in various mining scenarios. A handheld rock drill is appropriate for many rock types and hardness ranges and may be used for both surface and underground mining. Because of their versatility, they are useful in mica mining, where geological conditions might fluctuate. Handheld rock drills are built with safety measures to keep the user safe. They usually have ergonomic handles, anti-vibration systems, and protective protections. These characteristics lower the risk of injuries and create a safer working environment for miners.

Trommel Screen: A trommel screen is a cylindrical drum-shaped machine for screening that may be used to sort minerals based on their size in mica mining. Mica-bearing rocks are frequently found in association with other minerals such as soil, gravel, or bigger boulders. A trommel screen aids in the separation of various items based

on size. (Browning, 1963; Immo H. Redeker, Chief Engineer, 1981) The mica-containing rocks are put into the trommel screen, and as the drum turns, smaller particles, including mica, pass through while bigger materials are retained. This can help reduce the reliance on child labour by providing a more efficient alternative.The machines discussed above can be effectively applied to the mica excavation sites by taking environmental rules, regulations, and conditions into account to regulate the mines, eliminate child labour, and employ skilled operators as well as executive mining engineers. When engineered properly with the help of mine engineers, these machines can offer more productivity than child labour.

CHALLENGES AND RECOMMENDATIONS

Challenges are associated with financing small as well as large machines and the employment of skilled operators and engineers for mica mining. Various Operations Research (OR) topics and techniques can potentially be implemented to manage finances and make machinery procurement choices with the objective of eliminating child labour, such as simulation modelling, optimal resource allocation, portfolio optimization, and sensitivity analysis. These operation research techniques have the potential to optimise resource allocation, examine numerous variables, and assure ethical and sustainable decision-making. By applying these Operations Research (OR) techniques, researchers may take into account the intricate connection between financial, ethical, and operational factors when making judgments concerning the purchase of machinery, budget allocation, and the elimination of child labour. Mining companies and firms must do rigorous financial research, investigate numerous financing possibilities, and thoroughly analyse the related terms and circumstances before deciding on the best solution.

CONCLUSION

This research paper proposes a generic approach to implementing cost-effective machines in mica excavation sites to replace and eventually eliminate child labour and accidents in hazardous mica mines. The proposed generic approach, when applied, will be cost-effective as well as an ethical solution, and there will be supply chain transparency for the mica mine firms and also for those companies that use mica mineral since this generic approach refuses the intervention of child labour. This approach works to eliminate child labour while also enhancing the general well-being of the communities affected and the mining industry.

FUTURE SCOPE

Several operation research topics and strategies may be used in the context of choosing machines for eliminating child labour in order to ensure moral and effective decision-making, such as Multi-Criteria Decision Making (MCDM), Integer Programming (IP), Multi-Objective Optimization, Simulation Modelling, Stochastic Optimization, and Sensitivity Analysis, on the basis of various factors such as cost, capacity, budget limitation, and labour regulations, when selecting machines. Publishing sustainability reports and research, supply chain disclosures, and other transparent communication platforms to share progress, challenges, and successes in achieving supply chain transparency goals will help suppliers, particularly those in developing regions, comprehend responsible sourcing practises, labour rights, environmental stewardship, and transparency requirements. Businesses, industry associations, and technology suppliers should collaborate and share knowledge to spur innovation and find affordable solutions. Conferences, workshops, and platforms can help people share best practises.

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