

## Formalization: optimizing its principles for improving small-scale gold-mining

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## B17 - Formalization: Optimizing its principles for improving Small-scale Gold-Mining

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### **Abstract**

For years, the worldwide gold mining sector has grappled with environmental and social issues, particularly evident in the small-scale operations which are predominant in developing nations. This research examines the incorporation of “Mining Formalization” into a framework for small-scale gold mining, with the goal of suggesting methods that could bolster environmental conservation and social accountability. Concentrating on developing countries where small-scale mining significantly influences local economies, this study investigates the customization of formalization principles to diminish human and environmental harm, by advocating for ethical regulatory frameworks and standards, fostering community development, and achieving the advancement of enforcement and oversight.

Employing a multidisciplinary approach, this study adopts a single source systematic search (4S) strategy for its methodology. It then reviewed and integrated geological, environmental, social, and economic viewpoints to frame a holistic set of recommendations that can create significant positive changes when applied as an optimized set of Formalization Standards. Thus, by tackling specific challenges encountered by small-scale gold ventures, this investigation now offers practical insights and advice for policymakers, mining communities, and industry players that can be adopted to cultivate a more sustainable and socially accountable path for small-scale gold mining in developing nations. Envisaging a future where small-scale gold mining can contribute as a positive force for both environmental and local community welfare, this research also endeavoured to optimize its advantages, aligning them with global happenings that are tending toward responsible resource extraction.

**Keyword:** Formalization, Gold, Small-scale Gold Mining, Artisanal and Small-scale Mining, Mines Environmental Compliance.

### **Introduction**

Formalization, although a terminology that refers to the standardization of an organization or a sector, or of roles that govern desired outcomes from mostly semi-formal to informal settings within these institutions, can be argued to have had multidisciplinary roots. It is believed to have originated from formal thinking, which is as old as technology, and technology has been contended to be as old as the human mind, nevertheless, the ancient expression tools, were said to be crude and did not lead any far (Zemanek, 1975). Likewise, the global gold mining sector boasts a storied past stretching back centuries, leaving an indelible mark on economies and cultures worldwide. Gold's allure, rooted in its scarcity and intrinsic worth, has spurred exploration and extraction ventures across diverse landscapes. From the historic gold rushes of the 19th century to the establishment of expansive mining operations, the industry has undergone profound metamorphoses (Bell & Donnelly, 2006).

Ancient societies revered gold not only as a symbol of affluence but also as a pivotal element in cultural and religious rituals. With the onset of industrialization, gold mining has evolved into a multifaceted and intricate domain (Bell & Donnelly, 2006; R. Klemm & Klemm, 2013). Presently, the industry encompasses a blend of large-scale industrial mining, small-scale mining, and artisanal-scale mining, with a notable portion of small-scale and artisanal mining (ASM) concentrated in developing nations. Due to the impacts of the activities, the need for formalization, appears to be important not only as structural insertion (do Nascimento and Silva, 2020), but as a necessity for sustainable (Fritz et al., 2014), and inclusive (Munir, 2023), strategy for development.

### ***Clarifying the Artisanal and the Small-scale Mining Dichotomy***

Artisanal mining (AM), as defined by the World Bank, involves manual extraction using “minimal to no-technology,” typically characterized by “small-scale production” and the use of “basic tools” with rudimentary mining and recovery methods.

Divergently, though, in rural regions of developing nations, small-scale mining (SM or SSM), denotes the “utilization of elementary technology” for tasks such as drilling, blasting, mineral processing, and concentration, often overseen by cooperatives (International Institute for Sustainable Development [IISD], 2023; Ashman, 2014; Hentschel, Hruschka and Priester, 2003; Hilson, 2002; AngMINA, 2021). Put

together, Artisanal and Small-scale Mining (ASM) has become an immensely popular classification for a wide range of mining operations that cannot be sufficiently defined based on the variety of their activities in various regions, however, ASM has been grouped based on the financial and physical scale of their operations. Interestingly though, this group of miners now represents a crucial livelihood for over forty-four million individuals globally, with indirect dependence estimated to be 3 to 5 times greater than the direct number (Delve, 2023).

Consequently, to simply put these concepts in clear terms, artisanal miners are crude in their activities because they are “unable to afford” or “untrained to apply” the use of technology or complex tools to optimize their activities, and they may be “unregistered” with the relevant government agencies in the various locations where they operate. This is either because they are not aware of the benefits, or because they do have “impermanent locations or sites of operation”, as they migrate from place to place in search of the next mineral-rush. Hence, they are difficult to manage and could be untraceable. Divergently though, most small-scale miners may be minimally trained, partially or wholly registered with what is called the “small-scale mining leases (SSMLs)”, may have a permanent location for the number of years assigned to them on their leases, and are assigned to operate on some specific cadastral units, hence they could be easily supported, sponsored, trained, and are traceable.

### ***Magnitude of Small-scale Gold Mining in Developing Countries***

Discussions about the gold mining industry may have often revolved around large-scale operations (Hilson, Sauerwein and Owen, 2020; Okyere, Ayitey and Ajabuin, 2021), however, it's crucial to acknowledge the significant contribution of small-scale and artisanal mining, particularly in developing nations (Clifford, 2022). Unlike their industrial counterparts, small-scale gold mining activities are typically characterized by simplicity, reliance on manual labour, and community-based structures (Schindler et al., 2016; Hentschel, Hruschka and Priester, 2003).

Hence, the health, safety, environmental and social challenges associated with gold mining underscore the urgency of developing and improving sustainable and responsible small-scale gold mining practices for developing countries, especially in

nations like Nigeria and Zambia where there is an actual structure for small-scale mining that can be built upon (Eniowo, Kilambo and Meyer, 2022; Hilson, 2020). In the subsequent sections, we will explore how the formalization of the small-scale mining sector can address these challenges and optimize small-scale gold mining in developing countries.

## **Materials and Methods**

Applying a multidisciplinary approach, this study adopted a single source systematic search (4S) strategy, for its methodology which reviewed and integrated geological, environmental, social, and economic viewpoints to frame a holistic set of recommendations. A comprehensive research study was undertaken using a partisan-systematic approach, which focused on niche investigative evaluations. This study involved a meticulous examination and interpretation of sustainable mining principles extracted from research articles within a selected single repository. The reason for this selection was because there were lots of duplication when other repositories were compared, and the quality of papers, the subject of journal hosts, and the range of publication date for the subject of interest was much more fitting for this purpose of this study, with journals from the selected repository. Initially, a total of 2,518 publications were identified through a Scopus search on the key theme “min\* formalization”. The wild card (min\*) was applied for the initial search so that we do not miss any important publication related to mining, miners, mines, etcetera, in the subject of interest. Subsequently, to narrow the search results, the search was redefined to “mining formalization”, excluding the wild card, and this brought the number of publication results to 724. Furthermore, the search was narrowed down to 313 publications by limiting the search to four (4) subject areas. Then the keywords were limited to thirty-two which brought the papers to 198. Thereafter, the search strategy was focused by applying filters to limit the papers to English Language publications, which resulted in 189 papers only. Further narrowing the scope thereafter, the search strategy was focused by applying filters to specify the timeframe of interest (2013 – 2023), leaving the results at only 162 quality papers on the subject area. Finally, 28 quality articles were selected from five countries in a preferred region – these included Nigeria, Ghana, South Africa, Tanzania, & Congo (see: Figure 1).

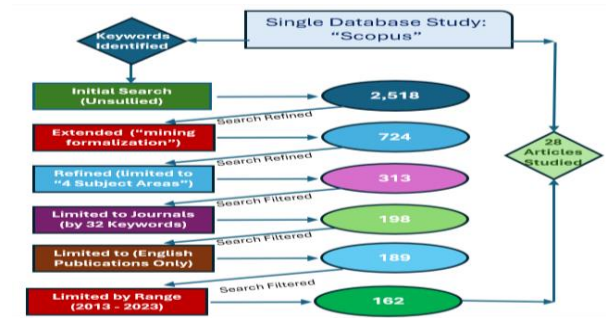


Figure 3: Search Strategy (Single Database Study)

The data analysis also utilized the "VOS viewer" software, which had one study, namely the "co-occurrence by index-keywords" analysis, standing out among others. Subsequently, the identified themes and keywords underwent a thorough examination, informing the structure of discussions and the formulation of recommendations. These recommendations were refined and enhanced based on the notable arguments, ideas, and principles encountered throughout the study.

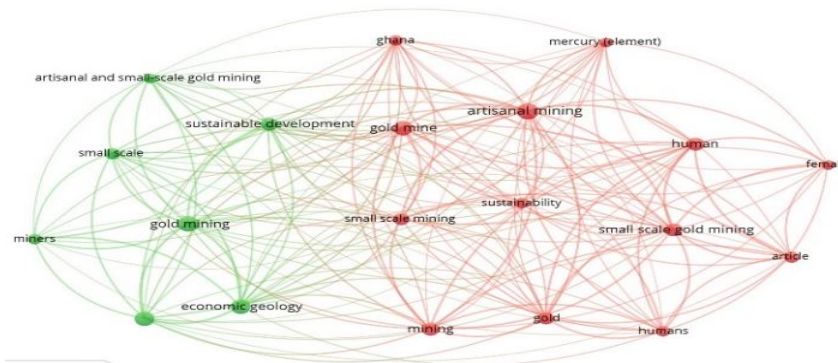
Table 2. Tabulated display of number of publications within the range of study

S/N	Year of Study	Number of Publications
01	2023	Results = 5
02	2022	Results = 5
03	2021	Results = 5
04	2020	Results = 2
05	2019	Results = 3
06	2018	Results = 4
07	2017	Results = 0
08	2016	Results = 0
09	2015	Results = 0
010	2014	Results = 2
011	2013	Results = 2

## Results

### Bibliometric Analysis

While the study initially provided an overview of the topic, including background information, clarification of the Artisanal and Small-scale Mining (ASM) distinction, and highlighting the significance of Small-scale Gold Mining (SGM) in developing nations, the statistical analysis also yielded thought-provoking insights. This analysis involved exploring and evaluating extensive scientific data, narrowing it down to a subset of articles for detailed examination (refer to Table 1). Through this process, the study delved into the intricate evolutionary dynamics of small-scale gold mining and illuminated emerging trends in sustainable mining practices. Consequently, following a refined and focused search, the data generated from co-occurrence analysis combined with index-keywords revealed a network of connections, highlighting prevalent research interests over the past decade (refer to Figure 2).



*Figure 4: Display of the network between "Co-occurrence and All-Keywords" (Unsullied).*

### "Co-occurrence" Bibliometric Analysis

A clear and resonating semantic network was observed when the analyzed graphic visualization was captured. It displayed the potential relationships between people and the major concepts represented within the papers that we studied (see Figure 2). The more captivating concepts in the semantic network or co-occurrence network were "sustainable mining, gold mining, artisanal mining, gold mine, mining, gold, mercury, human, environmental monitoring, sustainable development goal, risk assessment, hazard, Ghana, adult, male, female, etc." (see Figure 3). This gives a vivid picture of what is being discussed in relation to small-scale gold mining - when the semantic network was analysed - displaying how the buzzing keywords do

connect. Hence, figure 3 suggests that a healthy discussion about small-scale gold mining and its impact is ongoing in the academic sphere globally.

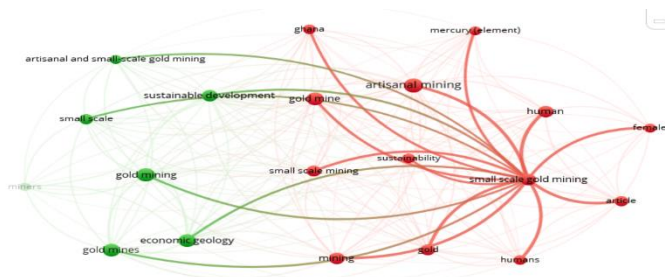


Figure 5: Display of the network between "Co-occurrence and All-Keywords" (With an emphasis on "small scale gold mining").

However, when the emphasis was placed on "gold mining", it was noticed that the co-occurrence network was focused on "sustainable development, economic geology, gold mines, miners, small scale, and artisanal and small-scale gold mining" (see Figure 4).

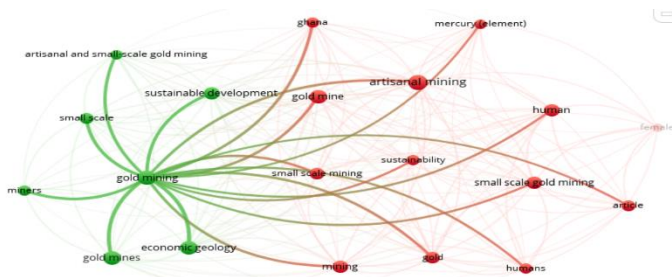


Figure 6: Display of the network between "Co-occurrence and All-Keywords" (With an emphasis on "gold mining").

## Discussion

Overall, this study reveals that the history of gold mining and formalization is marked by a complex interplay of economic, social, and environmental factors, reflecting the evolving dynamics of the global mining industry. As such a conceptualization of the principles and factors of formalization, for the sake of clarity, became necessary. This would lead to the recommendations made, based on the contextual, literature, and practice gaps observed during the research.

## Conceptualization of Formalization

Formalization of small-scale gold mining refers to the process of bringing informal or illegal gold mining activities into a regulated, legal framework. Small-scale gold mining often occurs in developing countries and involves individuals or small groups using rudimentary techniques to extract gold from the earth. Extracting highlighted concepts from the various notions in the literatures we have explored, formalization, would typically involve the integration of the following steps, which may include **“Legalization, Registration, Training and Capacity Building, Access to Finance, Health, Safety and Environmental Management, Market Access”**.

Overall, the concepts around formalization of small-scale gold mining seeks to balance the economic opportunities provided by mining with the need to protect the environment, promote social responsibility, and ensure the safety and well-being of miners and their communities. These simply leads to the benefits of applying these concepts.

### **Benefits of Formalization in Small-scale Gold Mining**

Further to the concepts of formalization explored, it was observed that there are both literature and practice gaps that covers and emphasizes on the benefits of formalization. Hence, is recommended that organised small-scale gold mining should be earmarked as a matter of urgency to be exercised by communities, local governments, states (or combined authorities), and national governments where these activities are happening. It is further recommended that they should seek for tailored ways to formalize the small-scale gold mining activities in their localities as these would improve impact of these activities, in several ways such as having a **regulatory framework, access to training and education, enforcement and oversight, investment in infrastructure, access to healthcare services, reduced exposure to hazardous substances, and community development**.

Expanding on these outlined benefits, it can be explicated that formalization of small-scale gold mining would significantly improve health and safety outcomes for miners and their communities in these following ways:

Table 3: Benefits of formalization of small-scale gold mining

Themes	Features
<b>Regulatory Framework</b>	Formalization would establish clear regulations and standards for health and safety in mining operations. This includes requirements for personal protective equipment (PPE), ventilation, sanitation facilities, and emergency response protocols (Salas-Urviola, Calsina-Paricahua and Vilca-Salas, 2021). Miners are more likely to comply with these regulations when they operate within a formalized framework.
<b>Access to Training and Education</b>	Formalization efforts should include training programs aimed at improving miners' knowledge of safe mining practices, hazard identification, and emergency response procedures (do Nascimento and Silva, 2020). Training can help miners understand the risks associated with their work and empower them to take steps to protect themselves and their colleagues.
<b>Enforcement and Oversight</b>	Formalization enables government authorities to monitor mining activities more effectively and enforce health and safety regulations. As such, inspections, audits, and penalties for non-compliance can help deter unsafe practices and hold operators accountable for maintaining safe working conditions.
<b>Investment in Infrastructure</b>	Formalization may involve investments in infrastructure such as safer mine entrances, improved ventilation systems, and better access roads (Bansah, 2023). These improvements can reduce the risk of accidents and facilitate emergency response efforts when incidents occur.
<b>Access to Healthcare Services</b>	Formalization can lead to improved access to healthcare services for miners and their families. Governments and other stakeholders may establish healthcare facilities or mobile clinics near mining areas, providing miners with access to medical care, vaccinations, and health education.
<b>Reduced Exposure to Hazardous Substances</b>	Formalization efforts ought to include measures to reduce miners' exposure to hazardous substances such as mercury and cyanide. Such efforts when implemented in small-scale gold mining are significant (Munir, 2023). Regulating such efforts would require the use of safer alternatives or the implementation of technologies to minimize environmental contamination and protect miners' health.
<b>Community Development</b>	Formalization initiatives should include provisions for community development projects aimed at improving living conditions, access to clean water, sanitation, and healthcare infrastructure in mining areas (Munir, 2023; Fritz et al., 2014; Salas-Urviola, Calsina-Paricahua and Vilca-Salas, 2021; Bansah, 2023). These improvements contribute to overall health and well-being, reducing the burden of disease on miners and their families.

Ultimately, if these aspects of formalization are addressed, then the benefits can be appreciated as it can transform small-scale gold mining from a hazardous and informal activity into a safer and more sustainable livelihood for miners and their communities.

## **Conclusions**

This call for Optimizing the Principles of Formalization has been initiated, obviously because, in recent decades there have been a growing recognition of the importance of small-scale and artisanal mining in many developing countries. Governments, international organizations, and NGOs have implemented formalization initiatives aimed at registration of the ASM actors, however, it should be aimed at improving the livelihoods of small-scale miners, promoting environmental sustainability, and addressing health and safety concerns. That's why, despite progress in formalization efforts, challenges remain, including limited enforcement capacity, corruption, and the complexity of formalization processes. However, if the principles of formalization can be optimised, it would also present opportunities for small-scale miners to access legal markets, improve their working conditions, and contribute to sustainable development, as recommended.

In conclusion, promoting formalised sustainable small-scale gold mining would require a holistic and inclusive approach that would address environmental, social, and economic dimensions of its impacts, and would encompass alliance among diverse stakeholders, in such a way that would prioritize the well-being of local communities and mining ecologies.

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