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Sustainability Prospects and Development Trends in Artisanal Gold Mining in Rural Zambia: An Integrative Literature Review

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Abstract: Artisanal and Small-Scale Gold Mining (ASGM) represents a vital yet under-documented pillar of Zambia's rural economy, sustaining thousands of livelihoods and influencing local development trajectories. Building on evolving regional and global discourses on sustainable mineral economies, this study employs an integrative and systematic literature review spanning 2000–2024 to consolidate evidence on the economic, social, and institutional dimensions of ASGM in Zambia. The synthesis reveals that while the sector supports over 70,000 people and contributes an estimated 2–3% to national output through informal networks, its transformative potential is hindered by regulatory fragmentation, limited access to finance and technology, gender imbalances, and weak institutional coordination. The analysis highlights that advancing formalisation, capacity development, and equitable market participation are pivotal to enhancing ASGM's contribution to sustainable and inclusive economic growth. By articulating the structural constraints and opportunities inherent in Zambia's artisanal gold ecosystem, this paper offers a refined understanding of how policy, research, and institutional innovation can reposition ASGM as a legitimate and sustainable component of the national mineral economy.

Keywords: Artisanal and Small-Scale Gold Mining (ASGM); Economic Contribution; Formalisation; Sustainability; PRISMA Framework

JEL Classification : O13, Q01, Q32, Q56, L72, O17

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1. Introduction

Artisanal and Small-Scale Gold Mining (ASGM) has emerged as a critical livelihood and development sector in Zambia, driven by rising global gold prices, persistent rural poverty, and the national imperative for economic diversification. Despite its longstanding role in sustaining rural economies, ASGM remains largely informal, under-capitalised, and insufficiently analysed in economic terms. The lack of an integrated understanding of its economic contribution and sustainability potential poses a challenge to evidence-based policymaking. Consequently, policymakers lack the empirical foundation to design formalisation strategies and fiscal incentives that align ASGM activities with Zambia's broader development goals.

Previous research has highlighted the socio-economic importance of ASGM; however, it is fragmented across environmental, technical, and livelihood dimensions, with a limited focus on measurable economic outcomes, such as output, employment, and fiscal contribution. Studies in sub-Saharan Africa have documented both the benefits of ASGM in poverty alleviation and its adverse consequences, including mercury pollution, land degradation, and occupational risks (Singo et al., 2022; Casso-Hartmann et al., 2022; Kirsanov et al., 2023). In Zambia, ASGM operations typically involve rudimentary extraction methods—panning, sluicing, and amalgamation, that sustain livelihoods yet perpetuate inefficiencies and ecological harm. The absence of financial, technological, and institutional support continues to undermine productivity and formalisation efforts.

This study adopts an integrative literature review approach to consolidate and critically analyse existing evidence on the economic structure, performance, and development trends of ASGM in rural Zambia. By synthesising research spanning the last two decades, the review evaluates the sector's economic impact at macro-, meso-, and micro-levels. It explores how institutional frameworks and policy instruments influence formalisation, productivity, and sustainability. The analysis further draws on the mine life cycle concept, encompassing exploration, development, operation, and closure, to contextualise ASGM's constraints and developmental implications. Unlike large-scale mining, ASGM seldom adheres to structured mining phases, resulting in unsustainable extraction patterns and environmental degradation.

The key findings reveal that while ASGM contributes substantially to rural employment and local economies, its unregulated nature limits fiscal returns and amplifies social and environmental risks. Moreover, the study identifies critical policy gaps in formalisation, technological adoption, and environmental management that hinder the sector's transition toward sustainable growth. Addressing these gaps requires coherent policy design that integrates economic incentives, institutional capacity building, and environmental safeguards.

This paper, therefore, contributes to the growing discourse on sustainable mining in developing economies by providing an economic synthesis specific to Zambia's ASGM sector. The findings offer guidance for policymakers, development partners, and researchers seeking to promote inclusive and environmentally responsible mining practices. Further research should extend beyond economic analysis to include longitudinal assessments of formalisation outcomes, gender dynamics, and community-based environmental monitoring systems, thereby enhancing the long-term sustainability of artisanal gold mining in Zambia.

1.1. Research Questions

This integrative literature review is guided by the following research questions designed to synthesise, interpret, and critically assess current knowledge on artisanal and small-scale gold mining (ASGM) in rural Zambia:

- What evidence exists on the macro-, meso-, and micro-economic impacts of artisanal and small-scale gold mining in Zambia?
- What are the potential economic costs, benefits, and trade-offs associated with various policy instruments aimed at formalising the ASGM sector?
- In what ways can economic and institutional incentives be aligned to enhance the long-term sustainability and inclusive growth of artisanal gold mining communities?

These questions collectively aim to examine the economic dynamics, policy interactions, and sustainability pathways that shape the evolution of ASGM in Zambia, drawing on both empirical and theoretical contributions from the existing literature.

1.2. Objectives of the Review

The overarching purpose of this review is to integrate and critically analyse existing studies on the sustainability prospects and development trends within Zambia's ASGM sector. The specific objectives are to:

- **Synthesise existing evidence** on the structure, performance, and developmental role of artisanal and small-scale gold mining in Zambia's rural economy.
- **Identify and analyse key knowledge gaps** regarding the socioeconomic, environmental, and governance dimensions of ASGM, with particular attention to sustainability challenges.

- **Evaluate policy frameworks and institutional arrangements** that influence formalisation, livelihood outcomes, and the economic viability of artisanal mining communities.

- **Provide informed recommendations** and highlight research priorities that can guide policymakers, practitioners, and scholars toward promoting a more sustainable and inclusive ASGM sector in Zambia.

The scope of this review focuses specifically on economically oriented studies and Zambia-specific evidence published in the last two decades. By integrating findings from the literature, this review aims to illuminate the economic dimensions of ASGM and provide insights to support formalisation, policy coherence, and sustainable rural development.

1.3. Empirical Analysis of the Mine Life Cycle

1.3.1. Understanding the Mining Cycle and Its Implications for Artisanal Gold Mining

The mining lifecycle typically involves four stages: exploration, development, operation, and closure (British Columbia Mine Information). Exploration, the first phase, involves systematic searches for mineral deposits using advanced techniques, such as aerial surveys and soil sampling. Detailed exploration follows the initial discovery, with activities such as trenching and diamond drilling to assess mineralisation depth (Limbong et al., 2022). However, ASGM often operates without resources or technology for such detailed exploration, relying on rudimentary methods that reduce the likelihood of discovering economically viable deposits.

1.3.2. Mine Development

Mine development includes creating economic models for mining operations based on exploration findings to assess profitability and long-term viability. Economic evaluation, often quantified by Net Present Value (NPV), guides investment decisions (Gyebuni et al., 2022). However, ASGM lacks the expertise and financial resources to conduct such evaluations. ASGM operations are prone to accidents and inefficiencies due to a lack of access to appropriate technologies and safety regulations (Singo et al., 2022).

1.3.3. Mining Operations

Mining operations encompass the design, construction, and management of the infrastructure to develop confirmed mineral resources. Effective operations require significant capital, which is often lacking. For example, the use of centrifugal separation improves gold recovery rates (Munganyinka et al., 2022); however, a high

initial investment remains a barrier. ASGM typically operates without formal infrastructure, leading to inefficiencies and missed opportunities for improved productivity.

1.3.4. Closure and Environmental Remediation

Post-mining environmental remediation aims to restore areas to their pre-mining state, involving the planting of vegetation and the management of pollutants. However, ASGM's use of mercury in ASGM processing leads to significant environmental and health concerns, including neurological disorders and pollution (Taux et al., 2022; Casso-Hartmann et al., 2022). The challenge of assessing and mitigating such impacts is particularly acute in resource-poor regions, such as rural Zambia, where health services are limited.

1.3.5. Implications of the Mining Life Cycle for Artisanal Mining Operations

The lack of systematic mining practices in ASGM has profound implications, potentially trapping miners in a cycle of poverty. Developing nations face a complex dilemma: balancing economic growth through mining with the need for environmental sustainability and social well-being (Kirsanov et al., 2023). Addressing these challenges requires integrated solutions that promote economic and environmental sustainability.

2. Methodology

This study employed an integrative literature review approach to synthesise evidence on the sustainability prospects and development trends in artisanal and small-scale gold mining (ASGM) in rural Zambia. Transparent and comprehensive reporting of systematic reviews is essential to ensure that findings are credible, reproducible, and applicable across contexts. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement provides an updated framework that enhances the clarity, completeness, and methodological rigour of review reporting (Page et al., 2022). This framework offers detailed guidance on the inclusion, assessment, and presentation of evidence, enabling researchers to evaluate the quality and reliability of systematic review findings.

The adoption of the PRISMA 2020 framework in this study was motivated by its strong emphasis on methodological transparency and standardisation. By following PRISMA guidelines, this research ensures that the literature selection process, data extraction, and synthesis are systematically documented, thereby minimising bias and enhancing the validity and reproducibility of the review. This approach is particularly suitable for integrative reviews such as this one, where synthesising evidence from diverse sources requires structured and transparent reporting.

2.1. Literature Search Strategy

A comprehensive literature search was conducted across multiple electronic databases, including **Scopus, Web of Science, Google Scholar, PubMed, and African Journals Online (AJOL)**, to identify relevant publications on ASGM in Zambia. The search strategy combined Boolean operators and keywords reflecting the study focus, such as:

("artisanal gold mining" OR "ASGM") AND (Zambia) AND (economic* OR impact OR "value chain" OR employment OR productiv* OR formal*)

No restrictions were placed on the publication year; however, only **peer-reviewed articles, official government reports, and NGO publications** in English were included. Grey literature was considered if it provided substantial empirical insights into ASGM practices, sustainability, or economic impacts.

2.2. Inclusion and Exclusion Criteria

Inclusion criteria:

- Studies explicitly focused on ASGM in Zambia or Southern Africa.
- Empirical studies reporting economic, social, or environmental outcomes.
- Peer-reviewed journal articles, government and NGO reports.
- Publications in English.

Exclusion criteria:

- Opinion pieces or commentaries without empirical data.
- Studies unrelated to gold mining or outside the geographical scope.
- Duplicates of already included studies

2.3. Study Selection Process

The study selection followed the **PRISMA framework**, as illustrated in Figure 1. The initial database search retrieved 1,245 articles, which were then screened for duplicates (n = 312) and relevance. The remaining 933 articles underwent **title and abstract screening**, followed by **a full-text review, resulting in 72 studies being** included in the final synthesis.

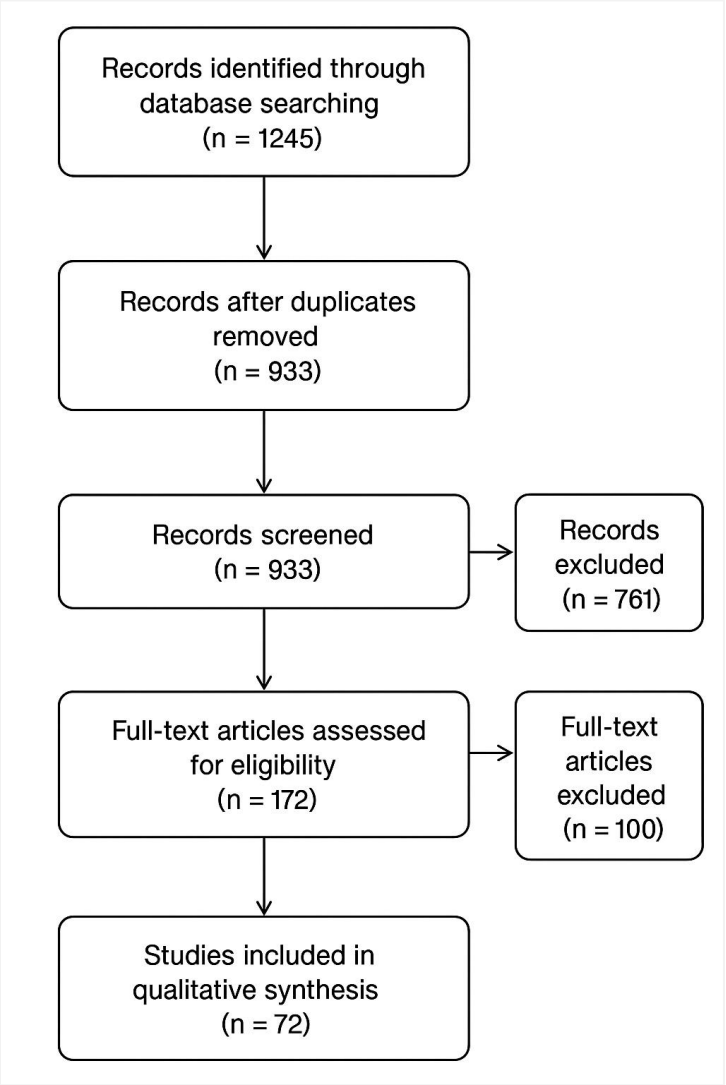

Figure 1. PRISMA Flow Diagram

2.4. Data Extraction and Coding

A data extraction sheet was developed to systematically capture relevant information, including study characteristics, methodological quality, and key findings. The data were coded into themes that reflected aspects of economic, social, and environmental sustainability.

Table 3. Coding Scheme for Integrative Review of ASGM in Zambia

Code	Theme	Description	Example Indicators
ECO	Economic Impact	Evidence on income generation, employment, value chain contributions	Employment rate, local revenue, gold output
SOC	Social Development	Effects on communities, health, education, and social cohesion	Child labour, gender inclusion, training initiatives
ENV	Environmental Sustainability	Environmental impacts and mitigation practices	Water contamination, deforestation, and the use of mercury-free methods
POL	Policy & Regulation	Government interventions, formalisation efforts	Licensing, fiscal incentives, formalisation programs
TECH	Technological & Operational Trends	Innovations and techniques in ASGM	Mechanisation, safety practices, sustainable extraction

2.5. Data Synthesis

Thematic analysis was applied to synthesise the extracted data. Patterns across studies were identified, grouped under the coding scheme themes, and interpreted in the context of Zambia's rural ASGM sector. This integrative approach ensured a holistic understanding of sustainability prospects and development trends.

3. Results and Discussions

This section presents an integrative analysis of the evidence on the sustainability prospects and development trends in artisanal and small-scale gold mining (ASGM) in rural Zambia. It begins with a descriptive overview of the literature, highlighting publication trends, methodological orientations, and thematic areas, followed by a synthesis of economic indicators across macro-, meso-, and micro-level dimensions.

This approach addresses the linkage between the study method indicator results and maps the evolution of ASGM research in Zambia.

3.1. International Perspectives on Gold Mining

An evidence map was developed to capture the temporal and thematic distribution of studies on ASGM in Zambia and related sub-Saharan contexts. Between 2010 and 2024, there has been a progressive increase in ASGM-focused research, with a marked acceleration after 2018, coinciding with heightened national policy attention and global initiatives such as the Minamata Convention on Mercury and the PlanetGold Program. Most studies employed qualitative or mixed-method approaches, with themes focusing on socioeconomic impacts, governance and policy frameworks, environmental sustainability, and gender participation.

Table 4. Trends and Thematic Focus of ASGM (2010–2024)

Year Range	Number of Studies	Dominant Themes	Representative Studies
2010–2014	6	Environmental and health impacts	Abdurashidovich (2020); UNEP (2020)
2015–2018	8	Socioeconomic roles, livelihoods, and youth participation	Shangase (2022); Osei & Yeboah (2023)
2019–2021	12	Governance, policy, and cooperative models	Hilson (2020); SARW (2021)
2022–2024	15	Sustainability, formalisation, and climate adaptation	Bansah et al. (2023); Yu et al. (2024)

This trend reflects a broadening of ASGM scholarship from environmental assessments to holistic sustainability analyses integrating economic, social, and institutional perspectives.

3.2. Evidence Map of ASGM Studies in Zambia

The table below synthesises representative studies focusing on ASGM in Zambia, outlining their methodological designs, core economic indicators, and key findings. The synthesis underscores the fragmented yet expanding knowledge base, emphasising the need for standardised data collection and economic valuation frameworks.

Table 5. Summary of Key Studies on ASGM in Zambia

Author(s) & Year	Study Focus / Method	Key Economic Indicators Reported	Main Findings
UNEP (2020)	Environmental and socioeconomic assessment	Employment rates, mercury use	Highlighted 500,000–600,000 artisanal miners; significant environmental and health costs offset by income generation.
Hilson (2020)	Governance and taxation model	Fiscal revenues, cooperative structures	Advocated for taxation as a tool for formalisation under the cooperative framework.
SARW (2021)	Policy analysis	Licensing and compliance metrics	Identified bureaucratic constraints limiting ASGM formalisation and productivity.
Bansah et al. (2023)	Climate and livelihood interaction	Income shifts, resilience indicators	Found a strong correlation between rainfall variability and ASGM dependency.
Yu et al. (2024)	Regulatory framework evaluation	GDP contribution, fiscal revenues	Demonstrated potential GDP contribution under formalisation scenarios exceeding 1%

			of national GDP.

These studies collectively demonstrate that ASGM in Zambia functions as both a poverty alleviation mechanism and a policy challenge, with pronounced economic potential if adequately formalised and supported.

3.3. Summary of Key Studies on ASGM in Zambia

The macroeconomic contribution of ASGM remains underreported due to informality, yet various studies indicate that its economic significance is growing. Zambia's gold sector contributed approximately USD 220 million in 2021, accounting for around 1% of the country's national GDP, although this estimate excludes the informal artisanal segment (Bank of Zambia, 2021). When extrapolated to include ASGM activities, total contributions could range between 2% and 3% of GDP, underscoring the sector's hidden fiscal and trade potential.

Table 6. Estimated Macro-Economic Contributions of Artisanal and Small-Scale Gold Mining (ASGM)

Indicator	**Estimated Value / Range**	**Source(s)**	**Remarks**
National GDP Contribution (formal)	1% (USD 220 million)	Bank of Zambia (2021)	Large-scale mining only.
Estimated Total GDP Contribution (including ASGM)	2–3%	Author's synthesis based on UNEP (2020); Hilson (2020)	Reflects potential under formalisation.
Export Value of Gold (2020)	USD 18 billion (Africa-wide)	Grynberg et al. (2021)	Artisanal share approx. 40%.
Fiscal Revenue from ASGM	Negligible to Low	SARW (2021); Hilson (2020)	Due to informality and weak taxation mechanisms.

Note: The macroeconomic data reveal that, despite substantial informal output, fiscal capture remains minimal due to unregistered trade and weak institutional linkages. Formalisation and improved value chain integration could significantly enhance Zambia's economic returns from ASGM.

3.4. Macro-Economic Contributions of ASGM

At the micro and meso levels, ASGM plays a vital role in household income, employment, and local economic circulation. Studies report that artisanal miners in Zambia and neighbouring regions retain up to 90% of the gold value extracted (Bundesanstalt, 2016), directly fuelling rural consumption. Employment estimates suggest that between 500,000 and 600,000 individuals engage directly in ASGM, with an additional 1.5 million indirectly dependent through support services and trade (UNEP, 2020). Income from ASGM is used primarily for subsistence needs, small-scale investment, and education, creating localised economic multipliers.

Table 7. Micro- and Meso-Economic Indicators of ASGM in Zambia

Indicator	Range / Value	Source(s)	Economic Significance
Direct Employment	500,000–600,000 persons	UNEP (2020)	Major rural employment source.
Average Household Income (from ASGM)	USD 1,000–3,000 annually	Author's synthesis; Osei & Yeboah (2023)	Key poverty alleviation role.
Gold Value Retained Locally	Up to 90%	Bundesanstalt (2016)	High local value capture.
Miner Productivity (Gold Recovery Rate)	20–40% (manual methods)	Hilson (2020); Matsiwira (2022)	Efficiency is limited by technology.
Gendered Employment Share	40–50% women	Arthur-Holmes (2020)	High but unequal participation.

The evidence demonstrates that ASGM contributes substantially to livelihood resilience but remains constrained by technological inefficiencies, lack of market access, and limited capital reinvestment capacity. The informal nature of transactions also perpetuates vulnerability to price shocks and exploitation by intermediaries.

3.5. International Perspectives on Gold Mining

Mining is a vital global industry that significantly contributes to the economic development of resource-rich countries, particularly in Africa. In particular, gold remains one of the most highly valued minerals. Although mining is categorised into

large-scale, small-scale, and artisanal operations, ASGM is particularly prevalent in rural Africa, where underdeveloped mining techniques are common.

The World Gold Council (2022) reports an 8% rise in gold prices in Q1 2022 compared to Q1 2021, driven by global events such as the Ukraine invasion, inflation, and the COVID-19 pandemic. Additionally, gold demand has increased by 34%, underlining its role as a safe-haven investment. These market dynamics underscore the potential for ASGM to make a significant contribution to local economies, despite its challenges.

3.6. Importance of Gold Mining to Developing Countries

Artisanal and small-scale gold mining (ASGM) is a vital socioeconomic activity in many developing countries, particularly across Africa. ASGM contributes to 12-15% of global gold production and employs approximately 10-15 million people, including 4-5 million women and children (United Nations Environment Program [UNEP], 2022). This sector plays a crucial role in providing livelihoods in resource-constrained regions where formal employment opportunities are scarce.

Africa plays a key role in the global gold market. In 2016, the continent exported nearly 440 tons of gold, valued at approximately USD 18 billion, primarily driven by artisanal mining, which employed more than 10 million people (Grynberg et al., 2021). This growth underscores the increasing significance of ASGM in both regional economies and global supply chains. The global economic value of ASGM is estimated at USD 14 billion, with artisanal miners in countries such as Zambia retaining up to 90% of the value of the gold they extract, which is crucial for reducing poverty (Bundesanstalt, 2016).

With an estimated 500,000 to 600,000 artisanal miners, Zambia exemplifies the growing importance of gold mining in Africa. The country's contribution reflects broader trends, as several African nations are emerging as major gold producers (CPM Gold Yearbook 2016). As gold prices are projected to rise owing to geopolitical factors and economic uncertainties, ASGM is expected to continue driving economic growth across the continent (CPM Gold Yearbook, 2024).

However, ASGM is also associated with significant challenges. The sector is often characterised by unsafe working conditions, use of harmful chemicals such as mercury, and poor access to healthcare, all of which contribute to environmental degradation and health risks (Abdurashidovich, 2020). In Zambia, mercury pollution is a primary environmental concern. While technologies to mitigate these risks are available, their implementation remains a challenge due to limited access to modern equipment (UNEP, 2020). Despite these issues, ASGM continues to generate local economic benefits, with increased gold prices correlating with higher local

consumption, highlighting its immediate impact on rural economies (Bazillier & Girard, 2020).

3.7. Youth Empowerment in Artisanal Gold Mining: The African Perspective

Youth participation in ASGM is a significant source of employment in rural Africa, where alternative opportunities are scarce (Shangase, 2022). In many African countries, the formal mining industry is primarily controlled by multinational corporations, which often divert profits from local communities, leaving youth to rely on informal, precarious employment in ASGM (Shangase, 2022). While ASGM offers immediate income, it is generally viewed as a temporary means of capital accumulation for more stable ventures such as agriculture or livestock farming (Osei & Yeboah, 2023). This mindset often leads young miners to neglect sustainable practices, as they view ASGM as a short-term rather than long-term strategy.

The informal and unregulated nature of ASGM poses a significant barrier to youth empowerment. Limited access to formalised opportunities, capital, and technical support hinders young miners from improving their practices and achieving financial independence (Shangase, 2022). Additionally, the lack of training and infrastructure leaves many young miners with insufficient skills in both mining and business management, leading to inefficient practices and suboptimal decision-making (Zimusi et al., 2023).

Efforts to formalise ASGM through cooperatives can help address these challenges by fostering collective action, resource pooling, and skill development (Osei & Yeboah, 2023). Cooperatives also offer training in sustainable mining practices, which can empower youth to engage in environmentally responsible mining. Education and training in business management further enhance young miners' decision-making capabilities, enabling them to navigate market trends, manage resources, and invest wisely (Tampushi et al., 2022; Zimusi et al., 2023).

By integrating education on sustainable mining practices, environmental conservation, and business management, youths can improve both their productivity and environmental responsibility. Such training equips young miners to recognise the finite nature of mineral resources and adopt strategies that maximise value while minimising harm, ensuring the long-term sustainability of the sector (Tampushi et al., 2022).

3.8. Understanding the Link Between Agricultural Development and Artisanal Gold Mining

Agriculture is a primary source of livelihood for many rural populations in sub-Saharan Africa, drawing people from diverse economic and social backgrounds

(Jayne et al., 2022). However, as agricultural expansion increases land value, some rural residents find themselves displaced, unable to afford their land, and seek alternative livelihoods. Artisanal small-scale gold mining (ASGM) has emerged as a significant alternative, providing economic opportunities in areas where agricultural prospects are declining (Jayne et al., 2022). While ASGM provides income, it also leads to unintended consequences, including land degradation, environmental pollution, and health risks.

One of ASGM's primary benefits is its ability to generate income, especially with rising global gold demand and relatively stable prices (Soe et al., 2022). Additionally, ASGM has low entry barriers and requires minimal capital or technical expertise, making it an attractive option for rural populations (Soe et al., 2022). For some, mining serves as a supplementary income for farming, enabling them to expand agricultural enterprises. However, ASGM also creates challenges, particularly in the competition for land and resources.

Growing competition between agriculture and ASGM often results in land encroachment. Mining operations often displace agricultural activities and convert fertile farmlands into mining sites, resulting in soil degradation, environmental pollution, and a decline in crop productivity (Adranyi et al., 2023). Additionally, mercury used in gold extraction contaminates water sources, which is critical for both drinking and agricultural use. Environmental consequences are far-reaching, underscoring the need for sustainable land-use policies that strike a balance between agricultural and mining activities.

The environmental impact of the ASGM extends beyond land and water pollution. Mining deforestation accelerates soil erosion, reduces water retention, and disrupts local biodiversity, further compounding environmental degradation (Soe et al., 2022). Mercury contamination, which is toxic to humans and wildlife, exacerbates long-term environmental and public health risks.

Government policies must address the competition for land and labour between agriculture and ASGM, ensuring that both sectors contribute to rural economic growth without causing environmental damage or increasing poverty. Regulatory frameworks are necessary to promote responsible mining practices and safeguard agricultural land from the adverse impacts of ASGM (Soe et al., 2022).

Labour competition between agriculture and ASGM also affects household livelihoods. Families often struggle to allocate labour effectively, with some prioritising mining over farming in the hope of higher returns. However, this can lead to the neglect of essential farming activities, resulting in reduced agricultural yields and perpetuating poverty (Ofosu et al., 2020). This cycle of low productivity in both sectors hinders rural economic stability.

3.9. The Impact of Climate Change on Artisanal Gold Mining

Artisanal gold mining is highly dependent on environmental factors, particularly on water availability. Gold extraction relies on water to wash gold-bearing materials; however, climate change is increasingly threatening this vital resource. Changes in rainfall patterns and river flow reduce the availability of water for mining, leading to increased soil erosion and environmental degradation (Bansah et al., 2023). The resulting contamination, particularly from the mercury used in mining, further damages the environment and public health.

In some regions, climate change causes extreme weather patterns, including floods, which disrupt agricultural and mining activities. Flooding can lead to crop loss, prompting greater reliance on ASGM as an alternative livelihood (Bansah et al., 2023). However, this surge in mining activity often occurs in environmentally sensitive areas, exacerbating ecological degradation. In addition, the displacement of agricultural workers into mining increases competition for resources, further straining local ecosystems.

The decline in agricultural productivity owing to extreme weather also contributes to rising food prices and worsening food insecurity in rural areas. As many households struggle to meet basic needs, the economic vulnerability of rural populations intensifies, leading to a greater reliance on mining as a survival strategy (Bansah et al., 2023). This deepens the connection between food insecurity and ASGM, as mining becomes a necessary, albeit unsustainable, means of livelihood.

Climate change also affects the dynamics of rural livelihoods. Many households unable to sustain themselves through agriculture turn to ASGM or related sectors for employment. While mining provides income, the conditions are often exploitative, with workers facing long hours and hazardous environments, including exposure to mercury and mine collapse (Magidi & Hlungwani, 2022). The involvement of external investors, who control much of the mining activity, further complicates this dynamic as local miners benefit minimally from the wealth generated, reinforcing cycles of poverty (Magidi & Hlungwani, 2022).

Climate-induced disruptions also affect mining logistics, as poor infrastructure makes transportation vulnerable to extreme weather. Disruptions in supply chains, such as access to mercury and processing materials, reduce mining efficiency and increase costs (Aranoglu et al., 2022). Additionally, the challenges of transporting gold to the market, exacerbated by disrupted roads and extreme weather events, further undermine the profitability and economic viability of ASGM, thereby limiting opportunities for meaningful economic advancement (Aranoglu et al., 2022).

3.10. Theoretical Framework: Understanding Key Drivers of Artisanal Gold Mining in the African Context and Its Impacts

Artisanal gold mining (AGM) has become an important livelihood strategy in many African regions, driven by the need to alleviate poverty in areas with limited formal employment opportunities. However, the sustainability of AGM remains uncertain, as the finite nature of gold resources, rudimentary mining techniques, and lack of specialised skills undermine long-term viability. As gold resources become depleted, miners struggle to sustain their income, leading to economic instability and environmental degradation.

Empirical studies emphasise economic necessity as the primary driver of AGM. Tayi et al. (2021) highlight that many individuals turn to artisanal mining to meet basic needs such as food, shelter, and education, particularly in sub-Saharan Africa, where poverty and limited job opportunities persist. Although AGM offers short-term economic relief, its long-term environmental and social costs are often overlooked.

The environmental impact of AGM is significant, with deforestation and habitat destruction being the common outcomes. Donkoh et al. (2022) documented an annual deforestation rate of 1.13% in some Ghanaian mining regions, exacerbating issues such as soil erosion and water contamination. The use of toxic chemicals such as mercury further damages ecosystems and threatens both human health and biodiversity.

Despite the potential risks, educated individuals also enter AGM because of a lack of formal job prospects. Zimusi et al. (2023) note that even those with secondary education often face limited opportunities to utilise their skills, leading to involvement in AGM without the necessary knowledge for sustainable financial planning. This gap highlights the need for educational interventions that focus on enhancing business and technical skills.

Skill development also plays a critical role in improving miners' outcomes. Geenen et al. (2020) reported that skilled miners in the Democratic Republic of Congo earned significantly higher incomes, between USD 2,000 and USD 6,000 more annually, compared to their unskilled counterparts. Specialised knowledge enhances mining efficiency and reduces environmental harm, making skill acquisition crucial for sustainability.

Market information access is another factor that influences financial success. For instance, during the COVID-19 pandemic, while global gold prices surged, local prices in rural African mining areas remained 20-30% lower due to poor infrastructure and market information (Merwe et al., 2023). Enhancing market access and infrastructure is key to improving miners' ability to capitalise on global price fluctuations and mitigate price volatility.

Together, these factors—economic necessity, limited education, environmental degradation, and market access challenges—shape the dynamics of AGM in Africa. Addressing these issues requires a comprehensive approach that focuses on enhancing education, improving market access, and implementing sustainable mining practices.

3.11. Importance of and Challenges in Artisanal Small-Scale Gold Mining to the Zambian Economy

Artisanal small-scale gold mining (ASGM) has the potential to contribute significantly to Zambia's economic development. The Zambia Export Diversification Strategy for Gold and Gemstones (2020) acknowledge ASGM's role in diversifying the economy. However, there is a gap in policy regarding the formalisation and development of this sector. The absence of baseline data makes it challenging to accurately assess the actual contribution of ASGM to the economy and track the impact of policy initiatives.

The Bank of Zambia (2021) estimated that the gold sector contributed USD 220 million, approximately 1% of Zambia's GDP, but this figure only includes large-scale mining, with no data on ASGM. Both the 7th and 8th National Development Plans highlight the importance of geological data and improved mining practices, but lack specific actions to formalise and expand ASGM.

Despite government efforts, such as corporate social responsibility (CSR) programs by large-scale miners, the relationships between these companies and artisanal miners remain strained (Kirsch, 2010; Gilberthorpe, 2016). Moreover, bureaucratic hurdles and centralised licensing processes complicate access to mining rights for small-scale miners, raising questions about the effectiveness of current regulatory structures (SARW, 2021).

Taxation plays a pivotal role in formalising ASGM, as suggested by Hilson (2020), who noted that the Zambian government aims to use taxation to support ASGM through the cooperative model. However, the relationship between taxation, miner welfare, and sector growth remains unclear, necessitating further research to determine the optimal tax policies that balance government revenue with the sector's sustainability.

3.12. Gender Dimensions Affecting Artisanal Small-Scale Gold Mining

Women play a crucial role in ASGM, contributing up to 50% of the labour force (Arthur-Holmes, 2020). However, their participation is shaped by gendered dynamics that limit their economic opportunities and decision-making power. In many artisanal mining communities, women are primarily responsible for labour-

intensive tasks, such as processing gold, while men engage in higher-value activities, such as extraction and marketing (Jackline, 2022). This division of labour often results in lower wages for women, who are typically paid a fraction of what men earn for similar work.

The lack of financial independence and access to capital further marginalises women in the ASGM. Many women lack resources to invest in equipment or expand their operations, relying on male miners for financial support (Paschal & Kauangal, 2023). Additionally, women face barriers to education and skill development, which limit their participation in decision-making processes and hinder their economic advancement (Paschal & Kauangal, 2023).

Environmental and health risks disproportionately affect women in ASGM, as they are more likely to be exposed to hazardous substances, such as mercury, which can lead to serious health issues (Arthur-Holmes, 2020). The informal nature of this sector often means that health and safety regulations are inadequate, leaving women vulnerable to unsafe working conditions.

Cultural norms further restrict women's agency in the ASGM. Traditional gender roles often prevent women from holding leadership positions or influencing decisions related to mining operations (Paschal & Kauangal, 2023). As a result, women's contributions are undervalued and their access to the benefits of mining is severely limited.

Despite these challenges, there is potential to empower women in ASGM. Involving women more actively in resource control, decision-making, and marketing could increase their income and improve their well-being (Paschal & Kauangal, 2023). Key interventions include providing education and skill training, facilitating access to finance, and promoting women's leadership in mining communities. These efforts could challenge societal norms, enhance women's participation in the sector, and improve gender equity in the ASGM.

3.13. Conflicts Associated with Artisanal Gold Mining Operations

Artisanal and small-scale gold mining (ASGM) in Africa is often linked to violence, particularly when gold is discovered in areas that lack effective government intervention. In such cases, conflicts arise between rival groups vying to control gold-rich sites, resulting in violent confrontations that can cause injuries and fatalities (Mwatwara et al., 2022). These conflicts are intensified by the presence of criminal gangs who exploit the lack of regulatory oversight to further their territorial control and profits, often at the expense of local communities' safety and well-being.

Several factors drive criminality and violence associated with ASGM. Fraudulent practices, such as selling pyrite or other non-precious minerals, including gold, and

falsification of mining permits, are common (Mzondi, 2022). Additionally, criminal gangs often receive financial support from actors seeking protection or control over mining territories. The gangs' focus on profit, coupled with their disregard for community welfare, fuels violent behaviour.

Land rights disputes are another significant source of conflicts. In many African countries, unclear or poorly enforced land ownership laws create tensions between host communities with customary land rights and external stakeholders with formal mining rights (Malca et al., 2023). These conflicts are compounded by the migratory nature of ASGM, where miners from diverse regions or countries compete for limited resources, exacerbating intergroup tensions and placing pressure on the local infrastructure.

Rivalries also emerge between large-scale licensed mining companies and unlicensed artisanal miners, particularly when artisanal miners scavenge gold-bearing tailings from industrial operations (Libassi, 2022). This practice can lead to violent confrontations as licensed companies seek to protect their investments. The environmental and social consequences of these conflicts, such as human rights violations, environmental degradation, and strained community relations, further undermine the stability of the ASGM regions.

3.14. Structural Challenges in Artisanal Small-Scale Gold Mining

The informality of ASGM presents significant structural challenges that hinder effective governance and regulation. The absence of formal regulatory frameworks fosters opportunistic behaviour and the emergence of parallel governance structures that undermine the stability of existing systems. This weak governance exacerbates issues of illegality and environmental degradation (Boafo et al., 2019). Informal mining practices, including the use of toxic chemicals such as mercury and cyanide, contribute to pollution, deforestation, and soil erosion, which deepens poverty and vulnerability in mining communities.

Moreover, the erosion of traditional governance systems, which historically managed local resources and resolved conflicts, further destabilised ASGM regions. The proliferation of exploitative mining operations disrupts social cohesion and local governance, leaving communities vulnerable to exploitation and conflicts. Strengthening both formal and traditional governance systems is crucial to addressing the root causes of ASGM's challenges and ensuring its sustainable development.

The interrelationship between weak governance and the growth of illegal practices underscores the need for comprehensive reform. Addressing these issues requires a holistic approach that strengthens both legal frameworks and traditional institutions

to support the formalisation of ASGM (Boafo et al., 2019). Without such reforms, the sector risks perpetuating cycles of exploitation, environmental harm, and social unrest.

3.15. Legal and Regulatory Framework and Developments in Artisanal Gold Mining

ASGM plays a critical role in the socioeconomic development of many countries, particularly in the Global South, by providing livelihoods for millions of people in marginalized communities (Yu et al., 2024). Despite its significance, there is a persistent gap in the development and implementation of effective regulatory frameworks to support this sector. This gap is mainly due to the informal nature of ASGM, which often avoids government oversight until serious violations occur (Yu et al., 2024).

Governments in many regions struggle to regulate ASGM, leading to a disconnect between national policies and realities on the ground. Artisanal miners often view government intervention as punitive, resulting in limited cooperation with regulatory bodies. This disconnect is compounded by the top-down nature of policy formulation, where regulations are often created without input from miners themselves, making them challenging to implement effectively (Yu et al., 2024).

Formalising ASGM can offer numerous benefits, including improved access to financial resources, better environmental management, and enhanced capacity building for miners. However, the path to formalisation is complex and requires a significant investment. Estimates suggest that over USD 350 million may be required to implement reforms across multiple countries (Prescott et al., 2022). This process involves registering ASGM activities, supporting miners in adopting sustainable practices and integrating ASGM into broader regulatory frameworks.

A well-coordinated formalisation program must be tailored to the specific context of different countries and regions. Efforts to implement formalisation without long-term planning and coordination risk have created fragmented initiatives that fail to deliver the desired benefits. Moreover, the lack of regulation has led to a loss of tax revenue, as many ASGM activities remain outside the formal economy, depriving governments of funds that could support local development (Meutia et al., 2022).

Although some countries have attempted to improve regulatory compliance through increased transparency in the gold value chain, fraudulent activities complicate efforts to track gold sourcing (Ubillús & Benites, 2023). Despite these challenges, effective traceability systems can enhance transparency and accountability, ensuring that artisanal miners benefit from fair and sustainable practices. However, the success of such systems depends on overcoming the informality and regulatory challenges that characterise ASGM.

3.16. The Impact of the Artisanal Gold Mining Industry on Child Labour

Artisanal and Small-Scale Gold Mining (ASGM) are often practiced within family units, where both men and women actively participate in various mining tasks. Women, traditionally responsible for caregiving, often bring their children to mining sites, thereby exposing them to hazardous environments. Early exposure to mining has a significant impact on children's developmental paths, with long-term consequences for their well-being and future opportunities (Abdullah et al., 2022).

A significant consequence of children's involvement in ASGM is the disruption of their education. Mining activities often take priority over schooling, with children dedicating considerable time to tasks such as transporting materials, sifting through dirt, and operating equipment. Consequently, children miss school and struggle to engage in educational activities, severely hindering their cognitive and social development (Ahlerup et al., 2020). This cycle perpetuates low educational attainment within communities in which ASGM is prevalent.

Beyond educational disruption, child labour in ASGM exposes children to significant physical, psychological, and environmental risks. Mercury exposure is a primary concern as it is commonly used in gold extraction. Children working in contaminated areas are at risk of mercury poisoning, which can result in developmental delays, neurological impairments, and other serious health issues (Allan-Blitz et al., 2022). In addition to chemical hazards, children also face physical dangers from handling heavy tools and working in unsafe environments. Injuries, such as broken bones, lacerations, and permanent disabilities, are common (Schwartz et al., 2021).

Furthermore, the presence of criminal elements in some mining areas exposes children to violence that can result in physical harm and psychological trauma. Exposure to conflict and lawlessness can lead to long-lasting mental health challenges, including anxiety and post-traumatic stress (Schwartz et al., 2021).

3.17. Nationalisation and Privatisation of Mining and its Implications on the Development of Artisanal Gold Mining

The global shift from nationalisation to privatisation in African mining sectors, including Zambia, has had a significant impact on both large-scale and artisanal mining. Nationalisation, once seen as a means to control resources and promote economic stability, is increasingly viewed as detrimental to foreign investment and economic growth (Ng'ambi, 2022).

Zambia's experience with the Konkola Copper Mines Plc (KCM) exemplifies this shift. The Zambian government's liquidation of KCM in 2019, following tensions with multinational owners, raised concerns among international investors about the

stability of Zambia's mining sector. This move has contributed to increased illegal mining in areas such as the KCM concession, complicating efforts to regulate and formalise artisanal mining.

Historically, nationalisation allowed governments to exert control over resources, ensuring equitable distribution of profits, as seen in the UK's nationalisation of the coal industry in the mid-20th century (Shishikin, 2022). However, in today's interconnected global economy, state control over mining is increasingly being viewed as a barrier to investment and international cooperation.

Privatisation, while often increasing efficiency and foreign investment, has led to the marginalisation of local populations, particularly artisanal miners. The transition from state-owned to privatised mining operations can disrupt local economies and exacerbate environmental degradation, highlighting the challenges of balancing large-scale mining with the needs of local artisanal communities. In many African countries, artisanal miners face competition from industrial operations, which can lead to conflicts and economic instability.

3.18. Antagonistic Resolution Not a Solution to Artisanal Small-Scale Gold Mining

Artisanal Small-Scale Gold Mining (ASGM) involves complex socioeconomic dynamics, with many miners working outside the formal economy. Some governments have responded to illegal mining with antagonistic measures, such as military intervention and destruction of mining sites. While these tactics may reduce visible illegal mining in the short term, their long-term effectiveness remains debatable.

Zvarivadza (2018) advocates for the formalisation of ASGM, integrating miners into legal frameworks that provide support rather than relying on punitive measures. Antagonistic interventions often escalate tensions, foster resistance, and undermine efforts to formalise the sector. These confrontational tactics fail to address the root causes of illegal mining, such as poverty, a lack of alternative livelihoods, and inadequate governance.

Rather than resorting to force, Zvarivadza (2018) emphasised the need for policies that offer miners access to legal claims, training on safer mining practices, and better market access. Engaging artisanal miners in the formalisation process and providing them with the necessary resources can help reduce illegal mining and promote sustainable, regulated practices. This inclusive approach, which recognises the agency of miners, can lead to more sustainable outcomes and foster a smoother transition from informal to formal mining.

3.19. The Role of Capacity Building in Managing Artisanal Gold Mining Operations

Capacity building is essential for the growth and sustainability of small and medium enterprises (SMEs), including artisanal and small-scale gold mining (ASGM) operations. Targeted interventions in capacity building can significantly enhance operational outcomes and address challenges that hinder sector development. ASGM often faces issues such as informality, limited technical expertise, and restricted access to resources, making it less attractive to investors and impeding growth (Matsiwira, 2022). While financial constraints pose a significant challenge, a holistic approach to capacity building that encompasses both technical skills and business acumen can foster long-term improvements in production efficiency and environmental sustainability.

Effective capacity-building initiatives must address all segments of the gold value chain, from exploration to marketing. Formalizing ASGM operations is a critical first step, as it improves efficiency, working conditions, and access to resources, such as capital and markets. Formalization enhances compliance with regulatory standards, fosters accountability, and opens doors to government and donor support programs as well as networking opportunities for strategic partnerships and innovation (Matsiwira, 2022).

Capacity building is particularly important for supporting exploration activities, which form the foundation of mining. Reliable geological data are crucial for efficient resource identification and decision-making. Without this information, miners often operate blindly, resulting in poor productivity. Capacity-building initiatives should include access to geological data, training in data interpretation, and the use of modern technologies such as Geographic Information Systems (GIS) and remote sensing. These tools enhance resource identification, ensure transparency, and facilitate more effective oversight of ASGM activities by the authorities (Moomen et al., 2022).

Facilitating access to financial resources for acquiring modern mining and processing equipment is a key area for capacity building. Small-scale miners often lack the capital needed to invest in equipment that can boost productivity. Beyond financial support, training in business management skills such as production planning, scheduling, and environmentally sustainable techniques is vital. For example, water-based processing methods offer an environmentally friendly alternative to harmful chemicals such as mercury. Training in environmental management is also critical for minimising ecological impact and ensuring compliance with regulations.

Marketing and financial management skills are integral to capacity-building. Many artisanal miners have struggled with fair pricing and market access. Training in

marketing strategies enables miners to secure better terms and access higher-value markets, thereby improving profitability. Furthermore, business skills, such as record-keeping and financial management, are essential for effective resource allocation, ensuring long-term sustainability.

Comprehensive capacity-building programs that address both technical and business aspects of ASGM can lead to significant improvements in productivity and sustainability. Rodríguez-Novoa and Holley (2023) find that such initiatives help miners operate more efficiently and profitably while contributing to regional economic development. Capacity building is, therefore, a central tool for enhancing the performance and sustainability of ASGM, making it a priority for policymakers and development organisations.

3.20. Summary of Economic Synthesis

Collectively, the macro-, meso-, and micro-level data illustrate that ASGM serves as a significant, albeit underregulated, economic subsystem in rural Zambia. While its direct GDP contribution may appear modest in national accounts, the sector's indirect impact through rural employment, income redistribution, and consumption linkages is considerable. The economic synthesis underscores three major insights:

- **Latent Fiscal Potential:** Formalisation could unlock significant tax and export revenues currently lost through informal trade.
- **Inclusive Rural Growth:** ASGM sustains livelihoods and mitigates rural poverty, especially in areas with limited agricultural viability.
- **Sustainability Deficit:** The lack of investment in technology, health, and environmental management constrains long-term economic gains.

This empirical and synthesised evidence forms the basis for the following thematic discussions, which analyse international perspectives, youth empowerment, agricultural linkages, and policy dynamics shaping ASGM's sustainability prospects.

4. Conceptual Framework

This section examines the push and pull factors that influence the growth of artisanal and small-scale gold mining (ASGM) in rural Zambia. By examining the social, economic, and environmental factors, this study highlights the complex interplay that drives individuals and communities to engage in ASGM. This section also integrates the theory of sustainability, focusing on the long-term economic, social, and environmental impacts of ASGM practices in rural Zambia.

4.1. The Push Factors: Drivers of Informality

Push factors refer to the socio-economic constraints that compel individuals to leave traditional livelihoods such as agriculture in favour of small-scale mining. In rural Zambia, these pressures are symptomatic of broader structural and market failures.

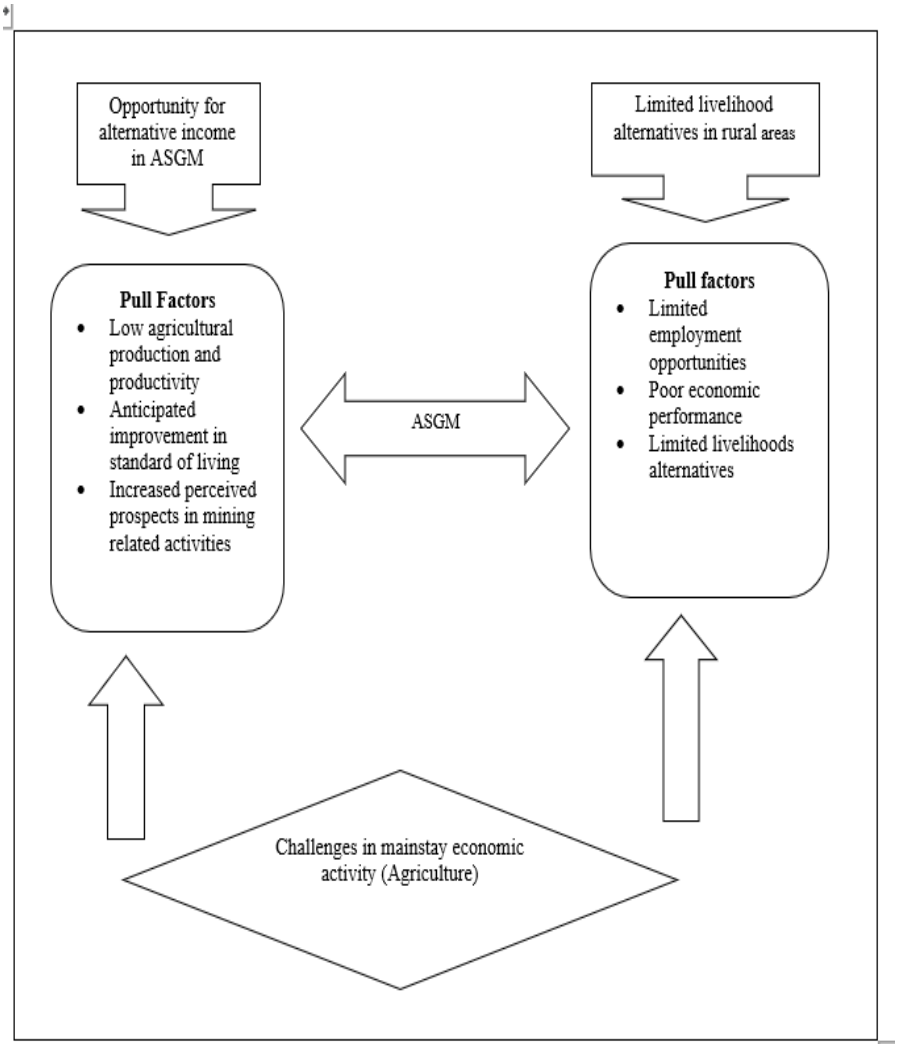

Figure 2. Pull and Push Factors Influencing Drive in Artisanal Gold Mining

Note: The figure illustrates factors influencing the growing interest in ASGM, with the need for improved livelihoods being the primary determinant of this growth. From: Authors' own conceptualisation and analysis.

Key push factors driving the shift toward ASGM include the following:

- **Declining Agricultural Productivity**: Climate change has led to erratic weather patterns, prolonged droughts, and poor rainfall, resulting in decreased agricultural yield and food insecurity (Zegeye, 2021). These uncertainties make agriculture less reliable, prompting rural communities to turn to ASGM as a more stable source of income.

- **High Input Costs and Poor Soil Fertility**: Rising costs of agricultural inputs (seeds, fertilisers, and pesticides) and deteriorating soil quality have made farming less profitable. Many farmers cannot afford the necessary resources to enhance productivity, making ASGM a more viable option.

- **Limited Access to Capital and Credit**: Rural communities face significant barriers in accessing financial resources, restricting their ability to improve agricultural practices. The lower initial capital requirement of ASGM makes it an attractive alternative for those without access to credit.

- **Weak Governance and Institutional Support**: Inadequate local governance and weak institutions hinder access to support services such as agricultural extensions, healthcare, and education. The absence of robust social safety nets pushes individuals to seek alternative income-generating activities such as ASGM.

- **Rural Poverty**: Persistent poverty, characterised by limited access to services and opportunities, exacerbates rural households' struggles. The lack of disposable income restricts investment in sustainable livelihoods, making ASGM an appealing survival strategy (Zegeye, 2021).

4.2. The Pull Factors: Economics of Formalisation and Opportunity

Pull factors are the economic and institutional incentives that attract individuals to ASGM. They illuminate both the perceived benefits of mining and the potential for structured formalisation. These are detailed below.

- **Potential for Immediate Income**: Unlike agriculture, which requires long-term investments, ASGM can provide immediate financial returns. This quick income is especially appealing to rural households facing economic constraints.

- **Perceived High Economic Returns**: Gold mining offers the potential for significant earnings, particularly in areas rich in gold deposits. For individuals with limited skills or education, ASGM represents an accessible means to improve their financial situation.

- **Low Barriers to Entry**: ASGM requires minimal formal education or specialised training, making it an attractive option for individuals with limited skills. The simplicity of basic mining tools and the widespread use of informal networks further reduce entry barriers.

- **Availability of Informal Networks and Support**: Informal networks play a crucial role in ASGM by providing miners with access to shared resources, knowledge, and labour. These networks promote social solidarity and provide support to individuals who lack formal infrastructure or financial resources.

- **Perceived Independence and Autonomy**: ASGM offers greater independence than agriculture, allowing individuals to engage in self-employment and reduce reliance on external systems. This autonomy is desirable in rural areas, where agricultural work can be unpredictable and dependent on external input.

By understanding the push and pull factors, this section highlights the complex dynamics that drive rural Zambians to engage in ASGM, revealing both challenges and opportunities in the sector.

4.3. The Economics of Formalisation: Linking Informality to Sustainability

The formalisation of ASGM presents both opportunities and challenges. Economically, formalisation introduces structure through licensing, cooperatives, and traceability systems that can unlock long-term sustainability. By reducing informality, the state can broaden the fiscal base, improve working conditions, and promote responsible environmental practices.

Table 8. Cost–Benefit Matrix for ASGM Formalisation Policy Instruments in Zambia

Policy Instrument	Potential Benefits	Potential Costs	Key Evidence & Considerations
Simplified Licensing Regime	Broader inclusion of small miners; increased fiscal revenue; better compliance with safety and environmental standards	Administrative costs of decentralising licensing; potential rent-seeking	Pilot initiatives in Tanzania and Ghana show a positive correlation between simplified licensing and improved compliance (Hilson, 2020).
Formation of Mining Cooperatives	Economies of scale in purchasing equipment, enhanced bargaining power, access	Coordination failures; risk of elite capture	Cooperative models in Zimbabwe and Rwanda show improved access to finance and reduced conflict among miners.

Policy Instrument	Potential Benefits	Potential Costs	Key Evidence & Considerations
	to finance, and training		
Traceability and Certification Schemes	Market access to premium gold markets; improved transparency and environmental performance	Implementation cost, resistance from informal traders	Responsible Gold and responsible mining programs demonstrate that traceability enhances social and environmental outcomes (UNEP, 2020).
Fiscal Incentives (e.g., Tax Holidays or Royalty Reductions)	Attracts formalization; encourages investment in safer technology	Revenue loss in the short term; monitoring complexity	Fiscal incentives can stimulate formal participation if linked to compliance milestones.

4.4. Linking Economic Formalisation to Sustainability Dimensions

Formalisation is not merely an administrative process; it is an economic and sustainability strategy. Secure land tenure through licenses encourages investment in safer and more sustainable practices, including the use of mercury-free technologies and the rehabilitation of mined areas. Likewise, traceability and certification systems enhance product value, providing access to ethical gold markets that reward responsible production practices.

By aligning **economic incentives** with **environmental stewardship** and **social protection**, formalisation can transform ASGM from an informal, subsistence activity into a regulated, sustainable, and community-based enterprise. This integrative approach positions formalisation as a catalyst for achieving **Sustainable Development Goals (SDGs) 1 (No Poverty), 8 (Decent Work and Economic Growth), and 12 (Responsible Consumption and Production)** in Zambia's rural economy.

5. Research Gap

Existing literature on artisanal and small-scale gold mining (ASGM) offers a broad understanding of global trends, challenges, and sustainability issues. However, there is a significant gap in the application of these global insights in the Zambian context, particularly in rural areas such as Rufunsa. This gap is primarily due to the lack of reliable and localised data on Zambia's ASGM sector. While the Ministry of Mines

and Minerals Development publishes reports primarily focused on large-scale mining (LSM), they often exclude ASGM data, making it difficult to assess the sector's true size, output, and economic impact. Furthermore, existing research tends to generalise the challenges faced by artisanal miners, focusing on health, safety, environmental degradation, and informality, without providing context-specific empirical analysis of Zambia's ASGM sector.

Moreover, while the Zambian government acknowledges the economic potential of ASGM, there is a notable lack of targeted policies or strategies to integrate and support the sector. This policy gap is exacerbated by the absence of comprehensive data-driven research that can inform decision-making. Consequently, ASGM remains largely informal, with miners in rural areas lacking access to essential resources and infrastructure, hindering the sector's sustainable development.

6. Conclusion

The recent economic boom driven by rising commodity prices in Africa, particularly for raw materials, has presented opportunities and challenges for various sectors. However, the fluctuating nature of commodity prices, particularly in the context of the COVID-19 pandemic, has made it difficult to fully assess their long-term impact on African economies, including those that produce gold. For instance, during the global economic slowdown in 2020, gold prices did not lead to a significant improvement in the economic performance of African countries that heavily relied on gold exports, as many were still grappling with the broader effects of the pandemic (UNCTAD, 2021).

This article has highlighted that while the technical challenges of artisanal and small-scale gold mining (ASGM) are well-documented, a more effective approach to ensuring its growth and sustainability lies in treating ASGM operations as legitimate business units. Reorganising ASGM operations with a focus on business principles, such as clear organisational structures, strategic planning, and financial management, can significantly enhance their performance and long-term viability.

Policymakers must address existing regulatory and operational barriers that hinder the development of the ASGM sector. For instance, there is a pressing need for comprehensive and multisectoral capacity-building initiatives that address the root causes of inefficiencies in the sector. Additionally, introducing incentives such as more favourable tax regimes could help foster a compliant and growth-oriented environment for ASGM activities.

ASGM operations, when guided by sound business principles, have the potential to grow and thrive, contributing not only to the national economy but also to the livelihoods of individuals in rural areas. Value addition within ASGM, although

requiring significant investment and skill development, offers a promising avenue to improve profitability. This process can also create sustainable economic benefits for mining communities. Although upfront investment in value addition may appear substantial, evidence suggests that the returns on such investments outweigh the costs (Tschirhart & Schulz, 2019).

Estimates indicate that Zambia is home to between 500,000 and 600,000 artisanal miners involved in various mining activities, including gold extraction. However, data on the number of gold miners remain sparse (Artisanal Inventory, 2022). The growing number of artisanal miners presents a compelling case for the government to improve the management and regulation of this sector. Proper management could lead to significant improvements in employment, particularly for the Zambian youth, and bolster the national economy.

7. Recommendations

This review provides a comprehensive overview of the factors that influence the growth and sustainability of ASGM in rural Zambia. It identifies the key challenges and opportunities for enhancing the sector's potential. Given the limitations of this review, further phenomenological research specific to rural Zambia is recommended to develop targeted interventions that are more closely aligned with the unique needs of the country's gold mining sector.

Based on this analysis, the following recommendations are proposed:

- **Review and Streamline the Licensing Process**

The government should reassess the current licensing process to eliminate excessive regulations that inhibit the growth of ASGM. While some regulatory frameworks are necessary for sustainable mining practices, overly complex bureaucratic procedures have had a negative impact on the sector's development. Simplifying the licensing process could encourage more miners to formalise their operations, enhancing both productivity and regulatory compliance.

- **Promote Infrastructure Development through Decentralisation**

In line with decentralisation policies, the government should prioritise infrastructure development, especially in rural areas where ASGM activities are prevalent. Improved road networks facilitate access to mining sites, markets, and value-added processing facilities. This infrastructure should be strategically linked to economic activities with the potential to enhance the local economy, particularly those tied to artisanal mining.

- **Establish a Comprehensive ASGM Monitoring Database**

The Ministry of Mines should establish a live, comprehensive database to monitor ASGM activities in real-time. This can be achieved by creating a dedicated implementing body, similar to Tanzania's Mining Commission, which has successfully improved the management of gold reserves and mining operations. The establishment of such a body in Zambia would ensure more effective governance of the gold subsector and provide real-time data to inform policy and decision-making.

- **Capacity Building for Sustainable Mining Practices**

The Department of Cooperatives, in partnership with the Ministry of Mines, should develop targeted capacity-building programmes for ASGM practitioners. These programs should focus on enhancing miners' skills in areas such as environmental management, financial literacy, and technological innovations to improve mining efficiency. Training should also include research methodologies to assess the impact of environmental factors on mining operations as well as the adoption of new technologies that could drive sectoral growth.

- **Conduct a PESTEL Analysis for ASGM Policy Development**

To support the long-term sustainability of ASGM, the Ministry of Mines should conduct a detailed Political, Economic, Socio-cultural, Technological, Environmental, and Legal (PESTEL) analysis. This analysis provides a comprehensive understanding of the factors influencing ASGM operations and offers valuable insights for developing policies that promote the sector's growth. For example, integrating new technologies, such as geophysics and resistivity methods, for detecting gold occurrences could significantly improve the efficiency and accuracy of mining operations, leading to higher yields.

- **Address Gender Inequality in ASGM**

Gender inequality remains a significant barrier to women's full economic participation in the artisanal mining sector. Efforts should be made to create an inclusive environment that empowers women to participate in all aspects of ASGM, from mining to value addition. Policy measures should aim to address discriminatory practices and ensure that women have equal access to training, resources, and decision-making within the sector.

- **Encourage Further Research Specific to Zambia's ASGM Sector**

There is a clear need for more focused research on the ASGM sector in Zambia, particularly concerning its socioeconomic, environmental, and technical challenges. Given the scarcity of data in this sector, further studies could provide valuable insights into the specific needs and challenges faced by artisanal miners, enabling the development of evidence-based policies and interventions that support the sector's growth.

- **Advance Future Research and Economic Modelling**

Future studies should employ computable general equilibrium (CGE) or input–output models to estimate the economy-wide impacts of ASGM formalisation. Additionally, primary research is needed to quantify key parameters, such as the price elasticity of ASGM labour supply and the fiscal incidence of differentiated taxation, to better inform future macroeconomic planning.

In conclusion, while the potential for growth and sustainability within Zambia's ASGM sector is significant, realising this potential requires concerted efforts from all stakeholders, including government agencies, policymakers, and local communities. By addressing the regulatory, infrastructural, and social challenges faced by artisanal miners, Zambia can unlock the full economic benefits of its gold reserves and contribute to the country's broader development.

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