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Research/Review

Economic Dependency and Ecological Challenges in Artisanal Gold Mining: A Case Study of Local Wisdom in Tedeboe Village

Yesaya Kaho[1], Feliks Arfid Guampe[2]*, Olvit Olniwati Kayupa[3]

[1] Student Department of Economics, Tentena Christian University, Indonesia
[2] Department of Economics, Tentena Christian University, Indonesia : feliksguampe@gmail.com
[3] Department of Economics, Tentena Christian University, Indonesia
*Corresponding Author: Feliks Arfid Guampe

Abstract This study explores the dual impact of artisanal gold mining on economic livelihood and environmental sustainability in Tedeboe Village, Rampi District, North Luwu Regency. Employing a qualitative case study design, data were gathered through in-depth interviews with four key informants—including the village head and three local miners—and through direct field observation. Data were analyzed using Creswell's qualitative analysis framework, encompassing coding and thematic development to capture nuanced insights. The findings indicate that artisanal gold mining has significantly improved household income, especially in meeting basic needs and funding education. However, the sector's informal nature and high dependency expose the community to economic volatility. Moreover, despite limited use of chemicals, awareness of mercury's environmental and health risks is rising among miners. Environmental degradation, particularly soil and water pollution, alongside potential respiratory hazards, emerges as a critical concern. The study underscores the urgent need for sustainable mining practices, stronger local regulation, and capacity-building through education and economic diversification. These findings advocate for a balanced approach to rural development—one that harmonizes economic benefits with ecological resilience and community well-being.

Keywords: Artisanal Gold Mining, Economic Dependency, Environmental Sustainability, Public Health Risk, Local Wisdom

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1. Introduction

Artisanal gold mining in Indonesia has become a significant economic phenomenon, especially in regions with gold reserves, despite often being conducted without formal permits (Illegal Mining or PETI). This activity presents both positive and negative implications for local communities. On the one hand, artisanal mining provides a major source of income for

many individuals and households, thereby improving their economic welfare. On the other hand, it is frequently conducted using environmentally harmful methods and poses health risks due to the use of toxic chemicals such as mercury.

Studies on the economic impacts of artisanal mining have shown that income derived from this activity is often significantly higher than that from other sectors, such as agriculture or labor. For instance, in Katingan Regency, Central Kalimantan, unlicensed artisanal mining has substantially increased community income (Adnyano, 2017). A similar situation is observed in Kulon Progo, Yogyakarta, where artisanal mining contributes significantly to local income (Kristianingsih, 2019).

These studies indicate that artisanal gold mining has a positive economic impact on local economies. Communities involved in gold mining often experience a rapid increase in income, allowing for better fulfillment of daily needs. This is supported by Iwansyah (2022), who reports that individuals who formerly worked as farmers or laborers experienced significant income increases after shifting to gold mining. A study in Nagari Padang Laweh by Kasmira & Fitrisia (2022) also found that gold mining became a major source of livelihood, enhancing overall community welfare.

However, behind the positive economic effects lie serious environmental and health concerns. The use of mercury in amalgamation—the process of separating gold from ore—is a major contributor to environmental pollution. Mercury used in this process often escapes into the environment through water and soil. According to Kristianingsih (2019), approximately 25-30% of the mercury used in gold processing is released into the environment, leading to contamination that endangers both human health and surrounding ecosystems.

Mercury pollution can cause long-term environmental degradation. Contaminated soil becomes infertile, while mercury-laden water can poison fish and other aquatic life. Communities consuming contaminated fish or water are at risk of mercury poisoning, which may cause neurological and kidney disorders (Anisa, 2016). Over time, such impacts threaten the sustainability of communities that depend on nearby natural resources, such as farming and fishing.

In addition to environmental pollution, artisanal gold mining also poses serious health threats. The use of hazardous substances like mercury and cyanide during mining operations can result in respiratory issues, poisoning, and even birth defects in children born to mothers with long-term mercury exposure (Anisa, 2016). These negative effects extend beyond miners to the broader community living near mining areas.

To reduce the negative consequences of artisanal mining, more sustainable and environmentally sound approaches are needed. One viable solution is community education on safer, more sustainable mining practices. Aswadi et al. (2019) emphasize the importance of raising awareness about the risks of hazardous chemicals and effective waste management

techniques. Improved understanding of safe mining practices may help communities minimize environmental and health risks.

Furthermore, tighter regulation from local governments is necessary to oversee artisanal mining activities. Authorities can encourage the adoption of environmentally friendly mining technologies and provide incentives for miners implementing sustainable practices. Several studies have shown that appropriate technologies can significantly reduce the use of mercury and other harmful substances, thereby mitigating environmental risks (Suhadi, 2023).

In this context, Tedeboe Village in Rampi District, North Luwu Regency, serves as a case study of a community engaged in artisanal gold mining. While mining activities have substantially boosted local incomes, environmental and health concerns remain pressing. Therefore, this study analyzes the income generated from artisanal gold mining in Tedeboe Village and explores its associated impacts. The research also seeks to assess the extent to which artisanal mining can be managed sustainably so that its economic benefits may continue without compromising community health and environmental integrity.

2. Research Method

This research was conducted in Tedeboe Village, Rampi District, North Luwu Regency, selected due to the intensity of artisanal gold mining activities and their significant impact on the local population. The study took place from September to October 2024, with data collection carried out through direct observation, interviews, and an assessment of the socio-economic and environmental impacts.

The study employed a qualitative research approach with a case study design, aiming to explore in depth the influence of artisanal gold mining on income, environmental conditions, and community welfare (Agustini et al., 2023). The focus of the research was limited to one location—Tedeboe Village—in order to obtain a comprehensive contextual understanding. Informants were selected purposively and consisted of four individuals: the village head and three artisanal gold miners. This selection aimed to gather perspectives from both local authorities and community members directly involved in mining activities.

Data were collected using semi-structured in-depth interviews, which enabled broader exploration of the informants' experiences and perspectives. The interviews were conducted face-to-face, recorded with consent, and transcribed for analytical purposes.

Data analysis was conducted using the qualitative data analysis method by Creswell & Creswell (2018), which consists of five stages:

- Organizing and transcribing the data,
- Comprehensive reading of transcripts,
- Coding the data into categories or themes,

- Developing key themes related to economic, environmental, and social impacts, and
- Interpreting the data in relation to relevant theories or existing literature.

This approach was chosen to provide a rich, comprehensive picture of the dynamics of artisanal gold mining and its effects on the people of Tedeboe Village.

3. Results and Discussion

General Overview of the Research Site

Tedeboe Village is located in Rampi District, North Luwu Regency, South Sulawesi Province. The village is a result of a relocation from the old settlement of Bolantai to a higher area, forming two hamlets—Efrat and Tigris—in 1993. Despite previously experiencing limited economic access and minimal government support, the people of Tedeboe have persistently developed their village through mutual cooperation.

Administratively, Tedeboe Village consists of four hamlets and eight neighborhood units (RT), covering an area of 319.17 hectares, with most of the land used for rice fields and gardens. The village is situated in a highland climate, with average temperatures between 32–35°C and low annual rainfall. Accessibility is a major issue; the village lies 21 km from the district capital, 87 km from the regency capital, and 259 km from Makassar.

As of 2024, the village population is 656 residents within 170 households, most of whom work as farmers. A small number are civil servants, healthcare workers, private employees, merchants, and laborers. About 287 residents are unemployed. In terms of education, most residents only completed elementary school or dropped out. Only ten individuals have achieved undergraduate degrees. This reflects a low level of education, which poses a significant challenge to the development of local human resources. Since 1990, the village has been governed by seven village heads.

Village Government Control Over Artisanal Mining Activities

Supervision and Education by the Village Government Regarding Artisanal Mining Activities

In supervising artisanal gold mining activities, the Tedeboe Village government plays an active role in educating the community about the importance of preserving the environment and ensuring safety during the mining process. This education includes appeals for the community to engage in manual mining and avoid indiscriminate tree cutting around mining sites. As stated by the Village Head, "We always remind the community that if they want to mine, they should try to use manual tools and avoid excessive use of heavy equipment or cutting trees carelessly around the mining site" (Interview, Basri Perutu, 2024).

This statement reflects the village government's efforts to minimize the negative impacts of mining activities by discouraging the use of heavy machinery that can damage the surrounding ecosystem. According to Basri, manual mining is not only safer for the

environment but also allows better control over potential damage to the soil and vegetation near the mining area.

In addition, the village government provides education on the importance of maintaining environmental sustainability with the aim of increasing community awareness of the long-term impacts of mining activities. "We also teach respect for nature by not taking more than we need and reminding people to replant trees once mining at a site is completed," Basri added in the interview (Interview, Basri Perutu, 2024). Through this approach, the village government seeks to instill environmental conservation values in the community.

This educational approach is important to note as part of the village government's strategy to reduce the potential environmental degradation caused by artisanal gold mining. In qualitative research, this finding illustrates that education-based policies are often effective in rural settings, where persuasive approaches are more acceptable than coercive ones (Miles, Huberman, & Saldana, 2014).

Local Regulations Implemented by the Village Government on Artisanal Gold Mining Activities

The Tedeboe Village government has made efforts to implement local regulations aimed at controlling artisanal gold mining activities and preventing their negative environmental impacts—particularly during the rainy season, which is prone to erosion and flooding. These regulations are applied through preventive and advisory approaches, adapted to the local context and the community's capacity to comply with the rules imposed.

According to Village Head Basri Perutu, the local government exercises caution in communicating regulations to the community to avoid conflict or misunderstanding. "When it comes to regulations on artisanal gold mining managed by the community, we often remind them on the ground to be cautious, because sometimes there are landslides or sudden collapses," he stated (Interview, Basri Perutu, 2024). Through these advisories, the village government seeks to raise awareness among miners about the natural risks they may encounter and encourages more careful and responsible mining practices.

Furthermore, the local government provides guidance to refrain from mining activities during the rainy season. This recommendation stems from the increased risk of natural disasters such as landslides and erosion that may endanger the safety of miners. "Policies issued by the village government regarding artisanal gold mining in Tedeboe are also directed toward anticipating natural disasters and increasing community awareness of the changing seasons—both the rainy and dry periods," Basri added (Interview, Basri Perutu, 2024).

Through these measures, the village government aims to establish a form of preventive regulation that takes into account seasonal weather conditions as a critical factor influencing mining safety. These locally adapted strategies reflect a context-sensitive approach to environmental governance, prioritizing public safety while maintaining harmony with traditional mining practices.

Village Government's Perspective on Environmental Impacts of Artisanal Gold Mining Activities

The Tedeboe Village government's perspective on the environmental impacts of artisanal gold mining reflects a cautious attitude and concern over potential ecological degradation, although no significant adverse effects have been observed thus far. Village Head Basri Perutu emphasized that they continuously monitor the environmental conditions surrounding the mining sites and actively remind the community to adopt safer mining practices.

According to Basri, "As for the impacts of artisanal gold mining, there have not been any significant effects so far, but we continue to observe that there are negative consequences, particularly because these mining activities are conducted manually by the community without using advanced equipment" (Interview, Basri Perutu, 2024).

This statement indicates the village government's awareness of the potential environmental damage that may arise from mining activities, especially considering that the extraction process is conducted using simple tools such as crowbars and shovels. Although no immediate or visible damage has occurred, the government remains vigilant in order to mitigate future risks.

Moreover, the village government stresses the importance of continuous monitoring of mining locations to ensure that the activities do not escalate into more severe environmental degradation. "We urge the community not to proceed with mining if the site is deemed unsuitable, as it could trigger undesirable incidents such as landslides or erosion," Basri further explained (Interview, Basri Perutu, 2024).

Through these advisories, the village government adopts a preventive stance by encouraging the community to carefully assess the suitability of mining sites. This approach aims to minimize the potential for extensive environmental damage that could ultimately harm the miners themselves and the surrounding ecosystem.

Educational and Outreach Programs by the Village Government on Safe and Environmentally Friendly Mining

The Tedeboe Village government has undertaken initiatives to educate the community on conducting artisanal gold mining in a safer and more environmentally responsible manner. These educational programs are delivered through direct outreach to the community, emphasizing the importance of maintaining ecological balance and preventing damage caused by illegal or excessive mining practices. As explained by Village Head Basri Perutu, "From the government's perspective, regarding education or safety, there are indeed several steps that the community must consider. We must truly care for nature, because as we live, we must also show respect to nature by avoiding illegal mining activities near our residential areas" (Interview, Basri Perutu, 2024).

During these outreach efforts, the village government underscores the value of respecting nature as a core principle that the community should internalize. The aim of the educational initiative is to instill awareness about the importance of preserving ecological balance, whereby nature must be honored in order for communities to continue relying on its resources.

In addition, the village government warns the community about potential risks to local wildlife that may be affected by mining activities. "We inform the community to be cautious when mining manually, ensuring that animals do not fall into mining pits as a result of illegal mining," Basri added (Interview, Basri Perutu, 2024).

This educational program promotes more environmentally friendly practices, such as ensuring that local fauna are not disturbed by mining operations and that open mining pits do not pose a threat to the surrounding ecosystem. This outreach-based approach demonstrates the village government's commitment to fostering a culture of responsible mining within the community.

Village Government's Efforts to Address Health Impacts from Artisanal Gold Mining Activities

The Tedeboe Village government acknowledges that artisanal gold mining activities pose potential health risks to the community, particularly for miners who are directly involved in the extraction process. As a result, the local government has placed specific attention on health and occupational safety, even though no formal regulations mandate the use of personal protective equipment. Health and safety outreach is conducted to raise awareness among the community about the health hazards associated with mining activities. As expressed by Village Head Basri Perutu: "To anticipate health-related issues, I, as the village head, often remind the community to pay attention to safety when entering mining sites, because when we work hard, we sometimes forget to care about our health and the physical strain it involves" (Interview, Basri Perutu, 2024).

This statement illustrates the village government's efforts to raise public awareness about the importance of maintaining physical health while working in high-risk mining environments that require intensive labor.

Additionally, the village government seeks to educate the community on the importance of hygiene and cleanliness at mining sites. "When it comes to the health impacts of artisanal gold mining on our villagers, we focus on educating them about maintaining cleanliness to avoid infections or health problems caused by dirty surroundings" (Interview, Basri Perutu, 2024).

Through this educational initiative, the local government hopes miners will pay closer attention to their working conditions, maintain cleanliness, and avoid behaviors that may lead to illness.

Perspectives of Customary Leaders on Artisanal Mining Activities in Tedeboe Village

As a community that still upholds traditional values, the people of Tedeboe Village view artisanal gold mining as a vital source of income that supports their daily needs. Customary leader Yonar Raho explained that the indigenous community holds a favorable view of artisanal gold mining, as long as the activity contributes to their economic well-being. "The indigenous community's view of artisanal gold mining in Tedeboe is very positive, because it serves as a source of income that supports both individual and family livelihoods" (Interview, Yonar Raho, 2024). This perspective shows that traditional communities acknowledge the economic role of gold mining in enhancing their welfare.

In addition to their positive view, traditional leaders have established customary rules regarding the management of natural resources, including gold mining. Yonar Raho emphasized the importance of conducting ritual ceremonies before initiating mining activities as a sign of respect for nature and ancestral spirits. "Certain values or rules must be observed—for instance, before starting artisanal mining activities, a Christian prayer service led by a pastor must first be held to officially commence the process" (Interview, Yonar Raho, 2024).

After the prayer, a ritual animal sacrifice is performed to symbolize gratitude and reverence: "One pig and one chicken are slaughtered, cooked, and shared as an expression of thankfulness" (Interview, Yonar Raho, 2024). This ritual reflects the community's commitment to maintaining indigenous wisdom and cultural traditions in their economic practices, striking a balance between economic needs and spiritual obligations.

However, artisanal mining activities also bring about social and cultural consequences that require attention. According to Yonar Raho, one notable impact is the disruption of other community activities and the potential rise in youth unemployment due to declining interest in pursuing education. This suggests that while gold mining yields economic benefits, it also presents social challenges that must be addressed to preserve the community's socio-cultural sustainability.

In promoting balance between mining and environmental stewardship, customary leaders advise the community to avoid mining in areas prone to natural disasters. As stated by Raho, "Balancing mining activities and the environment means avoiding areas that may be vulnerable to natural hazards" (Interview, Yonar Raho, 2024). This statement reflects the belief that mining should be carried out with caution to prevent environmental damage, underscoring the importance of ecological preservation for indigenous communities.

As an additional measure, customary leaders stress the need for compliance with both village government regulations and traditional laws to ensure harmony between economic activities and cultural values. This illustrates their commitment to preserving the coexistence of mining practices with cultural and environmental sustainability.

Mining Process (Location, Permits, and Mining Procedures)

Artisanal gold mining in Tedeboe Village involves several key stages, including site surveying, location selection, and securing permissions. The process integrates collaboration among local community members, traditional leaders, and the application of customary mining practices.

Initial Survey and Site Selection

Before initiating mining operations, Gedolin Tobo explained that a site survey is conducted in coordination with the local government and customary leaders to ensure that the chosen location holds sufficient potential for gold extraction. Only after confirming the site's viability is the customary ritual performed. Similarly, Martinus Dumpala emphasized the importance of conducting a preliminary survey to determine whether the location contains adequate gold resources.

Government and Community Permits

Following the survey, miners are required to obtain permission from both the village authorities and customary leaders. Gedolin Tobo noted that permits are granted on the condition that mining activities do not harm the surrounding environment, including settlements, gardens, and rice fields. Yonar Raho also stated that once a location has been identified, coordination with both government officials and traditional leaders must take place prior to the commencement of mining activities.

Traditional vs. Modern Techniques

Miners in Tedeboe Village prefer using traditional methods in their gold mining operations. According to Martinus Dumpala, they rely on simple, manual tools for excavation, which not only help to minimize operational costs but also reduce environmental impact and promote sustainability.

Community Involvement and Customary Rituals

The mining process is also deeply rooted in cultural practices. Gedolin Tobo mentioned that a customary ritual, led by traditional leaders, is conducted before any mining activity begins. This ritual serves as a form of respect toward ancestral spirits and nature, and seeks protection for those involved. Martinus Dumpala added that the ritual is carried out in accordance with Tedeboe Village tradition before the mining process starts.

This entire process underscores the cultural significance of artisanal gold mining in the region, reflecting a harmonious integration of economic activity and traditional values.

Figure 1. *Implementation of religious service and customary rituals to commence mining activities.*

Gold Sale Process

The sale of gold extracted from artisanal mining in Tedeboe Village is conducted in a very straightforward and direct manner. Miners typically sell their gold directly to local residents, without involving formal markets or external intermediaries.

Direct Sales to Local Community

Gedolin Tobo explained that mined gold is sold directly to members of the local community who are interested in purchasing it. This method simplifies transactions as no third-party involvement is required. Martinus Dumpala also noted that selling gold is relatively easy since it is manually mined and can be sold immediately.

Weight-Based Measurement and Sales

According to Yonar Raho, gold is measured and sold based on the number of grams extracted. Local buyers purchase gold according to the available weight, typically ranging from 1 to 4 grams. Miners can sell their gold incrementally based on their daily output until a desired quantity is accumulated.

Simple and Uncomplicated Transaction Process

The gold sales process in Tedeboe Village is notably uncomplicated, with no complex procedures or intermediaries involved. Martinus Dumpala emphasized that because the gold is manually mined, the transaction process is quick and straightforward, often taking place directly between the miner and familiar local buyers.

Average Income from Artisanal Gold Mining Activities

The income earned from artisanal gold mining in Tedeboe Village varies significantly and is highly dependent on the weekly yield. Miners such as Gedolin Tobo, Martinus Dumpala, and Yonar Raho explained that their earnings are unpredictable and fluctuate from week to week.

Gedolin Tobo revealed that miners can earn between IDR 700,000 and IDR 2,100,000 per week, depending on whether the mining pit contains gold. Similarly, Martinus Dumpala reported that weekly earnings typically range from IDR 700,000 to IDR 1,400,000.

This income instability reflects the inherent uncertainty faced by miners, as their earnings are contingent on the presence of gold in the excavation site. Yonar Raho added that it is difficult to estimate average income due to the varying quantity of gold found, which may range from 1 gram to 4 grams. As such, miners' incomes are directly influenced by their ability to extract gold, resulting in weekly income fluctuations. Consequently, this income volatility is one of the primary challenges impacting the economic security of artisanal miners in Tedeboe Village.

Key Challenges in Conducting Artisanal Gold Mining

Miners in Tedeboe Village face a range of substantial challenges in carrying out artisanal gold mining activities. One of the primary difficulties involves the excavation process. Gedolin Tobo explained that mining operations are highly labor-intensive due to reliance on rudimentary tools such as crowbars, shovels, and hoes. The limitations of such equipment make the digging process physically demanding and require significant manual effort. Martinus Dumpala echoed these sentiments, highlighting particular difficulties when miners encounter deep shafts or large rocks that are difficult to remove. In such cases, miners are often forced to relocate their digging sites, resulting in delays and added hardship.

Figure 2. *Tools used for artisanal gold mining.*

In addition to excavation challenges, limited access to modern equipment and technology presents a significant barrier. Yonar Raho emphasized that miners still rely on traditional, manually operated tools, which severely constrain efficiency and productivity. Furthermore, the community struggles to obtain modern equipment that could expedite the mining process. In the absence of advanced tools, miners must work harder and longer to achieve their desired yields.

Weather conditions also frequently hinder mining activities. Martinus Dumpala noted that rainfall can cause mine shafts to become slippery or waterlogged, rendering mining

operations temporarily impossible. Such adverse weather conditions often lead to delays, ultimately affecting the miners' income. Faced with these compounding challenges, the artisanal mining process in Tedeboe Village remains difficult, requiring miners to continuously adapt and persevere.

Figure 3. *Artisanal gold mining process.*

The Impact of Artisanal Gold Mining on Daily Life

Artisanal gold mining activities in Tedeboe Village have had a significant impact on the daily lives of miners and their families. These impacts are not only economic but also physical, involving the laborious nature of the work and the time consumed by mining operations. According to Gedolin Tobo, the income generated from gold mining has contributed positively to improving his family's economic conditions, particularly when the yield is favorable. Although the mining process is physically demanding, the profits earned can support household needs and sustain daily living expenses. Similarly, Martinus Dumpala noted that the financial benefits of gold mining extend beyond daily necessities and have allowed him to fund his children's education—from elementary school through to university. These statements illustrate that artisanal gold mining can provide substantial economic advantages for miners' families.

However, in addition to its economic benefits, gold mining imposes considerable physical strain. Gedolin Tobo emphasized that mining activities are extremely exhausting, indicating that they require intense physical effort and can lead to fatigue. Yonar Raho further explained that when mining yields fall short of expectations, the time and energy invested often result in a loss, affecting both the miners and their families. This highlights that inadequate mining returns may have adverse effects on physical health and family well-being, especially when the efforts made do not correspond to the outcomes achieved.

Moreover, artisanal gold mining demands significant time, often at the expense of quality time with family. Yonar Raho expressed that mining activities frequently reduce opportunities for other engagements, such as spending time with loved ones. This suggests that in addition to the physical burden, the time-intensive nature of mining disrupts social life and limits meaningful interactions with family members.

Health Risks Associated with the Use of Chemicals

Regarding their understanding of the use of chemicals such as mercury in the mining process, artisanal gold miners in Tedeboe Village—including Gedolin Tobo, Martinus Dumpala, and Yonar Raho—expressed awareness of the potential health risks that could arise from chemical usage during mining operations.

Gedolin Tobo stated that, so far, they have not experienced any adverse effects from chemicals, primarily because they have not used any in their mining activities. However, he acknowledged that chemicals could be hazardous, even though no direct negative impact has yet been observed. This reflects a general awareness of health risks, despite the current absence of chemical application in their practices. Meanwhile, Yonar Raho exhibited a deeper concern about the dangers that could emerge, particularly if chemicals are used in large quantities. He explained that the use of chemicals in mining may pose serious health risks, such as discoloration of gold and health complications among miners who may be sensitive to such substances.

Some miners, such as Martinus Dumpala, confirmed that they had not employed chemicals like mercury in their mining activities, thus making chemical-related health risks a lower priority in their concerns. This suggests that several miners still adhere to traditional methods to avoid the potentially harmful effects of mercury exposure. Nevertheless, Yonar Raho emphasized that the improper use of chemicals could result in severe illnesses among miners, indicating that although chemical usage remains infrequent, there is an underlying concern among miners about the potential long-term health impacts that may surface in the future.

Environmental Impacts of Artisanal Gold Mining Activities

Artisanal gold mining activities in Tedeboe Village have notable implications for the surrounding environment. Miners are aware of the potential environmental degradation resulting from their operations, especially due to the use of tools and traditional processing methods that may affect local ecosystems. The three key informants—Gedolin Tobo, Martinus Dumpala, and Yonar Raho—shared their perspectives on the environmental impacts of their mining activities.

Gedolin Tobo stated that mining activities could impact the surrounding environment, particularly if mining areas are located near residential settlements or agricultural lands. He noted, "So far, there have been no environmental impacts caused by the artisanal gold mining activities we conduct, as the sites are still far from villages, rice fields, and community plantations" (Interview, Gedolin Tobo). This statement indicates that although no direct environmental consequences have been observed, miners still consider the distance of mining sites from populated areas as a precautionary measure to minimize potential harm.

Meanwhile, Martinus Dumpala acknowledged that while environmental impacts do exist, they are relatively minor since the mining is carried out manually using traditional methods.

This suggests that traditional techniques are perceived to be safer for the environment compared to modern machinery, which may have a more destructive effect.

Yonar Raho also recognized that even when mining is conducted using simple methods, there remains a risk of environmental degradation. He remarked, "If we start using heavy equipment, there will certainly be environmental impacts" (Interview, Yonar Raho). This reflects concerns about the potential pollution and ecological damage that may arise if artisanal mining evolves to incorporate heavy machinery or chemical substances, which could lead to air, water, or soil pollution.

All three informants strive to minimize environmental impacts by maintaining traditional methods and ensuring that mining sites remain distant from community areas. Gedolin Tobo and Martinus Dumpala, for instance, continue to use manual tools to preserve the natural environment. "We still use simple or manual tools," said Martinus Dumpala (Interview, Martinus Dumpala). This highlights the miners' awareness of the importance of environmental conservation and their deliberate effort to avoid equipment that could harm the ecosystem.

Efforts Toward Environmentally Friendly and Sustainable Artisanal Gold Mining

Miners in Tedeboe Village demonstrate a strong awareness of the importance of environmental conservation in the context of artisanal gold mining. They actively seek to implement practices that ensure mining activities remain environmentally friendly and sustainable, including the continued use of traditional techniques and minimizing chemical use. The three informants—Gedolin Tobo, Martinus Dumpala, and Yonar Raho—shared their perspectives on the steps that can be taken to promote sustainability in artisanal mining operations.

Gedolin Tobo emphasized the necessity of preserving environmental integrity and conducting mining activities with greater caution to avoid environmental degradation. He stated, "In my opinion as a miner, we choose locations far from residential areas and avoid using chemicals to prevent environmental damage" (Interview, Gedolin Tobo). This statement reflects his understanding of the importance of maintaining distance between mining sites and settlements, as well as the need to refrain from using hazardous substances in order to protect the surrounding environment.

Martinus Dumpala agreed with Gedolin, stating that environmental preservation is a critical component of responsible mining. He said, "As a miner, I believe it is important to preserve the environment of indigenous communities and the mining area itself" (Interview, Martinus Dumpala). His remarks reaffirm a commitment to respecting indigenous environments and ensuring that mining operations do not compromise ecological integrity.

To this end, the miners consistently opt to use traditional methods in their mining activities as a means of safeguarding the environment. Yonar Raho noted that traditional tools are considered safer and more eco-friendly compared to heavy machinery, which may cause

extensive environmental harm. "We continue to use traditional tools," he stated (Interview, Yonar Raho). The use of manual equipment is a key strategy employed by miners to reduce the negative environmental impact of their operations.

In addition to using traditional techniques, the miners are also committed to minimizing or entirely avoiding the use of chemicals in their mining processes. Gedolin Tobo reiterated that chemical substances such as mercury can be harmful to the environment. "Do not use chemicals as a way to prevent environmental damage," he stressed (Interview, Gedolin Tobo). This reflects an awareness of the potential for soil and water contamination resulting from chemical use, and a proactive stance in favor of more environmentally sustainable mining practices.

Discussion

The Contribution of Artisanal Gold Mining to the Improvement of Community Income

In the context of development economics, artisanal gold mining activities in Tedeboe Village can be viewed as a form of economic transformation that enables income improvement for village communities, most of whom are still reliant on traditional sectors. Rostow's Modernization Theory (Ginting et al., 2020; Guampe, 2024; Lestari et al., 2021) emphasizes that traditional societies can achieve stages of economic modernization through a gradual process leading toward prosperity. In this regard, the presence of artisanal gold mining in Tedeboe Village holds the potential to push local communities toward better economic conditions, aligning with the modernization stages proposed by Rostow, where income sources shift from agrarian to mining sectors.

However, Dependency Theory highlights that reliance on the informal and unstructured mining sector poses risks that may limit the community's ability to achieve sustainable development. A high dependency on gold mining without economic diversification may result in unhealthy economic reliance, where the community becomes trapped in income uncertainty (Asri, 2023). This condition poses risks to income stability if mining resources begin to decline or if gold prices in the market become unstable. Thus, based on this theory, income gains from gold mining should be accompanied by economic diversification efforts to reduce the risk of excessive dependency.

Furthermore, Friedman's Permanent Income Hypothesis (Setyawan, 2023) is relevant for understanding consumption patterns and household expenditures. According to this theory, income generated from gold mining tends to be allocated based on long-term income expectations. However, given the fluctuating nature of income from artisanal gold mining, communities may not be able to rely on it consistently for long-term financial planning, ultimately affecting their economic stability. Other studies show that communities dependent on irregular income sources, such as mining, face challenges in managing their finances sustainably (Setyawan, 2023).

Previous research by Sulista (2019) indicated that artisanal mining activities significantly contribute to household income despite being informal in nature. However, income uncertainty remains a key issue for communities relying solely on mining as their main source of income. This study highlights that increased income from artisanal gold mining only yields optimal benefits if communities are encouraged to manage their earnings wisely and invest in other sectors that offer more stable revenue streams.

Additionally, Human Capital Theory suggests that improving skills and education levels plays a role in enhancing productivity and long-term income (Fahmi & Mulyono, 2016). In this context, community participation in mining activities can be seen as an opportunity to enhance technical skills in the mining field. However, low education levels may hinder the people of Tedeboe Village from fully optimizing mining opportunities. This is supported by the study of Lutfiani & Yuniasih (2021), which found that educational disparities contribute to income inequality.

Overall, based on the theories and previous studies, the contribution of artisanal gold mining to income improvement in Tedeboe Village appears significant, yet its sustainability and stability remain a challenge. Therefore, a more holistic economic approach is needed, including community skills development, economic diversification, and sound financial management, so that the benefits of artisanal gold mining can be realized optimally and sustainably.

Environmental and Health Impacts of Mining Activities

Artisanal gold mining activities in Tedeboe Village have produced complex effects on both the environment and public health, primarily due to the use of traditional methods and the often-unregulated application of hazardous chemicals. From the perspective of Bronfenbrenner's Ecological Systems Theory (Dharma, 2023; Safitri, 2023), these activities not only affect the physical environment but also influence the microsystems and exosystems—namely the local community and the interrelationships among individuals in society. Environmental degradation such as water and soil pollution caused by hazardous chemicals like mercury can compromise the quality of life of local residents and the natural resources on which they depend. Supporting this view, Ma'mun (2016) found that mining activities can disrupt other sectors such as agriculture due to environmental pollution spreading to surrounding areas.

Furthermore, the theory of Sustainable Development underscores the need to balance economic growth with environmental sustainability (Chotimah et al., 2022; Haeril, 2023). While artisanal gold mining may contribute to increased household income, a lack of regulation and poor waste management can lead to irreversible ecosystem damage. The Environmental Kuznets Curve (EKC) posits that in the early stages of economic development, environmental degradation tends to rise in tandem with economic growth, but eventually, with higher income levels, societies begin to adopt more environmentally friendly practices (Luhung, 2023). Tedeboe Village may still be in the early phase of this curve, where environmental exploitation outweighs conservation efforts. Therefore, fostering

environmental awareness and adopting sustainable practices are critical to mitigating the negative impacts of mining.

In previous studies, Iwansyah (2022) highlighted that poorly regulated artisanal mining tends to elevate health risks for local communities, particularly due to direct exposure to chemicals such as mercury. The Ecological Theory supports this understanding, indicating that exposure to pollutants within the microsystem can impact individual health and, over the long term, affect subsequent generations within the chronosystem. This highlights the need for strategies aimed at reducing chemical use and improving occupational safety standards as integral parts of more sustainable mining approaches.

In terms of public health, the theory of Sustainable Development also mandates the protection of community health as a component of responsible development. A study by Idrus (2021) showed that education on safe and environmentally friendly mining techniques, along with the use of personal protective equipment (PPE), can significantly reduce health risks among miners. These findings are consistent with the theoretical view that increasing environmental and health awareness within communities can drive more responsible and sustainable mining practices.

From a policy standpoint, Hapsari (2024) found that the absence of strict regulatory frameworks in artisanal mining exacerbates negative outcomes for both the environment and public health. Her study also emphasizes the importance of collaboration between village governments and local communities in developing regulations tailored to local conditions and capacities, to ensure that mining activities do not produce long-term adverse effects.

In conclusion, based on theoretical perspectives and previous research, artisanal gold mining in Tedeboe Village has produced significant negative impacts on the environment and public health. Effective intervention is required through stronger local regulations, continuous education on safe mining practices, and increased awareness of the need to balance economic gains with environmental and health protection. Such measures are crucial to ensuring that the community benefits from mining activities without compromising ecological sustainability and public well-being.

Community Well-being and Strategies for Addressing Environmental Issues

Artisanal gold mining activities in Tedeboe Village have produced complex impacts on community well-being, encompassing economic, social, and environmental dimensions. Based on Bronfenbrenner's Ecological Theory (Dharma, 2023; Saefullah, 2023), community well-being does not solely depend on increased income from mining, but also on the balance of human-environment interactions. Poorly managed gold mining activities pose risks to the microsystem and mesosystem—such as families and local communities—through environmental degradation and health disturbances. Therefore, the sustainability of mining activities depends on the community's capacity to maintain a balance between economic benefits and environmental impacts.

The theory of Sustainable Development emphasizes the importance of maintaining three key pillars—economic, social, and environmental—in order to preserve natural resources for future generations (Haeril, 2023). In the context of Tedeboe Village, solving environmental problems is critical to ensure that gold mining not only delivers short-term economic gains but also contributes to long-term well-being. Research by Sagala et al. (2021) highlights that sustainable development requires active community participation in natural resource management and transparent decision-making processes. This implies the need for local regulations that support sustainable mining practices and actively involve the community in ecosystem preservation.

From a broader perspective, the Environmental Kuznets Curve (EKC) describes that in the early stages of development, environmental degradation tends to increase. However, as income and awareness rise, communities tend to adopt more environmentally friendly practices (Luhung, 2023). The community of Tedeboe Village may be in this early phase, where the rise in prosperity from gold mining should be followed by policies and practices that promote environmental sustainability. This aligns with the findings of Hilson & McQuilken (2014), who emphasized that the implementation of sustainable practices in small-scale mining can enhance community economic well-being without sacrificing environmental quality.

Human Capital Theory also plays a role in improving sustainable community welfare by emphasizing the importance of education and skills in increasing income and well-being (Fahmi & Mulyono, 2016). In the context of artisanal gold mining, better-educated communities are more likely to manage mining profits wisely, including by investing in more sustainable economic sectors. Lutfiani & Yuniasih (2021) demonstrated that educational disparity contributes to income inequality, thus the development of human capital through education and training is essential for enhancing the long-term welfare of the Tedeboe community.

Regarding environmental remediation, Moomen et al. (2020) emphasized that community engagement and the adoption of environmentally friendly practices are essential steps toward achieving sustainable mining. A community-based approach enables local residents to actively preserve their environment, particularly by reducing the use of hazardous chemicals and adopting safer mining techniques. Idrus (2021) also highlighted the importance of education on environmentally safe mining techniques to mitigate health risks and environmental damage. Programs such as continuous environmental outreach and education will help raise community awareness about the importance of maintaining ecological balance in their mining practices.

In summary, the findings from theoretical and previous research indicate that increasing the well-being of Tedeboe Village through artisanal gold mining must be balanced with responsible environmental management and the development of human capital. Efforts to address environmental issues must involve active community participation, supportive regulations for sustainable practices, and educational programs on safe and environmentally

friendly mining techniques. In doing so, it is expected that economic welfare can be achieved without compromising environmental quality and long-term social equilibrium.

4. Conclusion

Artisanal gold mining activities in Tedeboe Village play a significant role in increasing household income, offering an additional source of revenue for families involved in the mining sector. However, the community's dependency on a highly fluctuating mining sector poses a risk of long-term economic instability. Therefore, economic diversification and human capital development through education and training are essential to achieving more sustainable community welfare.

The gold mining activities in Tedeboe Village also pose challenges to environmental sustainability and public health, particularly due to the continued use of traditional techniques and hazardous chemicals. To mitigate these negative impacts, measures such as the implementation of environmentally friendly mining practices, education on occupational safety, and the strengthening of local regulations are necessary. Active community participation in preserving the surrounding ecosystem is also key to maintaining a balance between the economic benefits of mining and long-term environmental sustainability.

Community welfare in Tedeboe Village has improved as a result of artisanal gold mining; however, the sustainability of this welfare depends on the collaboration between the community and village authorities in managing environmental impacts. The village government's initiatives to provide education on safe mining practices and support for environmentally conscious regulations demonstrate the importance of adaptive local policies. By strengthening cooperation between the government and the community, economic prosperity can be achieved without compromising environmental quality and public health in the future.

Recommendations

- Strengthen Regulations and Educational Programs:
  The village government of Tedeboe is advised to tighten regulations on artisanal gold mining, limit the use of hazardous chemicals such as mercury, and supervise mining practices in vulnerable areas. Educational programs on safe and environmentally friendly mining techniques should be enhanced. Additionally, the village government could collaborate with educational institutions to provide alternative skill training for community members.

- Promote Economic Diversification and Community Support:
  To reduce dependency on gold mining, the village government should facilitate the development of alternative economic sectors such as agriculture or local crafts, which can help increase household income. Providing business capital and training in other livelihood skills will also help the community explore alternative sectors that support long-term well-being.

- Conduct Long-Term Health and Environmental Impact Studies:
  Future research should focus on the long-term impacts of artisanal gold mining on health and the environment. This may include studying the chemical content of water and soil near mining areas, as well as health effects from exposure to harmful substances, to enable preventive measures to be taken.

- Economic Analysis for Sustainable Welfare:
  Further studies are needed to analyze the community's well-being and potential for economic diversification in Tedeboe Village. Such research can identify alternative sectors capable of improving welfare without relying on gold mining and analyze the factors that contribute to successful economic diversification.

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