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'Centres of excellence' for artisanal and small-scale gold mining in Tanzania: Assumptions around artisanal entrepreneurship and formalization

Abel Kinyondo[a], Christopher Huggins[b,*]

[a] Department of Economics, University of Dar es Salaam, Dar es Salaam, Tanzania
[b] School of International Development and Global Studies, University of Ottawa, 120 University Private, Ottawa ON K1N 6N5, Canada

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ABSTRACT

The Africa Mining Vision reiterates the importance of training centres or 'centres of excellence' (COEs) for artisanal and small-scale mining but historically, these have had mixed results, partly due to a lack of understanding of demand for services. Recently, understanding of artisanal and small-scale mining (ASM) organizational and financial structures has improved, allowing for a more nuanced comparison of formalization policies that emphasize the 'entrepreneurial' nature of ASM operators and those that foreground the importance of poverty as a driving factor. With World Bank support, Tanzania has recently established several COEs including two for the artisanal and small-scale gold mining sector. This article examines the potentials of these centres, based on key informant interviews, as well as a literature review of experiences from other African countries. Further, we analyse activities planned at COEs, within the Tanzanian institutional and policy context, which tends to treat ASM as 'entrepreneurs'. We explore implications of the Tanzanian approach for potential formalization of ASM and transformation of ASM operators into medium-scale mining firms; and identify some institutional tensions and risks involved in implementing the COE approach.

1. Introduction

Formalizing artisanal and small-scale mining (ASM), rather than criminalizing it, is now generally accepted as a global 'best practice' by major organizations and governments (e.g. African Union, 2009; UNITAR and UN Environment, 2018; World Bank, 2019a). Over decades, governments and donor organizations have established training and demonstration centres as part of the formalization process. Indeed, the Africa Mining Vision reiterates the importance of training centres or 'centres of excellence' (COEs) (African Union, 2009). Historically, these have had mixed results, partly due to limited understanding of ASM demand for particular services (Hilson, 2007). In recent years, understanding of ASM organizational and financial structures has improved. In most mining operations there are multiple 'tiers' of actors involved, including a small number of financial backers and paid managers, and a much larger number of workers who are paid little or are eventually rewarded with a share of the mine site's production. This understanding allows for more nuanced discussion of tensions within the formalization literature, which is divided into organizations that emphasize a) the 'entrepreneurial' nature of ASM operators (particularly financers and managers) or b) poverty as a driving factor (i.e. lack of alternative livelihood options for poorly-paid workers).

With World Bank support, Tanzania recently established several COEs including two for the artisanal and small-scale gold mining (ASGM) sector. Because the majority of COEs address the gold sector, this paper focuses on ASGM. Gold is one of Tanzania's most economically significant exports. ASM accounts for about 10 percent of Tanzania's gold production (World Bank, 2015). This article examines the potentials of these centres, based on key informant interviews and a literature review of experiences from other African countries. Further, we analyse activities planned at COEs, within the Tanzanian institutional and policy context. Our study focuses on financial sustainability, technical capacity, and institutional connections of the COEs; demand for COE services, and whether COE services will stimulate ASM formalization. Recognizing that many formalization strategies implicitly make assumptions about ASM (e.g. its poverty-driven or 'entrepreneurial' nature), we explore implications of the Tanzanian approach for ASGM operators potentially transforming into medium-scale mining (MSM) firms.

1.1. Formalization of ASM

Formalization initiatives can be categorized according to their emphasis on the most common issues: legal (acquisition of permits;

* Corresponding author.
E-mail address: chuggins@uottawa.ca (C. Huggins).

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environmental, health and safety requirements; labour laws etc.); technical (access to geological data; use of efficient equipment; processing, etc.); institutional (capacity-building and expansion of cooperatives or associations, with a view to facilitate monitoring and coordination); financial (payments of fees and taxes, capitalization of mining operations, etc.) (see e.g. UNITAR and UN Environment, 2018). Formalization programmes focusing on legal issues to the exclusion of others can be characterized as promoting 'legalization', also called "paper formalization" (World Bank, 2015: 13); efforts to institutionalize mining can also be legalistic if they only focus on increasing membership of organizations, and documentation, without considering the quality of institutional governance. On the other hand, projects which focus mainly on technical issues without accounting for contextual issues, risk failure (e.g., miners may lack capital to maintain equipment, or may not share the environmental, health and safety goals promoted by the project). Projects focusing on financial aspects will tend only to benefit certain actors unless they also invest in institutional reforms to ensure that benefits are more widely distributed.

Moreover, formalization can have unintended consequences, including, "exclusion, inequality, and exploitation of labour" (UNITAR and UN Environment, 2018: 11). Impacts are often gendered, with men and women being differently positioned (e.g. through educational opportunities, access to capital) to apply for licenses, loans, cooperative membership, and other requirements (Bashwira et al., 2014; Hilson et al., 2014). Although the gender dynamics of ASM may be slowly changing, women tend to have access only to lower-paying opportunities (washing, rock-breaking, etc.), and may be more vulnerable to job losses due to mechanization. There are, therefore, important debates over how formalization efforts should be designed and implemented.

1.2. ASM and theories of growth of small businesses

ASM operators, stigmatized for decades as primitive, anarchic and destructive (Childs, 2014), are increasingly being taken seriously as businesspeople. The different roles of pre-financers, pit owners or managers, paid workers, and workers operating under production sharing agreements (PSAs) have become clearer in recent years.[1] While the exact organizational structure varies, some typical organizational characteristics can be identified: "contrary to the entrenched notion of ASM as a purely poverty-driven, economically irrational and disorganised activity, it is governed by complex organisational models" (Merket, 2018: 27). Some scholars have noted a three-tiered structure, including a) site owners (possibly primary mineral license holders), b) pit owners, and c) teams of workers (Brycesson and Jønsson, 2013; Jønsson and Fold, 2013). Site owners tend to simply lease mines to pit managers, though they may operate in the background as financiers. Day-to-day management typically depends on pit owners, who pay specialist employees (e.g. mechanics), purchase equipment, and pay other operational expenses. The workers – by far the largest group – typically depend on PSAs. There are also mineral brokers and dealers. In reality, some individuals may play more than one role (i.e. dealers may pre-finance ASM, functioning as site owners).

Due to the informal nature of these arrangements, workers are particularly vulnerable to financial exploitation, and face most of the physical risk. The large number of 'workers' performing risky and precarious labour leads some to argue that, "international development institutions now widely agree that ASM is largely a poverty-driven activity" (Mutagwaba et al., 2018:17). At the same time, there is some awareness of the key role of site owners, pit owners, and other capitalized entrepreneurial individuals.

[1] Under PSAs, workers receive food and lodging but are not paid a salary. Once the mine is productive (i.e. there is a discovery of minerals, metals or gems) the workers receive a particular percentage of the production.

Understanding ASM organizational structures allows us to apply organization and management theory to the study of ASM. Many formalization efforts aim to facilitate ASM to become more productive and invest surplus profit in various forms of capital (human, technological, financial, etc.) to 'grow' businesses and move towards MSM operations. The growth of businesses has been analysed in several disciplines in the past half-century (see e.g. Machado, 2016; Achtenhagen et al., 2010; Jovanovich, 1982; Lucas, 1978; Penrose, 1959). Generally, three models are used to explain why businesses 'grow'. The most basic one, provided by econometricians, is the stochastic model. Under this model, the size of a firm is a result of cumulative random shocks over time such that growth reflects a stochastic (random) process (Machado, 2016). The second concept is the Human Capital Model (HCM). Penrose (1959) shows that HCM is governed by two arguments. On the one hand it is governed by 'resource push' arguments suggesting that a firm possesses a set of administrative skills which it needs to run the firm. On the other hand, the firm is bound by managerial limits:growth is constrained by the organizational and entrepreneurial capacity of managers. Indeed, according to Penrose, 2009 [1959]), expansion is a function of 'managerial capacity'. Penrose also mentions challenges specific to small businesses, especially access to capital (pg. 192). Penrose further cautions against assuming that profit maximization is synonymous with growth (Penrose, 2009 [1959]: xxviii). Lucas (1978) adds that the HCM assumes that entrepreneurs have certain Knowledge, Skills and Abilities (KSAs) that influence the success of their businesses. The third theory, the Learning Model (Jovanovich, 1982), is the most influential. It recognises that management skills vary among entrepreneurs, and firms have different unobservable efficiencies. Hence the firm's true efficiency can only be seen after it has started production, and firms update their expectations based on experiences. Revising abilities upwards leads to business growth and downward revisions otherwise.

The models above have their subtle differences. However, a common thread across them all is that managerial KSAs are key and learning is crucial to business growth (Arrow, 1962) because the business environment is stochastic (unpredictable). This raises obvious questions for our study: are ASM learning entities? Are they likely to grow and formalize? The three models may not adequately answer these questions, because, in reality, while most small businesses try but fail to grow, some refrain on purpose from expanding. Specifically, apart from a few young businesses with very fast growth (known as 'gazelles'), most small businesses refrain from growing while others prefer slow growth even when successful in increasing profits (Machado, 2016; Penrose, 2009 [1959]: xxviii). This is mostly because there are benefits from remaining small and informal, including avoiding taxes and stringent labour laws, using PSAs to avoid high operating costs, and quickly adjusting staffing arrangements in response to contextual changes (i.e. financial challenges, low productivity). Rather than assuming that ASM operators maintain informal arrangements due to ignorance or necessity, we should observe how, "informal economy actors systematically reposition themselves vis-a-vis the State, markets, international and national policies to secure their livelihoods" (Lapeyre, 2013). We should not assume that ASM operators always prioritize growth or formalization; nor should we conflate these two concepts.

2. Formalization of ASM in East Africa

To briefly illustrate points made above, we note that formalization efforts have taken different turns in three East African countries (Kenya, Uganda, Tanzania). Through the Mining Act (2003) and Mining Regulations (2004), small-scale miners in Uganda can obtain 'Location Licenses', but these are difficult for artisanal miners to purchase (Fisher, 2018). Training and Awareness Campaign Committees have been established for ASM, which conduct gender-based audits and offer training on business skills, health and safety, and geology. There is no single long-term strategy to formalise the ASM sector, nor is there a

strong financial (funding) or institutional basis (Barreto et al., 2018a). In general, emphasis has frequently been on ASM as a 'community' activity, rather than a business activity (see e.g. Tuhumwire, n.d.). To an extent, this reflects the 'poverty-driven' framing of ASM, and does not focus on ASM businesses transitioning into MSM operations.

In Kenya, laws were silent on ASM until 2016. Since then, the Mining Act (2016) and Mining and Minerals Policy (2016) grant mineral rights to ASM, as long as miners are members of associations or cooperatives (Fisher, 2018). Decentralization policies have provided County governments with powers to issue mining licenses and tax mining. Counties are advised in their activities by multi-stakeholder Artisan Mining Committees. For the first time, therefore, the Kenyan regulatory regime has space for ASM; on the other hand, the requirements for gaining an ASM license may be an obstacle for many, and "the state's bureaucratic construct of ASM seems oriented to those who possess the capital, education and social mobility necessary to meet the high threshold of 'legalized' artisanal mining" (Huggins et al., 2017: 149). Furthermore, the 2016 Mining Act defines ASM as non-mechanized, dependent on "traditional or customary" technologies, and prohibits use of chemicals such as mercury or cyanide. This effectively prevents ASM operators from legally acquiring new technologies without moving to an LSM permit (as there is no permit for MSM) (Barreto et al., 2018b), even though the gap between ASM and LSM licensing systems is vast. This definition of ASM as using only basic technologies and techniques is therefore also derived from the 'poverty-driven' or 'livelihoods-based' ASM concept, and restricts growth.

Tanzania arguably has the most advanced government formalization policies in the region (Fisher, 2018). Tanzanian citizens have been able to apply for prospecting licenses and engage in ASM since the promulgation of the Mining Act of 1979. Formalization projects have been implemented for years, but, "the effectiveness of these early interventions is questionable due to the lack of attention being paid to issues of geographical reach, institutionalization and scale, an excessive focus on the formalization of rights, and limited respect for the strength of existing informal practices that make sense in the context of ASM and therefore tend to persist" (Pedersen et al., 2019). The Mining Policy of 2009 emphasized providing ASM with access to capital and extension services; but the Mining Act, 2010, while recognizing the legitimacy of small-scale miners who acquire a primary mining license (PML), focused on large-scale mining (LSM). Nevertheless, the Sustainable Management of Mineral Resources Project (SMMRP), funded by the World Bank, invested in ASM in two phases between the late 2000s and 2019. SMMRP activities aimed at ASM included, "baseline studies, small grants programme, support to mineral value addition, institutional capacity building, private-sector development, establishing demonstration and training centres, and efforts to identify suitable geological areas for ASM." (Pedersen et al., 2019). More generally, while there were only 35 PMLs in existence in 1999 between 2010 and 2017 the government issued an annual average of approximately 5,500 PMLs (Merket, 2018).

Various training opportunities have been provided to ASM stakeholders in recent years. For example, the Ministry responsible for mining conducted training sessions in all mining zones in the country on 'small-scale mining, health and safety in mines, entrepreneurship and environmental protection' (Mutagwaba et al., 2018: 65). While major legal reforms in 2017 targeted LSM and ignored ASM (Kinyondo and Huggins, 2019) the government has recently engaged in unprecedented consultations with ASM associations and other stakeholders, established a royalty and fees regime for specifically for ASM (which is more affordable than the regime for LSM), and invested heavily in efforts to formalize the tanzanite sector, for example (Huggins and Kinyondo, 2019). In the tanzanite sector, efforts to impose contracts, regular salaries, payments to the Occupational Health and Safety Agency and other formalization measures have led to reductions in the ASM workforce, and other unintended consequences. An Online Mining Cadastre Transactional Portal was launched in 2015, which tend to benefit "well-connected, typically urban, political and economic elites" (Merket, 2018). Unlike Uganda and Kenya, Tanzanian strategies largely assume that ASM operators can, and should, move towards MSM through improved access to knowledge, technologies, capital, and institutional capacity. While this provides some ASM actors with opportunities, there are risks. According to Merket (2018): "the mining legal framework equates small-scale mining with primary license holders. The small-scale mining workforce [i.e. casual workers] is nowhere mentioned in the legislation, and thus has no rights to claim, or responsibilities to uphold [which] …evidently weakens professionalisation and formalization efforts."

3. Methodology

This qualitative study explores whether the Tanzanian approach for ASGM operators is likely to be sustainable, and whether it might assist ASGM actors transform into MSM firms. We used several research questions: 1) How financially sustainable are COEs? 2) Do they have adequate technical capacity? 3) What is the demand for COE services? 4) Do COEs help ASM formalize? 5) How do COEs leverage available institutional connections? It uses both primary and secondary data. Primary data was collected using semi-structured interview questions with five key stakeholders from government (e.g. Ministry of Minerals and STAMICO), four from the private sector (e.g. gold dealers, representatives of LSM), four from civil society (e.g. non-governmental organizations), three from academia, and three from ASM. Key informants were purposively sampled based on their knowledge. In total, 19 respondents were interviewed in Dar es Salaam and Geita regions. Dar es Salaam is a commercial city where most LSM firms, academic institutions, NGOs, mineral dealers and related institutions are located. Meanwhile, Geita has a completed COE (Katente) and a model mine (Lwamgasa).

Primary data was complemented with a review of government policies; donor reports; NGO reports, and academic articles. Gaps found in secondary data were used to develop interview questions; that is, key informants were asked about inconsistencies arising from secondary data, to establish clarity. Content analysis of the data permitted us to gauge various perspectives of key informants. Coding of interview transcripts was largely inductive (i.e. codes were based on the research questions); however deductive means were also used (i.e. new codes were developed when particular themes became clear in the transcripts); these included gender dimensions of the COE's strategies, and the role of local Village Councils. Finally, reliability and validity of the study was attained through triangulation of primary and secondary data (Yin, 2009).

4. Sub-Saharan African experiences in artisanal and small-scale mining demonstration and processing centres

The COE approach is not new, and SMMRP documents explain that COE approaches in Tanzania were inspired by other examples. "The experience of Chile shows that ENAMI, a State Mining Corporation, played a central role in development of a modern small and a medium mining sector in Chile. Similarly, the Minerals Commission of Ghana was instrumental in the success of ASM development" (World Bank, 2015). The World Bank's narrative of the Chile experience is that, "mining entrepreneurs began to emerge out of the small-scale mining business… and that ENAMI's support to miners stimulated a rapid growth of modern small- and medium scale mining enterprises and the phasing out of artisanal mining" (World Bank, 2015: 39). The emphasis on entrepreneurial activity is clear. It is important to note a difference between the Chile example and others mentioned below: the Empresa Nacional de Mineri´a (ENAMI) provided both small-scale and medium-scale mining firms with a range of services, including processing and purchasing (Castro & Sánchez, 2003). The MSM sector in Chile is much larger than in Tanzania, where it is still developing (see e.g.

Brightmore, 2019; and Schoneveld et al., 2018). This means that the success of ENAMI may be largely due to the MSM sector, and the Chile experience may be less relevant to the study of ASM.

The World Bank has also implemented the multi-sectoral Africa Higher Education Centers of Excellence Project, and has funded COEs in agriculture, oil and gas, health, water and other sectors. The project has funded some COEs on mining, including the Center of Excellence in Mines and Mining Environment (CEA-MEM) in Cote d'Ivoire and Copperbelt University Africa Center of Excellence for Sustainable Mining in Zambia. However, neither of these centres specialize in training the artisanal and small-scale sector.

World Bank support for ASM training dates from 1978 (Hilson and McQuilken, 2014). In the 1980s and 1990s, several training centres were established in various sub-Saharan African countries. The Shamva Mining Centre in Zimbabwe, built in 1989 to provide minerals processing services and training, was initially successful, increasing miner's incomes by up to 30% (Hentschel et al., 2002) but failed to increase its capacity to keep up with demand, and suffered management problems (Hilson, 2002a). In the 1990s, Zimbabwe (with UN support) established training centres for ASM (primarily focusing on alluvial gold mining), run by local governments. Gold marketing activities also took place at these centres (Spiegel, 2015). Several international donors supported training for ASM operators to reduce environmental impacts (ibid.). It should be noted then, that such centres were performing multiple roles. These programmes were highly decentralized, and local administrators had leeway to decide whether or not to issue legal permits to alluvial miners. Meanwhile, the legal framework for small-scale gold reef miners (mining in areas of hard rock) was extremely complicated, and the government offered not only technical training for reef miners but also legal advice about getting a permit (ibid).

In 2002, a "Train-the-Trainer" program was established, including pollution-reduction technologies, and business and organizational training (Spiegel, 2015). It was also supported by micro-finance programmes. This approach was widely viewed as successful, but over time the micro-finance mechanism became seen as corrupt, and facing economic recession, the government forced gold producers to sell to the Reserve Bank of Zimbabwe at very low prices. In 2014, the government set up gold buying centres and service provision centres, though the country's legal regime had already made many ASGM miners 'illegal' (Dube et al., 2016).

In Ghana, District support centres were established to register claims to mining areas, and provide technical advice to increase ASM productivity and safety (Hilson, 2002). The centres distributed basic equipment to miners and held two-week courses which, "emphasized health and safety, business management, environmental management, and technology" (Hilson, 2002b: 54). While these had some success, there were limitations. In the case of the Tarkwa District Centre, for example, locally-built equipment rented to ASM operators was unreliable, and artisanal miners were unwilling to use the laboratory at the centre in case they would face scrutiny for their unregistered ("illegal") activities (Hilson, 2007). Other technology diffusion efforts, such as the distribution of mercury abatement technologies (retorts) had limited success because technology was unaffordable or insufficiently durable (ibid.).

In Namibia, the government has established gemstone training centres in three regions, offering geological information, laboratories, and equipment rental. However, the state makes insufficient revenue from the gemstone sector to make the centres self-financing, causing analysts to recommend various complementary interventions to increase stakeholder coordination and improve productivity (Musiyarira et al., 2019).

Many centres in various African countries started with promising results, but became increasingly irrelevant over time, as their design had not been based on thorough research on the scale or nature of ASM activities (Hilson and McQuilken, 2014), or because inadequate awareness-raising had been done to raise demand (Hilson, 2007).

Reviewing the literature, Stocklin-Weinberg et al. (2019) conclude that ASM training programmes, "failed to make adjustments based on differences in local context and the unique attributes (necessities and motives) of each artisanal mining sector being targeted, which in turn results in inappropriate initiatives, misguided objectives, and poor results" (pg. 1534). Another issue identified by the late 1990s was that "technical projects were not sustainable; their achievements were short-lived because no income was generated to keep the project going after funding stopped" (Anonymous ASM expert quoted in Hilson and McQuilken, 2014: 114). Arguing that large scale central processing centres with state-of-the-art equipment offer the most efficient (and hence profitable) options for ASM, Zolnikov (2012) nevertheless accepts that centralized service provision is not widely accessible to ASM and that such centres require substantial ongoing government investment.

According to Hilson and McQuilken (2014), some problems with technical training and processing centres stemmed from assumptions about the nature of ASM. There was a dominant idea that artisanal miners were 'entrepreneurs' who would be able and willing to quickly build skills and scale up activities. However, in places such as rural Ghana, miners were typically "individuals crippled by hardship who were trying to sustain their livelihoods" and thus were unable and unwilling to pay for sophisticated services such as assaying (valuation). This situation is to some extent context specific: i.e. alluvial gold mining lends itself easily to the participation of the poor as it doesn't necessarily require machinery; other forms of mining need more capital investment and hence pre-financing and more sophisticated organization structures.

Stocklin-Weinberg et al. (2019) also emphasize that miners are likely to adopt new technologies and practices if it makes financial sense. Sustained government support is also key to encouraging improvements in practices and gaining accompanying environmental and health benefits (Zolnikov, 2012). These findings were used to generate the questionnaires used in our fieldwork.

5. Overview of centres of excellence in Tanzania

ASM accounts for more than 90 percent of employment in the mining sector in Tanzania (World Bank, 2015). Due to low investment, low productivity and use of informal marketing channels, it is estimated that ASM currently produces a mere 10% of all minerals (mainly gold, silver and copper) in the country (ibid). However, ASM still dominates production of gemstones, copper ore, iron ore, tin, bauxite, industrial minerals and building materials (Huggins and Kinyondo, 2019).

The idea of establishing COEs in Tanzania dates from the 1990s. The 1997 Mineral Policy called for "establishing centres of technical excellence in various fields for capacity building, and setting up mechanisms for exchange of knowledge and experience" (Tanzania Mineral Policy 199721). This policy also intended that intellectual transfers were realized through "promoting linkages among universities, colleges, research institutions and industry for the productive utilization of their interdependencies for mineral sector development" (Tanzania Mineral Policy 1997, 28). In terms of training opportunities, the Moshi Regional Vocational Training and Service Centre (VETA – Moshi) has been providing training in mining expertise since 2008 (with donor support) and the Mineral Resources Institute (MRI) in Dodoma also runs courses for small-scale miners. Neither of these facilities provide training which is affordable for the average ASM worker, however.[2]

[2] For example, fees at the MRI are between 600,000 tshs (US $260) and 1 million Tshs (US $ 434) per semester. This is a significant sum in Tanzania, which has a per capita GDP of US $1050 (World Bank, 2020). Moreover, students will also require funding for accommodation, food and incidental costs. For this reason, they usually require sponsors (see e.g. Lanka, 2018).

The government of Tanzania's has over the past decade engaged in various resource nationalist strategies aimed at increasing state control over the extractive industries and maximizing state revenues (Pedersen et al., 2019; Kinyondo and Huggins, 2019). The approach towards increasing benefits and revenues from mining has been two-pronged so far (World Bank, 2015). First, are efforts to re-negotiate the terms under which LSM operates, and to improve linkages between LSM and local communities. The second approach entails encouraging formalization of ASM thereby inculcating "entrepreneurial" and employment opportunities in the mining sector (World Bank, 2015: 4). To achieve these two policy development objectives, the government, with the help of the World Bank, initiated the SMMRP in 2009 with the view to complete it by June 30, 2015 (Ministry of Energy and Minerals, 2015). Among other successes, SMMRP helped in updating the mining regulatory framework (e.g. the Revised Mining Act of 2010 and the corresponding Mining Regulations). This was accompanied by a subproject called *strengthening environmental and social management*, which strengthened the policy framework for the mining sector. Moreover, seven COE were originally planned under the SMMRP program (Mutagwaba et al., 2018). They included Buhembe (Mara), D-reef and Kapanda (Mpanda), Itumbi (Chunya), Katente (Geita), Kyerwa (Kagera), Maweni (Tanga) and Masakasa/Mkwenyule (Kilwa). The cost to establish the centres is estimated at US$ 8.4 million. The original idea of the COE was to make them centres for processing minerals owned by ASM, *and* learning centres for sustainable management of mining operations by ASM (Ministry of Energy and Minerals, 2017).

Following some tangible successes from SMMRP, the government asked the World Bank to extend financing of the project for three years. While SMMRP II maintained the original objective of SMMRP, it added an emphasis on improving benefits for Tanzania and Tanzanians. Specifically, SMMRP II is meant to help ASM access suitable mining areas (based on geological information), create training and demonstration centres, increase the value addition of minerals, and help ASM build markets and access finance (Ministry of Energy and Minerals, 2015). According to the Ministry of Energy and Minerals (2015), SMMRP II was aimed at implementing three main activities. They include: 1) supporting Zonal Mining Offices (ZMO) through extending existing office facilities to create space for conference rooms, etc.; providing demonstration materials; preparing and disseminating training manuals; and training of trainers 2) establishing seven Centres of Excellence in mining hot spots throughout the country so as to improve processing technology among ASM and 3) scaling up the current Small Grants Program under the Project. The assumption was that small grants would help ASM to upgrade technologies and skills and reform their organizational and business arrangements. Beneficiaries had to provide Environmental Protection Plans (EPP) for them to qualify into the program. The EPP covers project areas and includes potential impacts, risk assessment and mitigation measures. The small grants programme of the SMMRP was suspended due to suspicions that beneficiaries were not selected in a transparent way (Merket, 2018); Pedersen et al., 2019) and because some recipients converted grants into commodities for personal use (cars, for example).[3]

The original governance framework of Centres of Excellence gave the State Mining Corporation (STAMICO) responsibility for providing, on a cost recovery basis, geological and mining advisory services to PML holders as well as managing demonstration sites (World Bank, 2015). Meanwhile, being licensing authorities, ZMO were expected to host and manage training and capacity building centres aimed at transforming ASM in Tanzania. To this end, ZMO are tasked with providing extension services, facilitating knowledge exchange, disseminating relevant information on best practices and appropriating technologies as well as ensuring compliance with relevant laws and regulations (World Bank, 2015). In the meantime, the Geological Survey of Tanzania (GST) is supposed to conduct geological surveys to identify promising areas for ASM to assist the government to designate ASM mining sites. Finally, under the COE arrangement, the Tanzania Investment Bank (TIB) is expected to provide financial services and grants to PML holders with Manufacturing Associations expected to provide PML holders with appropriate technologies (World Bank, 2015).

After geological surveying, some of the seven sites for the planned COEs were found to be unsuitable. The number was then reduced to four COE sites. Also, the Ministry of Mines has introduced a distinction between demonstration centres (model mines with processing facilities) and centres of excellence (focusing on training). As both are relevant to our research questions, we have included in this research a model mine (Lwamgasa site, Geita Region) which was originally established in partnership with an LSM firm, AngloGold Ashanti (World Bank, 2019b). The full list of sites is: Katente, Geita Region (gold), Lwamgasa, Geita Region (gold), Itumbi, Chunya District, Mbeya Region (gold), Mkwanyule Kilwa District, Lindi Region (salt), and Kona Z, Tanga Region (limestone). The World Bank argues that the processing technology at the Lwamgasa site, "could accelerate the adoption of its production model by ASM entrepreneurs throughout Tanzania" reiterating the 'entrepreneurial' model (World Bank, 2015: 47).

ASGM is still dominated by mercury amalgamation techniques, harmful to public health and the environment, and inefficient at gold recovery (recovering a maximum of 40% of the available gold). In the late 2000′s, Zimbabwean investors introduced vat leaching, using cyanide, which is more efficient. Medium-scale Chinese, Middle-Eastern and European investors, followed and basic vat leaching plants were fairly common by 2012 (Schoneveld et al., 2018: 31). Merket (2018) estimates that there are around 200 cyanide plants in four regions where ASGM is common (Geita, Shinyanga, Mara and Kigoma). However, mercury amalgamation is still the norm for many artisanal operations.

Following vat leaching, an elution process is used to remove the gold that is loaded onto activated carbons during the leaching process. Elution machinery is more expensive than leaching equipment and requires a steady supply of electricity, so there are fewer elution facilities: about 12 in Chula town, which serve the Lupa Goldfields, for example (ibid.). Much of the contemporary technological change in the ASM sector is driven by Chinese businesses which provide chemical inputs, machinery, and processing services, and Chinese investment may be leading some movement of small-scale operations towards MSM (Schoneveld et al., 2018). However, the model used is one of direct control of ASM activities by external investors, and the use of non-local technical experts (ibid.) This has led observers to argue that, "the MSM model that is emerging in Tanzania is more likely to conflict with rather than support the upgrading of ASM." (Schoneveld et al., 2018: 68). This narrative undermines the linear model of ASM growth and formalization.

6. Analysis of key stakeholder viewpoints

6.1. Financial sustainability

Due to delays, the centres were built but had not become functional by the end of the World Bank project, and the Government was obliged to provide money to make them functional. The World Bank suggested that, "The GoT's budget of TZS 6 billion may not be adequate for the four sites" (World Bank, 2019b). Due to budgetary constraints and an intention to install state-of-the-art facilities, some components of the centres were changed. For example, it was originally planned that the Lwamgasa centre would use a gravitational system to recover gold from mineralized material. However, as this technology is seen as basic and inefficient, a decision was made to install vat leaching and carbon in pulp (CIP) technologies. These have a higher recovery rate than

[3] Interview with civil servant, Dar Es Salaam, October 2018.

gravitational systems. However, they are expensive, which meant that some other activities at the Lwamgasa COE were scaled back. In addition, financial support for a tailings storage facility was provided by multinational mining firm, Geita Gold Mine (GGM). As Lwamgasa was provided with sophisticated recovery systems, a decision was made that nearby Katente COE specialize in complementary services, such as laboratory services, training, and equipment leasing.

Few participants were concerned with issues of financial viability, as there are likely to be several revenue streams at COEs. Lwamgasa COE will have a working mine, with a concrete shaft (rather than the typical wooden supports). There will also be a separate, but adjacent site where a local ASM cooperative will mine gold, supervised by COE management. Participants noted that gold recovered from these two mines will be processed at the centre, from which the government will earn royalties and fees.[4] The mine site was chosen with the assistance of the Geological Survey of Tanzania (GST) which gave most participants confidence that the mine will be productive. The site will also be able to process gold mined elsewhere in Geita region, assuming that its fees are competitive. Knowledgeable participants provided information on proposed fee payment modality. Specifically, rather than only accepting payment for processing services in cash, one government official proposed payment in kind (in minerals). For example, a client processing mineralized material would pay for the services as a percentage of the total minerals. One of the potential advantages of this approach is that it would be accessible to those, such as artisanal miners on the PSA system, who do not have ready access to cash. This might make the centres more useful to a wider range of ASM actors. It is important that the 'revenue maximization' emphasis of recent state intervention in the mining sector does not lead to excessive fees being charged, which will reduce access to the COEs by a range of actors.

At Katente, various activities, such as equipment rentals, extension services, and provision of elution gold recovery processes will all generate revenue. While few participants expressed concerns over financial viability, one NGO participant noted, "a lack of revenue management framework in the mining sector" and pointed out that revenue from such sources would have to be 'ring-fenced' for use only for COE's operations (rather than being transferred to central government for other purposes). Indeed, several participants noted that other processing and training centres in Tanzania had failed in the past because of a lack of effective cost-recovery mechanisms.

6.2. Technical capacity

Participants knowledgeable about the equipment and service installed at Lwamgasa and Katente centres argued that the technical capacity was appropriate. Importantly, the vat leaching and carbon-in-pulp systems do away with one of the most significant ASGM environmental and public health risks: the use of mercury. These systems therefore represent the most efficient processing systems in the country; at the same time, they are already in use in some medium-scale commercial processing sites around Geita. They are thus not beyond local technical capacity. Moreover, one participant who knows the project well observed that the processing systems have been modified to suit ASM, which implies that they will be easier to maintain. One participant added that processing equipment had been sourced from China, and technology (and marketing systems) has support from the Chinese state, so that access to materials, spare parts, and technical knowledge might be good.[5] Capacity of the COEs to manage and maintain the processing systems properly is important, as cyanide poses a potential health and environmental risk, and carbon products from processing have to be recycled and disposed of properly (World Bank, 2015).

At the same time, one participant pointed out that the vat leaching and carbon-in-pulp systems are too expensive for most ASM operators to purchase themselves; the 'technology transfer' aspect of the Lwamgasa COE is therefore questionable.

Several participants observed that COEs will be staffed by trained geologists, mining engineers, and mineral processing engineers. However, participants were unable to provide specifics about the number of people to be employed. They mentioned that the range of services available at the COE's would be expanded once they were successfully operating. One participant pointed out that, though government had previously tended to provide short-term training (e.g. a day or less) this would offer longer-term support, close to where miners are working.

If equipment rental services are provided in future, this may fill a gap. According to Merket (2018), "there is a dire need for training and accessible information on mechanization", because some ASM operators buy unsuitable equipment.

6.3. Demand for COE services

A participant familiar with the project mentioned that demand had been assessed through a major ASM survey; and consulting with ASM associations. A survey was undertaken in 2014 under the SMMRP, (see Table 1, below, from World Bank, 2015). The survey sought to ascertain whether the ASGM operations in the area generated sufficient surplus for miners to afford to pay for services at the COEs.

Most participants agreed that there is sufficient demand for services offered by COEs. Several participants, especially artisanal miners and other private sector actors said that geological surveys were particularly important. Those directly involved in the COE confirmed that geological information would be made available, though details are not yet available. Two participants mentioned the need for mining equipment to be available, but were concerned that it would be unaffordable for ASM. Several participants mentioned the need for training and support in issues that were key services offered by COEs, including financial literacy and health and safety. One participant was concerned about security in COEs and argued that closed circuit television should be installed so that miners could be sure of the integrity of the process as their minerals move between different stages of processing. On this note, a government participant confirmed that COEs will have rooms where clients can rest or sleep while their minerals are being processed, so they can feel more confident about security.

Most of the participants believe that sufficient demand exists, but three participants (from NGOs and the private sector) warned that services would have to be calibrated with demand to avoid becoming irrelevant over time. Other participants insisted that a communications strategy would be needed to ensure that ASGM actors understood what was available: "they have to be told the benefits of centres, otherwise they will turn into white elephants" [unused facilities].

6.4. Links to ASM formalization

Discussion over formalization of ASGM revealed several debates. Firstly, there is the question of whether the COE's should provide services to all miners, or only to those with a PML. Almost all participants said that COEs should serve all miners equally. However, one participant from the private sector argued if non-PML holders were served, the government would be encouraging 'invasions' of mine-sites by non-PML holders. Some participants, while saying that all miners should be

[4] It should be noted however that incentives (i.e. competitive fees for mineral recovery) and other measures (such as close monitoring of the mine sites by government personnel) may be needed to prevent gold being transported off-site and sold informally.

[5] While there is capacity in Tanzania to maintain, repair and customize the technologies, the base machines themselves have to be sourced from outside of the country.

Table 1
Baseline Survey of Selected Artisanal and Small-Scale Mining Operations in 3 Districts of Tanzania.
Source: Baseline Survey of Artisanal and Small-Scale Mining, Ministry of Energy and Minerals, 2014.

Mining (monthly production)	Tarime	Geita	Chunya
Average Number of miners pit	15	15	16
Investment working capital, Tsli	9,000,000	5,250,000	6,000,000
Monthly Production (sacks of ore)	538	100	200
Production (grams of gold sack of ore)	3	20	7
Selling price sack of ore, Tsh	150,000	50,000	40,000
Income, Tlis	80,700,000	100,000,000	56,000,000
Gross profit, Tsh	**71,700,000**	**94,750,000**	**50,000,000**
Shareholders income, Tsh	–	37,900,000	–
Owner's income (30%), Tsh	21,510,000	28,425,000	14,000,000
Miners overall earnings share (70%), Ths	50,190,000	28,425,000	6,000,000
Income share for each miner, Tsh	**3,346,000**	**1,895,000**	**2,250,000**

served equally, did add that there should be further requirements. One NGO representative said that those without a PML should at least demonstrate that the minesites meet minimum safety and environmental standards. A government participant also suggested that to receive services, miners might in future have to present an Environmental Protection Plan (EPP), though this is not yet a formal requirement.

The second issue arising was the nature of the obstacles preventing formalization. Some participants, especially ASM actors, academics and the private sector, emphasized the importance of financial obstacles, (which could prevent acquisition of better technologies). Access to affordable financing, they said, would facilitate formalization. A smaller number of participants, from the private sector, were concerned that future regulations around ASGM (for example, any ban on mercury use, or imposition of expensive monitoring and reporting requirements) could impede ASGM production overall. A poorly-designed formalization process, in their view, could block potentially reduce demand for COEs. One ASM actor warned that if forced to formalize, ASGM groups could have internal disputes over distribution of profits.

The third issue arising was the role of different actors in facilitating formalization. Using the example of the Lwamgasa Village mining Cooperative, one participant (directly involved in establishing the COEs) argued that Village Councils could play a role in assisting miners to formalize. Another participant argued that ASGM could formalize 'organically' if they could increase their productivity. Participants also warned against confusing 'legalization' with formalization. Legalization approaches, they argued, tended to emphasize bureaucratic requirements that cost ASM money but did not increase productivity. This concern is linked with the revenue maximization emphasis of resource nationalism. Kinyondo and Huggins (2019) warn that 'the developmentalist state in Tanzania will not hesitate to take very strong steps to force ASM to formalize and pay taxes' (pg. 186). Formalization should ensure productivity improvements, rather than use coercion, otherwise ASGM actors will continue to prefer to operate informally, and avoid COEs. The implication is that if miners see technological and other improvements resulting in greater productivity, efficiency, and hence profits, they will embrace formalization.

6.5. Institutional connections

The COEs have been separated into those, like Lwamgasa and Katente, which are run by STAMICO as 'model mines', and those COEs focusing on training, run by the Ministry of Mines. There are tensions within government over the roles and responsibilities of the two government agencies. In general, STAMICO is oriented towards technical issues, and is therefore positioned to offer ASM training; however, it has suffered financial and human resources limitations for many years and has a credibility problem. The Ministry of Mines focuses on managerial and governance aspects, and has more political influence. According to one participant, the original plan was for each centre to have cars provided; however cars were reserved for those centres run by the Ministry of Mines, not the STAMICO 'model mines'. This may have implications in terms of capacity of STAMICO's facilities. The tensions between the state agencies could reduce the COEs effectiveness especially if they attempt to undermine each other.

It is difficult to provide authoritative information on other institutional linkages, because COEs were not yet operational. One participant, directly involved with the COE project, confirmed that Geita Regional Miners Association (GEREMA) had been very involved, although the ASM actors said that not all miners were aware of what COEs were planning. Another government participant confirmed that the national ASM association, Federation of Miners Association of Tanzania (FEMATA), played a role in the establishment of Lwamgasa centre. Local village councils, especially in Lwamgasa, were also involved. Geita Gold Mine has been involved at Lwamgasa, though it is not clear if it will continue to play a role in the running or maintenance of the COEs. However, links to local NGOs are weak. Several participants noted that there was potential for linkages with the Mineral Resources Institute (MRI) in Dodoma, as well as Universities, though these have yet to be developed. The clearest institutional weakness is the lack of coordination between STAMICO and the Ministry of Mines, which is in charge of the minerals trading centres. For example, there were different responses from government participants regarding links between COEs and trading centres. Two government participants stated that links were 'automatic' or 'direct' and implied that gold processed at a COE would have to be sold at a government trading centre; while another stated that there was no link at all. Yet another government participant suggested that trading centres will eventually be within COEs thereby making them one-stop-shop for training, processing and selling minerals. Meanwhile, one participant from the government stated frankly that "politics remain a huge obstacle" in the success of the COEs. While it is too early to say whether the COEs will forge the links with national (and perhaps international) organizations that could provide further opportunities, it is clear that lack of institutional cooperation among state agencies could limit COE effectiveness over time.

7. Discussion

While our findings are tentative as it may take years before the overall impacts of the COEs are clear, lessons can be drawn from this study. The government, while supporting ASM rhetorically and through certain policies, has also demonstrated its intention to increase state revenues from the sector. Evidence from state intervention in tanzanite mining, for example, suggests that the state is willing to impose greater control (such as deploying the military to mining zones) to ensure revenue collection (Huggins and Kinyondo, 2019). If the state uses the centres primarily to generate profits, rather than to serve miners, it will become less relevant over time to miners' needs. This is a matter of balance and responsiveness to changing contextual factors and demands.

There is also a question of whether the state may instrumentalize COEs to encourage certain types of formalization; for example by only providing services to PML holders. Such a policy would exclude the vast majority of miners. Another option is to require miners without PML to comply with basic minimum requirements such as ensuring environmental and safety standards before they can access COEs' services. However such an approach remains untested.

Formalization, it seems, must also be tied to increased productivity if ASM miners have to buy into the idea of COEs. The government should also note that formalization is not just a function of awareness (see Hilson, 2007) and availability of COEs but one of affordability. For instance, it seems like mercury is preferred to cyanide not only because it produces better results but because it is a cheaper alternative. The

same logic might be applied to mining tools, which might be more affordable to rent than buy.

COEs in Tanzania are built, among other things, on an assumption that miners are entrepreneurs (Fisher, 2018; Hilson and McQuilken, 2014) and that COEs will automatically enable ASM miners to formalize. However, we should distinguish between the small number of site managers, pit managers and other entrepreneurs in the sector, and ASM 'workers' benefitting from PSA. Many clients of the processing facilities are likely to be 'workers' rather than entrepreneurs, pursuing ASM activities to sustain their livelihoods. They may be expected to invest their profits outside of the mining sector rather than in technological or other mining investments.

The issue of sustainability of COEs also emerged strongly from interviews. While at the beginning donors, particularly the World Bank and GGM, played a crucial role in funding establishment of COEs, such a model is not sustainable (see Hilson, 2014). A cost-recovery model must thus be entrenched in all COEs. It is interesting to note that the government is keen to borrow from the traditionally enduring model of payment-in-kind from ASM. This model, which allows various shareholders to be paid using mined ore, is relatively cheaper and convenient especially to miners. It is important that the government's tendency to prioritize revenue collection does not result in the costs of COE services being increased over time, thus excluding many potential clients.

We noted that there seems to be ample demand for services from COEs in Tanzania. This fact was backed by the needs assessment survey conducted by the government (Ministry of Energy and Minerals, 2014, cited in World Bank, 2015). It is however, critical to understand what services are mainly demanded by ASM. Our interviews suggest that in addition to processing, two services are key: geological information and access to finance and financial literacy. Given the failure of the SMMRP small grants programme, this will have to be approached carefully.

The success of COEs relies on strong institutional linkages in and around the ministry responsible for mining. While it is still early days, we noted a power struggle between the ministry and STAMICO, which should be overseeing the implementation of COEs. Any interference will only be counterproductive, since managerial capability resides with STAMICO.

Perhaps the most surprising take-away from the study is the near-silence when it comes to gendered dimensions of COEs' operations. This partly reflects the very brief mention of gender issues in relevant project documents (World Bank, 2015). While clarity may come later, this observation provides an early sign of perpetuation of gender-blindness in state assistance to ASM. With the introduction of COEs, the government has an opportunity to address the issue but the strategy should be introduced from the start, rather than as an afterthought.

8. Conclusion

The concept of COE has been around for over four decades now. However, impacts have been patchy, suggesting that critical analysis is needed to ensure their relevance and success. Narratives around COEs (particularly from the World Bank) assume that ASM operations can formalize and grow as they are inherently 'entrepreneurial'. However, this assumption is problematic because first, ASM may benefit financially from remaining 'informal'; and second, profit maximization does not necessarily require 'growth' in the classic sense. The use of improved processing technologies, for example, does not 'automatically' lead to formalization of ASM. Further, while a small number of ASM actors are managers, ASM activities are also driven by the need for unpaid or poorly-paid workers to sustain their livelihoods. The urge for business expansion or formalization may thus be secondary in the ASM sector; something which must be internalized in the COE arrangement.

The study also shows that to attract miners, COEs may have to provide in-demand services such as equipment rentals, geological information, accessibility to loans, and training on financial literacy. Crucially, COEs will have to be financially sustainable. Experience suggests that sustainability can only be attained if COEs have an in-built cost recovery model rather than relying on external funding. In addition, lasting institutional linkages within and without the ministry responsible for minerals are crucial in making COEs work, and avoiding damaging struggles between state agencies that may thwart strategic planning.

Declaration of Competing Interest

None

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Supplementary materials

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