

VALIDATING AN ENVIRONMENTAL MANAGEMENT ACCOUNTING PRACTICES FRAMEWORK FOR THE GREENING OF ZIMBABWEAN GOLDMINING

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Abstract: The impact of gold mining on the environment remains a challenge despite its footprint being less than other mineral mining or farming. Through a comprehensive literature review, a conceptual framework was previously developed based on qualitative propositions to integrate environmental management accounting practices to address the impact of gold mining on the environment and other stakeholders. This work aims to enhance and validate our framework through interviews at mining companies and validate the resultant framework via a focus group at one of the mining companies. Some important findings from the interviews and the focus group are that government should play an active role in encouraging innovation in greening the sector, managing the environment, and providing safe water. The sector should be regulated and monitored; waste should be reduced through EMAPs, including Activity-Based Costing. Participants were less knowledgeable of other EMAPs, such as Material Flow Cost Accounting and Life Cycle Costing. Regarding sustainability, the sector's negative impacts outweigh its positive contribution through failure to invest in greener technology. Illegal mining has further damaged the image of gold mining. Implications for theory and practice, management and policymakers are considered. Future work will involve case studies in Zimbabwean gold mines.

Keywords: Activity-Based Costing (ABC), Environmental Management Accounting Practices (EMAPs), Life-Cycle Costing (LCC), Material Flow Cost Accounting (MFCA), sustainability.

Introduction

The mining sector is one of the major sources of revenue in the Zimbabwean economy (Munowenyu, 1996), contributing 5% to the country's GDP and 23% to total exports, respectively, providing much-needed foreign income (Mapira, 2017). Gold mining, for example, has become an essential economic activity in many African countries (Weng *et al.*, 2015). Zimbabwe is being undertaken by different social groups (Mkodzongi & Veronica, 2020). Over one million people are estimated to be employed in the gold mining sector in Zimbabwe (Pact Institute, 2015). Mining, the provider of inputs required by other industrial sectors, is essential in sustaining the functionality of global economies and population well-being (Mancini

& Sala, 2018). The authors note that mining can generate adverse environmental impacts besides its positive impact. Hence, improvement of the sustainability performance of the sector is critical.

The environment has been adversely impacted by excessive consumption of scarce natural resources (Moors *et al.*, 2005). Concerning manufacturing, a related economic activity, natural resources account for 50% of a manufacturing company's overall operating costs (Sygulla *et al.*, 2011), indicating a high demand for natural resources. It should be noted that 20% of these operating costs are usually ineffectively exploited during manufacturing (Jasch, 2009; Doorasamy, 2014). Based on the above argument, it means that manufacturing comes at a cost

to the environment despite its contribution to the economy. These environmental costs have been obscured in traditional cost accounting systems as general overheads, making it hard for management to observe and identify them (Ferreira *et al.*, 2010).

Scholarly debates have reflected and tested the resource curse theory, which claims that countries with abundant natural resources grow slower than countries with limited natural resources (Cai & Newth, 2013). However, results from empirical tests provided divergent results, and researchers concur on the role that institutions and governments can play in determining the outcomes (Mehlum *et al.*, 2006; van der Ploeg, 2011). Furthermore, environmental accounting is gaining momentum due to the search for sustainable companies (Christ & Burritt, 2015). Using EMA and implementing environmental strategies have been viewed as key competitive advantages for companies (Gunarathne & Lee, 2015). The move towards sustainable companies calls for a planning process that integrates all key stakeholders and concepts (Latan *et al.*, 2018).

In this article, the environmental impact of Zimbabwean gold mining on the natural environment is traced through previous work by the authors, which resulted in the formulation of a conceptual framework to promote sustainable gold mining in the said context. The framework is subsequently enhanced through a set of interviews among stakeholders in the industry, followed by a focus group to validate the enhanced framework.

The layout of the article is: We present our research objectives next, followed by a condensed literature review that led to a conceptual framework developed in previous work. After that, we present the research methodology that underpins this research, followed by a discussion of the findings from the interviews used to enhance the conceptual framework. The framework is subsequently validated through a focus group. Implications for theory and practice, management and policymakers are presented. Conclusions and

future work in this area is presented towards the end, followed by a list of references and two appendices.

Research Objectives (OBJs)

From the above introduction, the following objectives are formulated:

- OBJ1:** Determine the roles to be played by institutional forces such as the government and other key stakeholders in facilitating a greener gold mining sector.
- OBJ2:** Elicit the effects of gold mining operations on the environment.
- OBJ3:** Establish the information needed and strategies that gold mining companies could employ to reduce waste.
- OBJ4:** Formulate the characteristics, benefits, and gaps of selected Environmental Management Accounting Practices (EMAPs) and how their integration may address the said gaps.
- OBJ5:** Enhance the conceptual framework previously developed and validate the resultant framework.

Literature Review

As the world population increases, more demands emerge for natural resources like fresh water, minerals, and so forth (Eze *et al.*, 2015). Mining operations are particularly resource-hungry, and despite the need for resources, the Zimbabwean mining sector contributes much to the country's Foreign Direct Investment (FDI) (Murombo, 2013). That said, Zimbabwean gold mining has led to numerous challenges, chief among these are impacts on the environment and animal and human life, leading to poor health and affecting general well-being (Mactaggart *et al.*, 2016; Smith, 2019).

In this literature review, we trace previous work concerning the environmental challenges of gold mining as linked to sustainability, the role that could be played by Environmental Management Accounting (EMA) and its tools,

namely, Material Flow Cost Accounting (MFCA), Life-Cycle Costing (LCC), and Activity-Based Costing, and finally the role of government. We conclude that a combined approach to all these oughts will be followed. A conceptual framework previously developed (Nyakuwanika *et al.*, 2021) is presented.

Environmental and Human Impacts

The Zimbabwean gold mining industry incurred hardship in local communities through the pollution of air and freshwater, loss of grazing land, coupled agricultural challenges, and forced eviction and relocation of communities without fair compensation (Dhliwayo, 2013; Murombo, 2013), leading to social injustice (Morrice & Colagiuri, 2013). Fauna and flora are also affected by mining operations; land formations are changed; untreated waste may be dumped; effluents like Acid Mine Drainage (AMD) are formed; and noise pollution may result because of ongoing mining operations (Sahu *et al.*, 2015).

Globally, deforestation and climate change may result as mining operations increase worldwide (Freeman, 2002). Gold mining operations also lead to an influx of the population (Hresc *et al.*, 2018), changing the demographics, resulting in an increased demand for natural resources, accommodation and housing, in turn leading to an increase in the price of properties (Haslam Mckenzie & Rowley, 2013).

Sustainability

The above challenges compromise the United Nations Sustainable Development Goals (SDGs) formulated in 2015 [United Nations Development Programme (UNDP), 2015]. The gold mining industry should also reduce its environmental footprint to support Agenda 2063 [African Union (AU), 2015]. The SDGs and the Agenda 2063 strive for long-term sustainability for the environment and all living beings. The UN (2012) notes a lack of common ground and definitions that amalgamate sustainable development in

existing frameworks to address sustainability in sustainable, greener gold mining. This observation gave impetus to the conceptual framework developed by Nyakuwanika *et al.* (2021), which the current article seeks to enhance and validate, as discussed later.

Nyakuwanika *et al.* (2021) proposed the use of Environmental Management Accounting (EMA) together with its underlying tools, namely, Material Flow Cost Accounting (MFCA), Life-Cycle Costing (LCC), Activity-Based Costing (ABC), and MFCA subsidiary's Monetary EMA (MEMA) and Physical EMA (PEMA) as an important step towards the greening of gold mining.

Environmental Management Accounting (EMA)

Deegan (2008) confirms that traditional environmental costing exercises did not attempt to reduce the said costs. As the tracing of these costs became increasingly important, accounting methodologies like EMA, carbon management accounting (CMA), and greenhouse gas accounting (GHGA) came to the fore (Tsai *et al.*, 2012). As indicated, EMA as a generic term, includes monetary and physical EMA. Monetary (MEMA) addresses environmental aspects of organisational activities expressed in monetary terms, while PEMA focuses on an organisation's impact on the natural environment in terms of physical units (Burritt *et al.*, 2002).

The gold mining industry has adopted various voluntary codes and standards, for example, the ISO 14001 Environmental Management System and the International Council on Mining and Metals Sustainable Development Framework. EMA is defined in ISO 14001 with one of its major tools, focusing on internal decision-making (ISO - Central Secretariat, 2011). A brief discussion on the EMA methods, namely, MFCA, LCC and ABC, to cost environmental impacts (du Plessis & Oberholzer, 2014). Nyakuwanika *et al.* (2021) present a more detailed discussion of these.

Material Flow Cost Accounting (MFCA)

Schaltegger *et al.* (2006) confirm that cost reductions can be achieved by managing material flows positively affecting our environment. Consequently, MFCA as an accounting method, aims to improve resource efficiency by categorising product costs and waste, all based on the flow of materials (Onishi *et al.*, 2008; du Plessis & Oberholzer, 2014; Schmidt *et al.*, 2015). MFCA can, therefore, lead to cleaner production by improving the flow and utilisation of products moving through the system (ISO - Central Secretariat, 2011; Bhardwaj, 2014). Any output that becomes a non-product is considered waste (Kokubu *et al.*, 2009).

Secretariat (2011) and (Kokubu *et al.*, 2009) indicate that MFCA is universally applicable, i.e., it applies to any organisation or product, management, or accounting system. Consequently, it would apply to the gold mining sector in a developing economy like Zimbabwe. MFCA is viewed as the most fundamental EMAP (Kokubu & Tachikawa, 2013), yet it incurs several disadvantages. Since MFCA only assists in calculating costs associated with products and waste, it does not calculate total environmental costs (Kokubu *et al.*, 2009). As a result, the full benefit of EMA may be achieved by using MFCA in conjunction with other EMAPs (du Plessis & Oberholzer, 2014), calling for an integrated conceptual framework like the one developed in Nyakuwanika *et al.* (2021).

Life Cycle Costing (LCC)

The complete cost of a waste-management system needs to be gauged in addition to the cost of a treatment method (Zhou *et al.*, 2017). This leads to the idea of life-cycle costing (LCC) whereby the accumulated cost of a product is estimated over its entire life cycle (du Plessis & Oberholzer, 2014). For example, concerning manufacturing, one should consider expenses that occur during the pre- and post-manufacturing phases of a product (Boussabaine & Kirkham, 2004). Using LCC as an EMAP may, therefore, assist the gold mining industry in

gauging the complete cost of waste management over the entire life of a gold mining project. Consequently, LCC is included as an EMAP in the conceptual framework of Nyakuwanika *et al.* (2021).

Activity-Based Costing (ABC)

ABC was developed to address overhead costs associated with products or services (du Plessis & Oberholzer, 2014). ABC is an effective way to estimate the cost of production, using activities and cost drivers (Boussabaine & Kirkham, 2004) while at the same time paying attention to environmental considerations (Tsai *et al.*, 2012).

Through conducting a detailed assessment of a supply chain, an optimal configuration of the chain is achieved by equally distributing costs and benefits (Lalonde & Pohlen, 1996). ABC allows management to better understand why costs arise, enabling them to embark on Activity Based Management (ABM) (Kinney & Raiborn, 2008; Schulze *et al.*, 2012). Consequently, the conceptual framework in Figure 1 embeds ABC as an EMAP, facilitating decision-making for costs incurred in the gold mining industry.

The Role of Government and Other Stakeholders in Sustainable Development

It is generally accepted that governments should act as a catalyst for change (Van der Walddt, 2016). Therefore, environmental regulations should be in place, especially for the gold mining industry (du Plessis & Oberholzer, 2014; Henriques & Sadorsky, 1996).

The conceptual framework developed acknowledges the important role to be played by the government through legislation. This also came out during the stakeholder survey, described further in this article.

Integrating Techniques and Methods

While a substantial body of literature is available on the separate EMAPs, MFCA, and LCC, limited work has been undertaken on the relationships among these or combining

these into a comprehensive approach towards achieving sustainability. We postulate that there is a need to integrate the said EMAPs.

Combining several EMAPs supports an important principle of sustainability, namely, to maximise a single goal and to integrate and balance several mechanisms to address environmental challenges (Thiele, 2013). The conceptual framework presented in Figure 1 is an important step in this direction. Using primarily environmental management accounting, the framework aims to address environmental challenges by greening the Zimbabwean gold mining industry.

Nyakuwanika *et al.* (2021) formulated several propositions to assist with the construction of the conceptual framework. A proposition in this context is essentially a qualitative guideline concerning an observation or a suggestion. The propositions are of three kinds and are discussed.

Classification of Propositions

The propositions indicated in Figure 1 are embodied by content, association, and general propositions:

- Content propositions, labelled as C_{pi} , $i = 1, 2, 3, \dots$, of which the purpose is to identify the various content-related building elements of the framework.
- Association propositions, indicated by A_{pj} , $j = 1, 2, 3, \dots$, are used to define associations among the building blocks of the framework.
- General propositions denoted as G_{pk} , $k = 1, 2, 3, \dots$, are used to capture information that may be more generic to the development of the framework.

A summary of the propositions from Nyakuwanika *et al.* (2021) is given in Table 1.

Table 1: Summary of propositions

Proposition Number	Proposition Description
Content Propositions	
Proposition C_{p1}	Employees, who are internal to a mining environment, and the media, who are external stakeholders, may likewise exert pressure that motivates mining organisations to adopt strategies for greener gold mining.
Proposition C_{p2}	NGOs and other essential pressure groups assist in the diffusion of ideas among mining organisations, motivating them to adopt environmental management initiatives.
Proposition C_{p3}	Government and other key stakeholders may adopt legislation that may accelerate the rate at which organisations comply with environmental regulations.
Proposition C_{p4}	Government and other regulatory bodies with rich resources could exert numerous forces on mining organisations to adopt greener initiative practices and avoid penalties for failing to comply (refer C_{p2}).
Proposition C_{p5}	Stakeholder engagement helps build lasting beneficial relationships, and stakeholder mapping and identification of their needs are essential strategies for mining organisations.
Proposition C_{p6}	Social order within the mining sector may be based on a shared social reality. (Note that this may be a general proposition in other spheres of life.)
Proposition C_{p7}	Gold mining activities adversely affect the natural environment, leaving a strong footprint on the environment, arguably more than any other industrial activity.
Proposition C_{p8a}	ISO standards play an essential role in the governance of environmental regulations concerning gold mining and the development of EMAPs.

Proposition Number	Proposition Description
Proposition Cp8	ISO standards play an essential role in the governance of environmental regulations and the development of EMAPs such as MFCA.
Proposition Cp9	To be granted a social licence to operate (SLO), gold mining organisations should consider the societal needs of the communities in which they operate.
Proposition Cp10	Gold mining systems should have a management accounting system that determines wasteful activities and optimises costs.
Proposition Cp11	EMA may hold much promise to be employed to manage the gold mining sector’s various challenges.
Proposition Cp12	EMA divisions of PEMA and MEMA, together with carbon management accounting (CMA) and greenhouse-gas accounting (GHGA), may provide essential information for the sustainable management of the challenges facing gold mining.
Proposition Cp13	MFCA, as an EMAP, supports eco-efficiency decisions that enhance resource efficiency to improve the economic and environmental performance of a mining organisation.
Proposition Cp14	MFCA assists in achieving resource and energy efficiency, as it facilitates the speedy availability of waste information.
Proposition Cp15a	MFCA can assist gold mining organisations in reducing waste to enhance the economic and environmental performance of the gold mining sector.
Proposition Cp15	<p>Proposition Cp15: MFCA can assist gold mining organisations in economic and environmental performance through:</p> <ul style="list-style-type: none"> ➤ reduction in waste; ➤ improved energy usage; ➤ improved decision-making and accountability.
Proposition Cp16a	LCC may be implemented in conjunction with MFCA by the gold mining sector following the principles of sustainable development, thereby considering the economic, social, and environmental aspects of an investment project.
Proposition Cp16	<p>Proposition Cp16: LCC may be implemented in conjunction with MFCA by the gold mining sector to facilitate:</p> <ul style="list-style-type: none"> ➤ principles of sustainable development; ➤ economic, social, and environmental aspects of an investment project; ➤ feasibility of environmental management strategies; ➤ cost savings; ➤ enhanced decision-making.
Proposition Cp17	ABC may be used with the aforementioned accounting strategies to assist with product-related decision-making for the gold mining sector, focusing on accurately assigning product overhead costs.
Proposition Cp18	The gold mining industry in a developing economy with limited resources may benefit through adopting and integrating various EMA strategies, notably MFCA, LCC, and ABC.

Proposition Number	Proposition Description
Association propositions	
Proposition Ap1	An association is needed between applying EMAPs and meeting the objectives and goals of a mining enterprise.
Proposition Ap2	There is an association between meeting the objectives/goals of a mining company and expected results concerning cost savings and minimising environmental impacts.
Proposition Ap3	There is an association between accounting subject matter, EMA, and EMAPs such as LCC, ABC, and MFCA.
Proposition Ap4a	There is an association between aspects of social responsibility concerning sustainability and the expected results of a gold mining company.
Proposition Ap4b	There is a shared association between institutional forces, environment, governance systems and rules and legislation of a country.
Proposition Ap4	There is a shared association among corporate governance systems and structures (social responsibility) concerning rules: Legislation. Expected results of a gold mining company concerning sustainability strategy.
Proposition Ap5	There is an association between EMAPs concerning the EMA tools MFCA, LCC, and ABC and the environmental impacts of gold mining.
Proposition Ap6	There is an association between stakeholder pressure and environmental management (involving EMAPs) strategy adoption.
General propositions	
Proposition Gp1	Communication and engagement are essential among stakeholders to create a common vision.

Source: Nyakuwanika *et al.* (2021)

The propositions in Table 1 were subsequently used to construct the Figure 1 framework.

The framework is enhanced in this article through a set of interviews, followed by a validation using a focus group, but first, we present our research methodology used in the said surveys.

Materials and Methods

We utilised the research onion of (Saunders *et al.*, 2019), depicted in Figure 2, to develop the research methodology in this article.

Discussion of the Methodological Layers

As indicated, the researchers conducted a comprehensive literature review on environmental aspects of gold mining and EMA, culminating

in three sets of qualitative propositions in Table 1. The propositions were used to develop the Figure 1 framework. We indicate this as phase 1 of the work. The present article reports on in-depth interviews that were conducted (phase 2) to enhance the Figure 1 framework, and this was followed by a focus group discussion (phase 3) to validate the resultant framework. Consequently, starting from the outer layer of the onion, our research philosophy in this article is interpretivism since the responses from the interviewees and focus group members were interpreted. At the next layer from the outside, our theory development approach is inductive and deductive. It is inductive in that an existing framework is enhanced and deductive since the enhanced framework is subsequently validated. Amongst others, the researchers made generalisations using deductive reasoning.

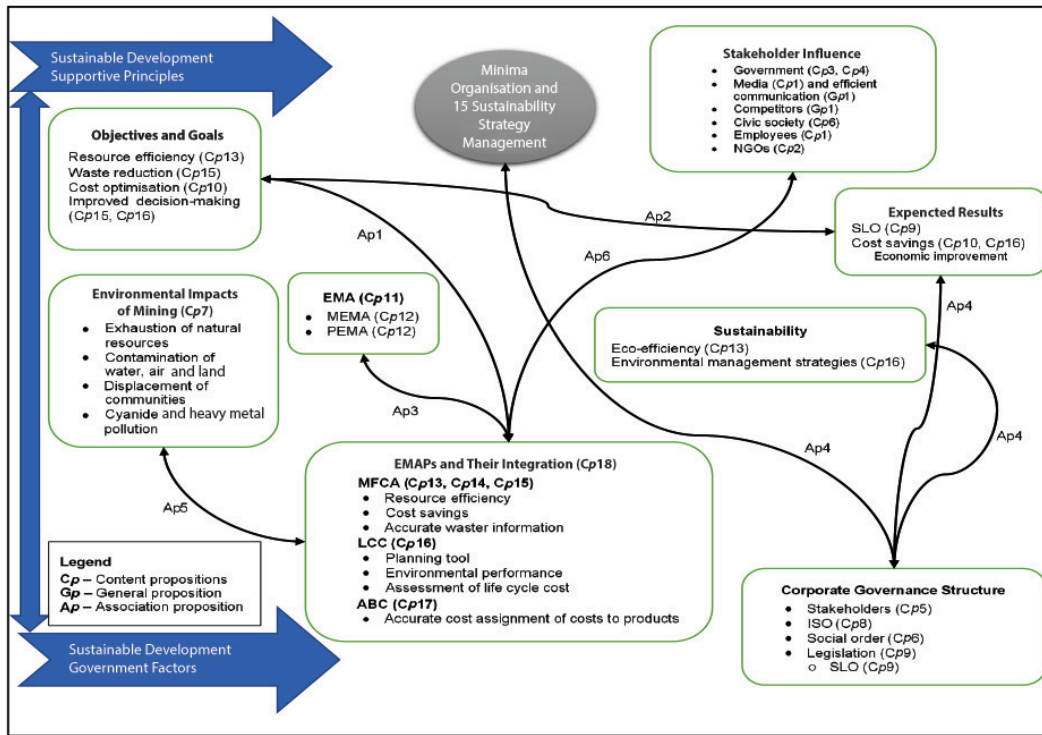


Figure 1: Conceptualising the Greening of Goldmining through EMA.
 Source: Nyakuwanika *et al.* (2021)

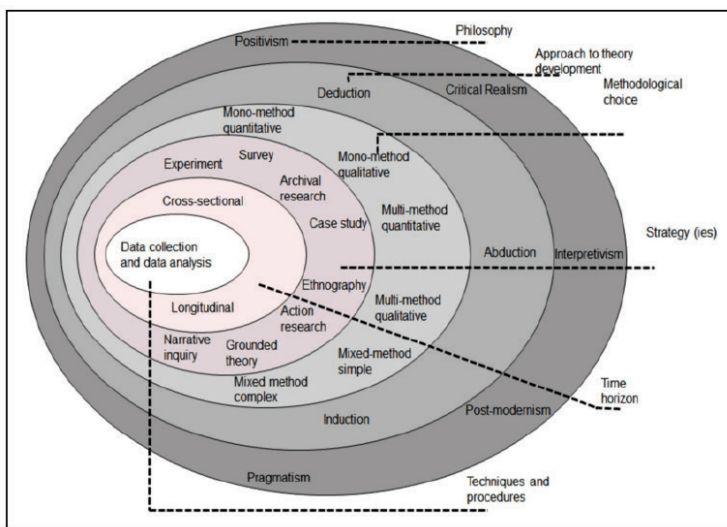


Figure 2: Saunders *et al.* (2019) Research Onion

Our research choice at level three is multi-qualitative since in-depth interviews and a focus group were conducted. The strategy at level four is a survey since surveys are done among humans - interviews and a focus group. In future

work, our strategy will become a case study as we move into companies to exercise the final framework that we developed. The time horizon of the present research is cross-sectional since the use of EMAPs in relationship with the

framework is examined largely at a specific time rather than over many years. Naturally, as case studies in the gold mining industry are conducted, the research could migrate to a longitudinal time horizon. The techniques and procedures at the innermost layer of the onion are characterised by data collection and analyses from the surveys (interviews and a focus group) among humans.

Towards the Qualitative Surveys

Personnel from goldmines in Kadoma, Bindura, and Gwanda in Zimbabwe were approached for in-depth interviews and a focus group. Each participant received a participant information sheet outlining the study's purpose and the rights of the interviews. Before being asked to participate in the research, interviewees had to sign an informed consent form. In addition, interviewees were assured that their responses would be kept anonymous, albeit this could not be guaranteed during the focus group. Appendix 1 presents the interview questions, whilst Appendix 2 presents the questions from the focus group. Ethical clearance for the surveys was obtained beforehand from the home institution of the researchers with identification ERC reference number 2021_CAS_037.

With a qualitative research choice, aspects of trustworthiness involving authenticity, confirmability, credibility, dependability, and transferability should be considered to ensure the reliability and validity of the research (Connelly, 2016). These aspects are addressed after reporting on the interviews and focus group findings.

Results and Discussion

In the following subsection, the findings from the interviews are discussed.

Interviews

A total of 12 interviews, coded as P1, P2, ..., and P12, were conducted and transcribed by a transcriber who signed a confidentiality agreement as part of the ethical clearance

approval. The interview guide is given in Appendix 1. The interview questions were factored in so that groups of them would provide answers to our first four (4) objectives above. Interview questions 1 and 2 in Appendix 1 aimed to meet our OBJ1, namely, to determine the roles to be played by institutions and key stakeholders to facilitate greener gold mining in Zimbabwe. The responses from the interviews are discussed in the sections that follow.

Roles of Institutional Forces and Key Stakeholders in Facilitating Greener Gold Mining

The first question in Appendix 1 asked:

“When you look at key stakeholders of the gold mining sector, which one exerts the highest amount of force and why?”

It was found that the Government, Ministry of Mines and Zimbabwe Environmental Management Agency (ZEMA) exerts the highest coercive pressure and has the greatest influence on the gold mining sector due to its ability to impose fines and withdraw its operating licence. This aligns with the argument (Phan *et al.*, 2018) that mining companies respond more positively to coercive pressure than any other type of pressure that may be applied to them.

The second interview question posed was:

“Do you think governments and other regulatory bodies must exert coercive pressures on companies to adopt greener initiatives? Kindly explain your answer.”

The interviewees' responses varied. Some argued that though coercive pressure is good, it should be applied with due diligence since it tended to reduce gold mining companies to compliers of the law. However, some companies proactively address environmental issues independently and do not need to be bossed around. Interviewees P5 and P6 pointed out the need to assist mining companies in developing a culture of environmental management and

accountability. They argued that culture should be blended with the training of employees on environmental management initiatives, which is essential in the long term. To emphasise the importance of culture, P5 remarked:

“We have a culture where an organisation is willing to resource in terms of human resources, to avail competent personnel in charge of environmental management, which alone indicates an enabling environment.”

A divergent view was that coercive pressure only affected companies polluting the environment and were the ones having problems with government agencies, whilst those that were environmentally responsible had little or no problems with government agencies. Participant P4, in support of this sentiment, responded as follows to the question raised:

“... we have principles in environmental management, and we have what we call pollute affairs principles, that one can only be affected by government agencies if they are polluting...”

Consequently, gold mining companies may need to proactively manage the environment and strive to innovate on environmental management issues. Furthermore, the government should provide a framework that encourages innovation and uses minimum force unless a company is negligent regarding the environment.

The responses to the above interview questions answer our **OBJ1**, namely, determine the roles to be played by institutional forces such as government and other key stakeholders in facilitating a greener gold mining sector.

Next, we posed questions to meet our **OBJ2**, which deals with discovering the effects of gold mining on the environment.

Impact of Gold Mining Activities on the Environment

The question concerning the impact of mining activities on the environment was:

“What are the impacts of gold mining on the environment?” (Question 3 in Appendix 1)

The interviewees revealed that there are both positive and negative impacts. The positive contribution of the sector was identified as the creation of employment opportunities for residents and the provision of safe water to local communities by drilling boreholes. Furthermore, developing the local community by constructing roads, bridges, schools, and clinics was also a positive. To emphasise the essence of community development, interviewee P1 remarked:

“We help them because we are in the community, and we are part of them. We need to access our mines and our employees need health care and drinking water.”

Many interviewees (P1, P2, P3, P4, P6 and P7) revealed that gold mining activities are not in harmony with environmental management and conservation since the desired mineral exists underground, beneath forests. They indicated that underground mining is the most dominant form of gold mining, though there are also instances of surface gold mining. A synthesis of responses revealed the following to be the major negative impacts of gold mining activities on the environment. Land degradation since vast amounts of vegetation, soil, and rocks have to be removed to access the mineral; displacement of people from mining areas, which normally results in conflicts with local communities; substantial industrial accidents owing to poachers who are disregarding sustainable mining principles; air pollution from dust that comes out when rocks are being crushed to extract gold; erosion of culture as many people from different areas come in pursuit of employment; and violation of human rights because of compromised safety and health of miners owing to poaching by unlicensed gold miners. Some of the responses from interviewees P3 and P6 were:

“We used to have a very decent community here with people who are well behaved, but with the intrusion

of these guys who come from outside, they brought their own culture. A mine attracts lots of people who come seeking employment. We also have intruders who come to poach our gold claims.” (P3)

“...we need to be digging the earth depending with (on) the type of mining that we will be doing. Sometimes it is open cast mining where you have large excavations so a lot of disturbances are done to the environment since you need to sort of take-out trees so that you can dig holes to extract the mineral.” (P6)

The preceding explanations support the idea that surface mining degrades the environment and reduces the ecosystem’s service values more than subterranean mining (Qian *et al.*, 2018), as well as the view that mining results in land disturbance and destruction of habitat (Sahu *et al.*, 2015).

The next interview question posed was:

“To what extent does it hold that gold mining leaves the strongest footprint on the environment more than any other industrial activity?” (Question 4 in Appendix 1)

A synthesis of the responses indicated that the impact of gold mining activities on the environment is far less when compared to other mining such as coal, platinum, and chrome, which are open cast since much of the gold mining is done underground and hence, gold mining does not leave the strongest footprint. In addition, P1, P4 and P5 indicated that farming, compared to gold mining, leaves the strongest environmental footprint because of the hectareage involved. Large land areas should be cleared to grow enough crops to feed the nation. Furthermore, gold mining gained a bad reputation since it attracted poachers or illegal miners not concerned with environmental management. In support of the above, P6 indicated:

“Most of (the) gold is extracted underground, and it’s done maintaining standards to achieve minimum dilution whilst the minerals outlined above involve surface mining and are more disruptive to the environment than gold mining.”

The above responses contrast the popular belief that mineral extraction generally has the most environmental impact of any economic activity (Sahu *et al.*, 2015).

The next question posed was:

“Which strategies have been employed by your company in managing ecological damage? And how have these assisted?” (Question 5 in Appendix 1)

A synthesis of the responses revealed the following: Goldminers use a lot of water to suppress dust during the crushing of rocks to extract gold; they do teach employees the importance of environmental management since it is a requirement of EMAG; Zimbabwe has a day set aside as a national tree planting day annually on 21 December and as part of the strategy, gold mining companies do observe this day and plant trees around their mining communities; effluent water from the plant is pumped, recirculated, and used in the plant to avoid flowing downstream and contaminating waterbodies; gold mining companies have gone on to create quarry companies that are crushing stones used in the construction sector as a strategy to manage waste rocks; and mining companies are working on minimising their footprint on the environment by adopting international accepted environmental standards. Interviewees P2 and P6 said:

“We teach our staff in terms of protecting the environment, and not unnecessarily cutting down trees, since we operate in a protected area.” (P2)

“We observe the national tree planting day by planting trees and ensure revegetation of the environment.” (P6)

From the above gold mining has both positive and negative impacts. The possible negative impacts need to be addressed using EMAPs, where possible, using the developed framework. The above discussion meets our **OBJ2** to elicit the effects of gold mining operations on the environment.

Next, we consider responses to the interview questions aimed at meeting our OBJ3, which is about strategies and information needed to reduce waste.

Strategies Employed and Information Needed by Gold Mining Companies to Reduce Waste Generated Through Their Activities

The first question posed concerning strategies employed and information needed by gold mining companies to reduce waste was:

“What are the major challenges in the gold process waste-reduction? What are the efforts that have been taken in an attempt to address these challenges?” (Question 6 in Appendix 1)

On challenges in the gold process of waste-reduction, the responses of most of the interviewees revealed the following: The nature of the rift being mined determines the waste being generated as a narrow rift tended to result in more waste than a wider rift; most gold mining companies lacked the capital to invest in modern waste-reduction technologies; adopting greener technology is very expensive owing to the Zimbabwean punitive tax system and the excessive duty charged by the Zimbabwean government on imports that hindered the adoption of greener technologies by the Zimbabwean gold mining sector.

The varied responses from the interviewees are: some of the mining companies are engaging in environmental awareness programs; communities are engaged to hear their expectations and how they can work together since they are affected by operations of the goldmine; most of the regulations governing goldmines in Zimbabwe are a copy and paste from other countries and engagement would

help in their diffusion and finding each other; and there is a need to invest in modern waste-reduction technologies since those that adopted them have been able to extract gold from ore that was deemed not extractable and thereby reducing waste being generated. P4 emphasised this by saying:

“We have a lot of stakeholders and I think engagement is very key because we need to find each other. Critical stakeholders that we have are regulators as I explain(ed) before (the) Environmental Management Agency. We need to engage because some of our challenges with the Zimbabwean regulations is the adoption of American regulations or British regulations. It is just copied and pasted like that.”

Some gold mining companies limit cyanide to acceptable levels before discharging effluent water into downstream operations. Cyanide levels are decreased using chemicals, and some are reduced naturally by exposure to the sun. Waste in other mining companies could be regarded as an asset. For example, some mining organisations convert waste rock into quarry stones sold to building contractors. Hence, such waste rocks are viewed as assets. Presently, no financially viable technology could be used to extract all available gold within the ore or rift, and what is regarded as waste is built up in tales, which become assets to the mining companies as they wait for gold to be extracted from them in future. P2 stated:

“...the waste in gold is your tales, and though gold could have been extracted within the tales, gold is never exhausted. As you extract it, whatever waste you throw away, you dump it somewhere. Then, as you improve, and as new mining methods are discovered (developed) you still revisit that waste which now sits as an asset and retreat that dump to get more gold because when we are looking at the mining aspects as you build up that dump you are creating value out of it.”

Hence, new technologies are needed to reduce waste; to this end, EMAPs are integrated into the framework to highlight and reduce waste. The above discussions meet our **OBJ3** to establish the information needed and strategies that gold mining companies could employ to reduce waste.

Next, we consider the interview questions aimed at meeting our OBJ4 to find the gaps and benefits of EMA's EMAPs and how the gaps may be addressed.

Benefits and Gaps of Selected EMAPs and How Their Integration Can Address Gaps Identified

The first question posed in this group was:

“How does the accounting system in use support environmental management or eco-efficiency decisions?” (Question 7 in Appendix 1)

A synthesis of the responses revealed the following: The accounting system does not support eco-efficient decisions owing to the nature of the reports that the environmental regulator requires, and the accounting systems used by most companies focus on financial accounting issues and not the environment. Responses from interviewees P9 and P11 were:

“Accounting system in use handles accounting issues only. It does not have other modules even to use by HR or plant processing, and hence it is just for accounting purposes.” (P9)

“We only subscribe to EMAG, which is the environmental regulator. They have what they call quarterly reports and (the) also raise invoices for specific environmental impacts and assessments that has (have) to do with mining activities.” (P11)

The next question posed was:

“Which one(s) among the EMAPs (MFCA, LCC and ABC) have you been using and how have they benefited you?” (Question 8 in Appendix 1)

Responses revealed that most of the mining companies in Zimbabwe are applying ABC as an EMAP and LCC to a lesser extent, while none use MFCA. Some of the interviewees, for example, P10 and P12, responded as follows to the question:

“... ABC is mainly on the activity side because we look at the cost of each activity, of each section right up to exploiting the resource to when you finally get the ore. These are the final output of the gold and the actual dump, which is earmarked for future use.” (P10)

“... at our mine, we can link it to the ABC where costing per activity (is) done and you realise that like I have mentioned before that when we look at waste.” (P12)

Furthermore, ABC allows managers and other decision-makers to focus on specific areas that would have presented challenges. The above discussion concurs with the idea of (Kennedy & Affleck-Graves, 2001), who argue that ABC provides information leading to new management insights for taking fresh actions.

The next question posed was:

“How has the EMAP in use promoted material efficiency and cost-saving opportunities in the gold mining process?” (Question 9 in Appendix 1)

A synthesis of responses revealed the following: The implementation of ABC by mining companies in Zimbabwe has resulted in an improvement in environmental performance which has led to resource efficiency; the EMAP in use has resulted in the identification of inefficient activities, which resulted in strategies to manage them; ABC which is the EMAP mostly employed promotes material efficiency and cost savings opportunities in the gold mining process by identifying those activities and materials that are adversely impacting on the environment; decisions were made on the adoption of less harmful materials and improvement in activities

to improve efficiency and reduce environmental impacts based on the results from ABC; and knowing the different activities performed in gold mining and processing is essential since it assists in the estimation of the requirements of each activity. To emphasise the importance of ABC, some interviewees, P8 and P10, stated:

“You cannot measure what you don’t know. So, knowing when the process starts and when the process ends is one of the things to do.” (P8)

“... we are looking at our waste and we identify where we are losing out since there’s a slag in our system and obviously, we can improve our efficiency because we monitor that on our database”... “Since we have got separated operations based on activity, you can easily determine where efficiencies are high and where efficiencies are low and try to focus on cost minimising.” (P10)

The above discussion is consistent with the view that ABC has been observed to enhance efficiency, resource allocation and performance evaluation (Griesel & Cronje, 2005).

The last question was:

“What have been the barriers to implementing EMAPs?” (Question 10 in Appendix 1)

On the challenges faced in implementing EMAPs, the responses suggest the following: mining companies are faced with implementation costs and technology adaptation challenges; it is hard for Zimbabwean goldmines to benchmark with global companies owing to the deteriorating economic challenges facing the country; interviewees indicated that most goldmines are unable to import green technology because of high tax being levied by the Zimbabwean government and the deteriorating economy; and acquisition costs and resource shortage. Some of the interviewees reinforced the above aspects, for example, P8 and P11 stated:

“The economic problems facing the country have made it difficult to import the latest technologies required to promote greener mining.” (P8)

“... our major barrier is lack of resources. We are using a manual system because of a lack of resources which makes it difficult in providing information. Documenting information using a manual system increases your cost.” (P11)

The above discussions agree with the view that ABC’s success required adequate resources (Shields, 1995) and, therefore, meets our **OBJ4**, namely, to formulate the characteristics, benefits, and gaps of selected Environmental Management Accounting Practices (EMAPs) and how their integration may address the said gaps.

The preceding discussions conclude the second phase of the study, namely face-to-face in-depth interviews with experts in the gold mining sector, aimed at enhancing the conceptual framework developed before. Some new aspects augmenting the entities in the preliminary framework in Figure 1 from the researchers’ previous work (Nyakuwanika *et al.*, 2021) are shown in Table 1. The enhancements to the entities (blocks in the framework) are indicated in **bold**.

The entities in the conceptual framework Figure 1 can be augmented in line with the new information (indicated in **bold**) in Table 2. However, we do so after the research’s validation phase (phase 3). The Table 2 enhancements partially meet our **OBJ5** concerning enhancing the conceptual framework. Aspects of the original framework and the enhanced items identified through the interviews are discussed next.

The vital aspect of government responsibility was acknowledged in the conceptual framework before and confirmed through the interviews. Coercive pressures by governments through its agents like the Ministry of Mines and EMAG were the most

Table 2: Present and additional aspects of entities

<u>Subject Matter</u>	<u>Objectives or Goals</u>
EMA	Resource efficiency
PEMA	Waste reduction
MEMA	Reduced water consumption
CMA	Cost optimisation
	Improved energy efficient
	Improved decision making
	Reduction of adverse mining impacts
	Upholding of human rights
	Conservation of wildlife
<u>Expected Results</u>	<u>EMAPs</u>
SLO	MFCA
Cost savings	LCC
Economic improvement	ABC
Optimised processes	ABM
Integration of processes	Accounting packages
	Environmental management
<u>Corporate Governance Structure</u>	<u>Stakeholder Influence</u>
Stakeholder influence	Government responsibility
Legislation	Ministry of Mines
Addressing prohibitive taxes	Competitors
ISO	Civic society
Social order	Media (external) and efficient communication
Management support	Employees
Training of employees	Customers
Deep-rooted environmental management culture	NGOs
Community engagement	Triple bottom line
Adoption of greener technology	
Environmental standards	
<u>Sustainability</u>	
Eco-efficiency	
Environmental management strategies	
Dumping site construction	
Legend 1:	
EMA: Environmental Management Accounting	
ISO: International Organisation for Standardisation	
PEMA: Physical Environmental Management Accounting	
MEMA: Monetary Environmental Management Accounting	
CMA: Carbon Management Accounting	
Legend 2:	
Bold indicates enhancements following the interviews	

influential and exerted the highest pressure on goldmines to adopt green initiatives, even though the interviewees in phase 2 felt the coercive pressure was too much. A further aspect that emerged from the interviews was that

gold mining should be regulated and all mining companies should be monitored since some are using toxic chemicals like mercury that have long been banned. This aspect has been added to the enhanced framework in Figure 3 by

reducing adverse mining impacts. In addition, some companies should build proper dumping sites to contain toxic waste chemicals from their production processes, posing a risk to local communities and animals owing to polluted water sources. These aspects were partly present in the conceptual framework (for example, resource efficiency) but have been enhanced as per Table 1.

The challenging footprint of gold mining on the environment linked to the rights of communities has been captured through upholding human rights and community engagement in the new framework. These aspects likewise link with wildlife conservation and environmental culture. Environmental standards through the strategies of mining companies emerged from the interviews and have been captured by the Table 2 additions in the framework. Waste reduction was recognised in the initial framework but has been enhanced by emphasising reducing water consumption while suppressing dust formation during crushing operations. The use of newer technologies to reduce waste is vital, but implementation costs and lack of capital are prohibitive factors. High taxes being levied by the Zimbabwean government owing to a challenged economy are further prohibitive factors in the adoption of green technology. Our enhanced framework recognises these aspects.

A further addition to the framework is using a modern accounting system, focusing on environmental management as an additional EMAP, being part of the EMAPs entity in Table 2. The interviews confirmed the importance of ABC and LCC as EMAPs in the original framework. The implementation of ABC can improve environmental performance, which leads to resource efficiency since it has assisted in identifying inefficient activities, which has been beneficial in producing strategies to manage them. These aspects were recognised in the original framework through resource efficiency and were confirmed through the interviews. MFCA remained an important EMAP, even though no company interviewed was found

to use MFCA. Next, we present discussions and findings around the focus group, aimed at meeting the second part of **OBJ5** to validate the resultant framework.

Focus Group

The focus group discussion comprised six (6) participants, P1, P2, ..., and P6, who were drawn from different departments of one of the mines. The focus group was conducted at the mine after the management granted the researchers permission to conduct a focus group. Part of the discussion is linked to the framework with enhancements as presented in Table 2, while other questions brought in new dimensions, resulting in new themes. The discussions centred around the five focus-group questions in Appendix 2. The findings from the focus group are presented next.

Job Function and Sustainability

The first question in Appendix 2 posed to check whether participants did work related to environmental management was:

“Please tell us your name and what your job entails or what you do?”

The responses revealed that participants P2 and P4 were from the finance department, with participant P2 overseeing all the organisational corporate secretarial services and other statutory requirements for the company, whilst P4 was responsible for managing and consolidating all the financial reporting for the group. Participant P3 was from the surveying department, responsible for taking measurements of quantities of ore underground and for planning purposes.

Participants P1 and P6 were from management, with P1 being the general manager of the mine, additionally responsible for planning and controlling mining activities. P6 was the operations manager responsible for managing plant operations where ore extracted underground was crushed and gold extracted. Participant P5 was from Safety, Health, and

Environment (SHE) responsible for planning and developing strategies to manage the business risks of the gold mine. The researchers concluded that the group was well represented, with participants involved in environmental management.

Expected Results and Sustainability

The second question to check whether participants understood the subject matter under consideration was:

“When you hear the words “environmental management,” what comes to mind?”

A synthesis of the responses indicated that all the participants agreed they understood what environmental management implied. Participants pointed out that environmental management implied sustainable usage of resources, which involved planning, organising, leading, and controlling activities to decouple environmental impact. On probing further, P5 stated that environmental management is a positive way to balance mining and preserving the environment. Participants emphasised the need for their operations to avoid negatively impacting the environment. From the findings of the focus group, it was concluded that participants understand what environmental management means; this was essential for validating the framework.

Special Skills and Environmental Management

The third question in Appendix 2 posed to check for any skills required to oversee environmental management was:

“Are there any special skills one must have to manage the environment?”

Fifty per cent of the participants (P1, P3 and P5) indicated that there was a need to have the skill to be able to discharge environmental management duties, whilst the other 50% (P2, P4 and P6) argued that environmental management does not require a skill but a mindset which can be developed through organisational culture.

P5 indicated that environmental management was a science and art which could not be left in the hands of untrained people. The argument was that one must understand environmental management principles to appreciate environmental management. P1 agreed and continued to state that you cannot know the negative impacts of a mining activity if you do not have the skill and that having the skill would direct one on strategies to adopt to minimise negative impacts. In support of the discussion, P3 indicated that environmental management is broad and further involves convincing the community where a mining company operates to adopt sustainable initiatives. We infer, therefore, that being able to convince the community through public awareness, convincing employees to embrace environmental management initiatives and developing an adoptable culture of environmental responsiveness for all is an art or a skill.

Participants P2, P4 and P6 counter-argued that there is no need for a special skill for one to be able to oversee environmental management. They argued that one only needs to understand the impact of mining activities on the environment, which will assist in designing strategies to reduce mining footprints on the environment. In response, P1, P3 and P5 indicated that there is a need for a special skill to be able to discharge environmental management duties.

Having evaluated the responses, the researchers conclude that skill is essential for managing the environment and will serve the purpose of a corporate governance structure indicated in the framework, which in the long term will benefit sustainability.

Views on the Proposed Framework

The fourth question was:

“What are your views on the proposed framework?”

The participants indicated that the proposed framework was good as it integrates numerous environmental management principles. The following claim was presented to the group: The

framework will bring sustainable development and green management to the Zimbabwean mining sector in general and the gold mining sector in particular. They provided that the inclusion of aspects like resource efficiency, waste reduction and cost optimisation were key to the generation of profit by the gold mining sector, and hence, the framework is applicable in practice. In addition, they also indicated that the aspect of wildlife conservation within the framework was essential in managing conflict between the gold mining sector, civil society, and National Parks, hence ensuring a balance between mining and wildlife conservation.

When further probed, P2 stated that the framework reflects a holistic approach to environmental management issues. Once adopted and implemented, it would assist the gold mining sector to be a good corporate citizen and earn a social licence to operate (SLO). Therefore, wildlife conservation within the framework is essential in managing conflict between the gold mining sector, civil society, and National Parks. From the discussion among group members, the framework found general acceptance; it also emerged that environmental management is indeed a broad area encompassing, amongst others, wildlife conservation.

Key Environmental Management Aspects in the Proposed Framework

On the strength of the richness of the preceding discussion, the lead researcher decided to pose an additional question to the group, namely:

“What do you view as key in the proposed framework?”

Participants P2 and P3 viewed stakeholder pressure as key in the proposed framework. They indicated that gold mining companies need a push to adhere to environmental management. They argued it would be prudent to develop policies everyone may agree to, yet if gold mining companies are not pushed to comply with them, they tend to ignore them. With

this argument, they agreed that stakeholder influence is key to achieving environmental management goals within the mining sector. P4 highlighted upholding human rights and wildlife conservation as key components of the proposed framework. The participants indicated that in most instances, they tended to have conflicts with communities where they discovered gold deposits, and some community members would be forced to relocate to pave the way for mining activities.

Participant P2 pointed to sustainability as the key aspect of the proposed framework. The participant argued that what was good about the whole framework was advocating for eco-efficiency, which was going to ensure that the mining company benefits and, at the same time, conserves the environment for future generations. The participant believed that aspects like a corporate governance structure, deep-rooted environmental culture, and the engagement and adoption of greener technology are critical in fostering sustainability within the gold mining sector.

Participant P1 viewed the objectives as key within the proposed framework. The participant indicated that if those objectives are met, the gold mining sector would not have challenges in environmental management. According to the participant, attainment of the objectives is realising the environmental management goal since they all work towards such an objective.

Lastly, P5 indicated that what was good about the proposed framework was the internalising of externalities for a company to improve efficiencies. Hence, the various views of the participants confirm that all aspects of the framework are essential in fostering environmental management. Stakeholder pressure, upholding human rights, conservation of wildlife, objectives or goals, and sustainability are all key aspects in fostering sustainable environmental management and should therefore, be included in the framework (Lee, 2011).

Essential Environmental Management Aspect

The question posed to identify the most essential environmental aspect was:

“Of all the environmental management aspects we discussed, which one is most important to you?”

The responses varied. Participants P1, P3 and P6 identified stakeholder influence as the most important aspect. They argued that stakeholder pressure was essential for the gold mining sector to adhere to environmental management principles. They indicated that all relevant stakeholders should actively participate in environmental management, and owing to gold mining being capital intensive, sustainability issues can sometimes be ignored because they increase costs.

Participant P2 pointed to sustainability as the most essential aspect of the framework. The participant indicated that the overall goal of the framework is working towards reducing the environmental impacts of gold mining, and hence, achieving sustainable gold mining was key. Participant P4 indicated that resource efficiency was the most essential aspect. The participant argued that achieving resource efficiency would mean other objectives like waste reduction and cost optimisation are being met, which translates into the company’s financial performance.

Participant P5 pointed out that all aspects are essential since they are supposed to work as a unit to attain the environmental management objective. The participant indicated that care should be exercised when using the framework since there is no one-size-fits-all and that risk is managed as low as the reasonable practice (ALARP) principle. Therefore, all aspects of the framework are key in environmental management. Stakeholder pressure is essential for the gold mining sector to adhere to environmental management (Darnall *et al.*, 2010; Phan *et al.*, 2018). The researchers concur that all aspects of the framework are key and ought to be present to facilitate a greener gold

mining industry in Zimbabwe as a developing economy. Next, we consider the trustworthiness of our survey concerning both the interviews and the focus group.

Trustworthiness

To confirm the trustworthiness of the interviews and focus groups, we consider the five trustworthiness aspects (Connelly, 2016).

Authenticity

Authenticity indicates the extent to which we as researchers, truthfully and fairly convey the diversity of opinions expressed by the interviewees and focus group members. We believe we truthfully and fairly expressed the views of all the participants. In all cases, verbatim expressions were captured on audio tape and indicated in the above sections.

Confirmability

Confirmability indicates neutrality in the research and the extent to which the findings may be repeated. Subject to the interpretivism philosophy indicated in the (Saunders *et al.*, 2019) research onion in Figure 2, we maintained neutrality in the interview- and focus group data collection. Further, owing to the cross-sectional time horizon of our research, we believe the same answers would be received should the interviews and the focus group be repeated.

Credibility

Credibility indicates confidence in the truth of the research. Again, this may be hard to determine due to the interpretive nature of the research. With that comes how free participants felt to express their opinions. The interviews were conducted one-on-one by the lead author of this article, and interviewees were assured of the utmost confidentiality of their answers, while the differing opinions by the six (6) focus group members indicated that they had no hesitation in expressing their opinions. We believe, therefore, that our research findings are highly credible.

Dependability

Dependability refers to the stability of the data over time. Again, this may be hard to maintain, given the cross-sectional nature of the research. Nevertheless, we believe the same findings will be obtained over time should the gold mining industry continue with the present way of conducting its business. Either way, sustainable gold mining and caring for the environment are expected to be at the forefront of environmental issues shortly.

Transferability

Transferability, reminiscent of generalisability in quantitative work, indicates to what extent the findings may be applicable in other research settings or other (in our case) economic settings. The findings obtained in this article largely agree with the conceptual findings of the researchers (Nyakuwanika *et al.*, 2021). Therefore, we believe the findings obtained in this research may transfer well to other environmental settings.

Final Framework

Based on the enhancing aspects that emerged from the in-depth interviews (Table 2) and insights obtained from the focus group, the enhanced, integrated, and final EMAPs framework to promote green gold mining in Zimbabwe is presented in Figure 3.

The Figure 3 framework finally meets our OBJ5, namely, having formulated an enhanced and validated framework for greening Zimbabwean gold mining.

Discussion of the Integrated Framework

A conceptual framework was previously developed on the strength of a comprehensive scholarly literature review (Nyakuwanika *et al.*, 2021). The black (automatic) text in Table 2 captured the essence of such a framework. The in-depth interviews discussed before enhanced the framework through the items added in **bold** in Table 2. This was achieved through a thematic data analysis based on the interview findings.

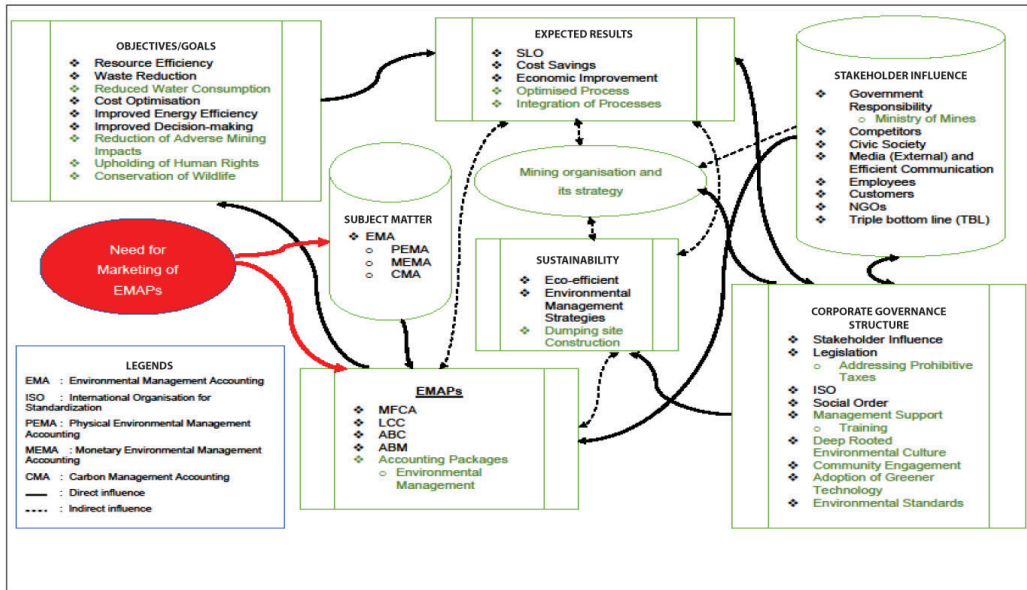


Figure 3: An integrated framework of environmental management accounting practices to promote greener gold mining in Zimbabwe
Source: Synthesised by Researchers

Concerning the focus group, the participants were actively involved in and had experience in environmental management. The issue of environmental management skills divided the participants through the middle (50-50). Consequently, the skills aspects could not be validated and have been omitted from the final, integrated framework. Regarding their views on the proposed framework, all the participants indicated it was good since it integrated numerous environmental management principles. They identified key aspects in the framework as resource efficiency, cost optimisation, stakeholder influence and pressure, upholding human rights, sustainability, objectives, and processes to improve efficiencies. Participants also indicated that the framework appeared practical, though there was a need to see how it could be automated in gathering data. Automation of the framework is briefly discussed as future work in the following section.

Comparison with Previous Work

Our work centred on the enhancement of a previously developed framework through sets of interviews, followed by a validation of the enhanced framework through a focus group. Previous work in this area, where similar approaches were followed, was done in the South African coal mining industry, the knowledge management arena, and the auditing industry, amongst others. Table 3 summarises some of these studies.

In addition to Table 3, we observed that numerous studies in the literature agreed with the findings emanating from our interviews and the focus group.

Limitations of The Research

While we believe our work and the final integrated framework in Figure 3 add much value to sustainability in Zimbabwe as a developing economy, it is not without limitations. The propositions we developed in previous work (Nyakuwanika *et al.*, 2021) are qualitative in nature and may be open to

interpretation and criticism. That said, they assisted us in formulating the conceptual framework in Figure 1. Owing to the qualitative research choice followed in this article, our work has an interpretive flavour, and the natural language responses by both the interviewees and the focus group participants could be open to different interpretations. For this reason, we suggest in the future work section that the integrated framework be exercised in one or more gold mining companies over time. Linking with the qualitative nature of our work, a quantitative phase could be defined during which the framework is evaluated more formally.

Implications for Theory and Practice

Theoretically, we believe our work contributes to the body of knowledge in sustainability concerning addressing the environmental challenges of gold mining in developing countries. Despite the theoretical nature of our approach through environmental management accounting and the various EMAPs, it appears to have been well received by practitioners as is evident in the responses by the interviewees and focus group participants. The work, therefore, has value for theory development.

At a practical level, we believe the gold mining industry will adopt our framework, even if only partially. This is why exercising the framework in the industry is proposed in the future work section. Community leaders may embrace the framework at a humanitarian level since it may offer a solution to the community challenges indicated before, such as upholding the human rights aspect of the framework.

Managerial Implications of This Research

It has often been said that any project that does not receive upper management support is doomed to failure. The importance of management support and government at a higher level is captured in the enhancements (refer to Table 2) to the original framework in Figure 1. Management may, therefore, need to look wider at environmental aspects instead of just the profit margin of the company. The framework does,

Table 3: Comparison with approaches in the literature

References	Description	Similarities and Differences
Mbedzi <i>et al.</i> (2018)	A conceptual framework for the South African coal mining industry was developed. The framework is subsequently validated.	Similarities A conceptual framework was developed as a first step.
Mbedzi <i>et al.</i> (2020)	The content of the building blocks (essentially entities) was validated through interviews, while the links among these entities were validated through a focus group.	The conceptual framework was validated through a survey among stakeholders in the industry. Differences The survey comprised a validation only. That said, the content of the framework was changed through the surveys.
Robberts <i>et al.</i> (2020)	A conceptual framework for mobile knowledge worker commitment in the short-term insurance industry was developed. The framework was subsequently greatly enhanced into several sub-frameworks.	Similarities A rudimentary framework was developed as a first step. The framework was exercised through stakeholders in the industry. Differences A survey of the insurance industry was conducted. The survey aimed to both enhance the framework and validate it. The survey, therefore, served a dual purpose.
Netshisaulu <i>et al.</i> (2022)	A conceptual framework to address illicit financial flows (IFFs) with interfaces to the auditing industry was developed.	Similarities A rudimentary framework was developed to curb IFFs.
Van Zyl <i>et al.</i> (2020)	A conceptual framework for adopting knowledge management (KM) in SMEs was developed.	Similarities A conceptual framework was developed. The framework was validated in the SME industry.
Van Zyl <i>et al.</i> (2022)	The framework was subsequently validated among SME owners and senior staff.	Differences The survey aimed to flesh out constructs in the framework through adoption frameworks, e.g., DOI and TOE.

however, recognise the importance of profit as indicated by the triple bottom line (TBL) in the final framework.

Legislation may be a further incentive for gold mining management to effect change in the operations of a mine. It is hoped, however, that change in the day-to-day business would be a voluntary commitment rather than a forced one from the government. Understanding this important difference between voluntary commitment and a forced change from governmental structures may well assist organisations to improve on their decisions.

All these may assist both government and organisations to make better decisions in future.

Implications for Policymakers

Implications for policymakers have anchor points in the framework through multiple aspects. For example, both the stakeholder influence and corporate governance structures refer indirectly to policies through the Ministry of Mines and legislation, taxes and so forth. Regarding taxes, it is plausible that gold mines could also be taxed if they do not adhere to environmental regulations. Conversely, a

tax rebate could reward good adherence to sustainable environmental practices. These decisions may partly be beyond the jurisdiction of the management of a mine but certainly fall within the ambit of government ministries.

Somewhat further into the future, it might not be far-fetched that policymakers, either at a national level or at the management level of a mine, may introduce policies or legislation that make using EMAP practices compulsory.

Conclusion

In this article, the reasons why the gold mining sector is leaving a strong environmental footprint were investigated and led to how EMAPs could assist the sector in reducing its footprint. Following the literature review, a preliminary framework was developed in previous work as phase 1. Face-to-face interviews resulted in new aspects emerging, which enhanced the framework. The enhanced framework was validated through a focus group, resulting in the final integrated framework. The gold mining sector is responsible for reducing its environmental footprint, and EMA, together with its subsidiaries in the form of EMAPs, aims to ensure that appropriate practices are available to foster greener gold mining.

The findings of this research reveal that coercive stakeholder pressure may be the most effective in influencing the gold mining sector to adopt greener strategies. In addition, it was also established that most participants do not know of or are using MFCA, thereby losing out on potential benefits that could have accrued had the practice been used. The researchers argue that this may be the general problem of the mining sector. While the focus was on the gold mining sector, the findings from this research may well be generalised to other sectors of the economy in Zimbabwe.

The gold mining sector was found to have negative impacts, possibly outweighing its positive contribution. It was established that though gold mining leaves a strong environmental footprint, its impact was incomparable to

coal, platinum and chrome mining, which are open cast. The researchers postulate that the gold mining sector should be regulated and its activities be monitored. Gold mines were found to fail to invest in greener technology because the Zimbabwe Revenue Authority (ZIMRA) levied high import tax rates. The findings from the research indicated that the framework could be applied in practice and assist the sector in fostering environmental management. Our research relies on a comprehensive literature review, in-depth interviews, and a focus group.

Future work in this area may be pursued along several avenues. While the interviews made useful enhancements to the framework and the focus group confirmed the utility of the enhanced framework, more information can be collected through in-person observations and spending time at some of the selected goldmines, that is, through a case-study exercise. Other improvements to the framework could come from its application in other mining sectors. Important future work alluded to is a follow-up survey embodying a quantitative research choice among the same or different stakeholders. The framework developed in this research is a static structure and future research may involve incorporating a dynamic component to develop sequences of steps to be followed by the gold mining industry towards a greener environment.

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Appendix 1 – Interview Guide

- 1) When you look at key stakeholders of the gold mining sector, which one exerts the highest amount of force and why?
- 2) Do you think governments and other regulatory bodies must exert coercive pressures on gold mining companies to adopt greener initiatives? Kindly explain your answer.
- 3) What are the impacts of gold mining on the environment?
- 4) To what extent does it hold that gold mining leaves the strongest footprint on the environment more than any other industrial activity?
- 5) Which strategies have been employed by your company in managing ecological damage? And how have these assisted?
- 6) What are the major challenges in gold process waste reduction? What are the efforts that have been taken in an attempt to address these challenges?
- 7) How does the accounting system in use support environmental management or eco-efficiency decisions?
- 8) Which one(s) among the EMAPs (MFCA, LCC and ABC) have you been using and how have they benefited you?
- 9) How has the EMAP in use promoted material efficiency and cost-saving opportunities in the gold mining process?
- 10) What have been the barriers to the implementation of EMAPs?

Appendix 2 – Focus Group questions

- 1) Please tell us your name and what your job entails or what you do.
- 2) When you hear the words “environmental management,” what comes to mind?
- 3) Are there any special skills one must have to manage the environment?
- 4) What are your views on the proposed framework?
- 5) Of all the environmental management aspects we discussed, which one is most important to you?