Preprint

Community-centred Approach for Assessing Social sustainability in mining regions: A case study of Chingola district, Zambia

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How to cite this article:

Kourouma, J. M., Monde, C., Phiri, D., & Syampungani, S. (2023). Community-centred approach for assessing social sustainability in mining regions: A case study of Chingola district, Zambia. Sustainable Development, 1–26. https://doi.org/10.1002/sd.2572.

Publisher:

Community-centred Approach for Assessing Social sustainability in mining regions: A case study of Chingola district, Zambia

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Abstract

Social sustainability has received the least attention among the three-pillars of sustainable development in the mining regions of Africa. However, with the rapid population growth globally, social sustainability assessment using clearly defined indicators is becoming essential to ensuring urban sustainability, specifically in mining regions. This study assessed the contribution of the mining industry to the social sustainability of the Chingola district in terms of cumulative impacts and the extent to which CSR initiatives have contributed to a social sustainability profile. Mixed methods including in-depth key informant interviews guide and observation were used to collect data on social sustainability. The data were collected from 10 out of the 28 wards of Chingola, selected using a systematic random sampling. A total of 500 households of which 49 households (with a sampling unit of 10) and 10 key informants' stakeholders were purposively selected. Aggregation and normalization techniques were used to construct the composite indicators depicting the strength of each indicator. The social sustainability of the Chingola district based on the calculated composite indicators varies from weak-to-moderate sustainability. The proposed indicators could serve local government and mining companies, redirect development schemes, re-strategize the stakeholders' involvement, and support corporate governance.

K eywords: Chingola, mining community, objective indicators, social sustainability, subjective indicators

1. Introduction

Mining is the most controversial development industry with both positive and negative impacts on the social, the environment, and the economy of mining regions (Syahrir *et al.* 2020). It has a great potential to aid in achieving the sustainable development goals (SDGs) because metals and minerals are required for developing new technology toward sustainable economies (Vidal-Legaz *et al.* 2013) and for the enhancement of national economies and human development (Elshkaki *et al.* 2016).

Nowadays, mining companies are subject to more scrutiny from society than they were in the past. In the context of global warming and increasing societal issues, businesses need to demonstrate their contribution towards tackling key societal problems. The *'Business as usual'* endeavour, with a sole focus on profitability, is becoming obsolete. Companies should create real value for the communities in which they operate (across their value chains), by creating jobs, training workers, building physical infrastructure, transferring technology, paying taxes, and expanding access to products and services ranging from food, healthcare, and energy to obtain and maintain their social licence to operate. Mining companies contribute to the social sustainability of their host communities when it affects positively the people's assets, capabilities, opportunities, and standards of living.

Zambia is a mineral-rich country in the southern part of Africa where mineral-ore extraction and transformation activities generate revenue for both local and national governments. The mining industry, directly and indirectly, contributes to the local economy through multiplier effects and its connections to other sectors (Lippert, 2014). However, the benefits accruing to the majority in the nation are scarcely noticeable and are largely reaped by a few local elites, shareholders, and executives of Multinational companies (MNCs) (Mwansa, 2016).

Despite the commitment to more sustainable behaviour in Zambia, the mining companies are still failing to effectively integrate sustainability issues and practices into their business routines and strategies (Ramus & Montiel, 2005).

Corporate Social Responsibility (CSR) initiatives have been seen as a way for mining companies to contribute to the sustainable development of their host communities. However, this strategy has faced criticism consistently from various authors. Ihugba, (2012) and McKenzie (2004) regard CSR as a vague and rhetorical initiative without a coherent impact on socio-economic development, lacking a perspective on power relations, a smokescreen designed and used to content stakeholders' needs and demands. Several authors claimed that CSR has also been regarded as an alternative to the traditional growth and profit-maximation

models, with a negligible impact on sustainable development (Lungu & Mulenga, 2005; Marias, 2010; Torugsa *et al.* 2013; Franco & Ali, 2016).

Furthermore, several drawbacks have been identified to hinder the effective implementation of CSR initiatives. Firstly, mine investment in CSR is dependent on its economic performance, taxation regimes, mining conditions, and the quality and quantity of the ore grade. For example, an increase in copper production improved the living standards of households not directly employed in the mining sector through linkages and spill-over effects (Kitula (2004; Lippert, 2014). In contrast, several other scholars ascertained earlier that these linkages to the rest of the economy are weak if not negligible (Fraser & Lungu, 2007; Lungu, 2008; Adam & Simpasa, 2009; Goderis & Malone, 2011).

Firstly, commodity-dependent economies are highly influenced by commodity price fluctuations, with a significant impact on government, foreign direct investments, and the societal responsibility of corporate industries (Cerda, 2007). Secondly, Veiga *et al.* (2001) and Franks *et al.* (2009), observed that the older mining projects get the lesser the manoeuver it has to face its corporate social responsibility by providing jobs, social services and infrastructures and environmental protection. The impacts of mining on the socioeconomic constructs of local communities can be either positive or neutral. Wegenast *et al*. (2020) argued that the presence of multinational mining companies in Africa has contributed to increasing food insecurity and Viliani *et al.* (2017) claimed that multinational mining decreases the wealth of mining-affected households by increasing their expenditures on uncontrolled infectious diseases. Environmental pollution, deforestation, degradation of water resources, and modification of the environmental and bioclimatic factors have been reported as environmental shortcomings in the Copperbelt Province. Additionally, the copper concentrations in the Kafue River sediments are far beyond that of other polluted river sediments worldwide. Zabre *et al.* (2021) observed that the most positive changes in the socioeconomic development of the impacted mining communities compared to non-impacted communities were noted in the early phases of mine development between 2015 and 2019. However, other studies have found no difference in poverty reduction between mining communities and non-mining communities Chuhan-Pole *et al.* (2017).

In Zambia Mondoloka (2018) claimed that the mining industry in the North-western province failed to mitigate the barrier to literacy within host communities. Moreover, environmental pollution (Simukanga, 2002), deforestation, degradation of water resources, and modification of the environmental and bioclimatic factors (Kourouma *et al.* 2022) as a result of mining activities have been reported as environmental shortcomings in the Copperbelt

Province. A study by Von der Heyden & New, (2004) revealed that the copper concentrations in the Kafue River sediments are far beyond that of other polluted river sediments worldwide. Chansa, (2006) claimed that the pollution of Kafue River as a result of mining activities has reduced fish stocks in the river, and about 44,556 people have been displaced on the Copperbelt since 1997 to allow mine operations (Lusonde, 2019) with the negative effect on the livelihoods of mining communities. A mismatch between the existing sustainability assessment framework and the practice of sustainability itself was pinpointed by Olofsson (2016) and Sultana (2019).

All these examples rendered CSR initiatives to be entangled with tensions between corporate mining objectives, recipient community needs and wellbeing, and governmental policy goals for development (Li *et al.* 2012). In the mining district of Luanshya, a mismatch between mining companies' CSR investment priorities and the actual needs of the host communities was also identified by Mutale (2019). Whilst the communities needed investments in agriculture and capacity-building, the mine instead, invested in infrastructure development. Although these investments were essential and needed, the top-down approach used by the mining company posed a mismatch of context-specific priorities. Mutale regretted the cavalierness of most CSR initiatives, which are mostly dispensed as haphazard donations and lacking a guiding framework and tools to measure their effectiveness. The lack of guiding frameworks and effective tools for assessing CSR performance was identified by Sdoukopoulos *et al.* (2019), as hindering institutional measures to addressing social services in the global south.

In the Chingola district, although the mining companies within the district continue to allot some parts of their profits through CSR initiatives to support the district's socioeconomic development, the cumulative impacts on the communities have been rarely assessed. It is yet to ascertain whether this strategy has been effective or not in addressing social issues and contributing effectively to social sustainability. The need for relevant sustainability indicators has thus, never ceased growing (Mameli & Martetto, 2014; Pojani & Stead, 2015).

Consequently, implementing effective CSR initiatives using an adequate social sustainability framework will benefit both local governments and mining companies in addressing social services and the mining community's context-specific priorities. This is critical for a mining district such as Chingola, subject to rapid urbanisation and population growth, and where the social infrastructures and services are rapidly becoming insufficient and unsuitable to cope with the demands. Nevertheless, if the traditional approach to assessing development policies and sustainability issues is often based on objective indicators generated through expert surveys and statistics (Palma *et al.* 2014), other prominent authors believe that

subjective indicators obtained from surveying citizen opinions on sustainability indicators and policies objectives are necessary (Martello & Mameli, 2012; Munira & San Santoso, 2017).

Social objective indicators measure a social reality, while subjective indicators measure a subjective state, such as perceptions, feelings, and preferences. Similarly, people's evaluations of various public services have greater meaning for both policymakers and researchers when they are viewed in light of the actual performance of those services.

However, to date, a very limited number of efforts have been made in recent years to collect both types of indicators within mining communities to improve social sustainability and guide CSR initiatives. A practical sustainability assessment considering local context, local planners' expertise and knowledge on sustainability issues, availability of quality data has been considered a prerequisite (Toth-Szabo & Varhelyi, 2012; Ramani *et al.* 2013; Shiau & Liu, 2013). It is, therefore, very seldom to find studies that comprehensively analyse several dimensions of social sustainability and develop a composite sustainability index for each dimension, explicitly taking into account the subjective and objective sustainability indicators. Many researchers only focus on a single social construct. For instance, social equity (Colantonio, 2010); green building standards (Atanda, 2019); satisfaction of human needs (Littig & Griessler, 2005), human well-being (Magis & Shinn, 2009), quality of life (Colantonio, 2010), social interaction, cohesion and inclusion (Jackson 2003; Dempsey *et al.* 2011) and sense of belonging to a community (Dempsey, 2006; Karuppannan and Sivam, 2011; Colantonio, 2012).

This study adopts a comprehensive approach to measuring social sustainability, combining subjective and objective social sustainability indicators: (1) to analyze each component of social sustainability; (2) to generate a composite urban social sustainability index of the district and provide recommendations to address social issues and improve mining CSR initiatives.

2. Research Methods

2.1. Description of the study area

Chingola is one of the central mining districts of Zambia, located in Copperbelt Province (Fig. 1). It is situated at 12°20′ south and 27°50′ East and 1300 m above sea level (DPU, 2019). The district covers a land area of 1678 km^2. Of this area, 355 km^2 (21%) is allotted to copper mining, which is controlled by the Konkola Copper Mine (KCM), one of the largest open-cast copper and cobalt mining companies in the world. The Late Proterozoic Katanga Supergroup sediments, underlain the basement rocks of Chingola, consisting of deposits of Cu-Co and

many other metals. One of the legacies of several decades of copper mining in Chingola by KCM is an open pit with an average depth of 400 m (DPU, 2019) and several ageing mining infrastructures left by previous mining companies. Apart from mining, agricultural activities are the mainstay of most of the population. Chingola is one of the oldest, fast-growing, and most developed districts of Zambia. Based on the First Order Dominance Approach (FOD) developed by Arndt (2012), Masumbu *et al.* (2014) ranked Chingola as the fourth most developed district in Zambia. Its rate of urbanisation in 2019 stands at 3.3 % against a national average of 27.8% (DPU, 2019)**.** Considering the 2010 general population census, the population of Chingola stands at 185,246 inhabitants. However, this population has increased by about 40.3 % between 2010 and 2015, and it is projected to increase by about 27.6 % in 2025 (Housing, 2015).

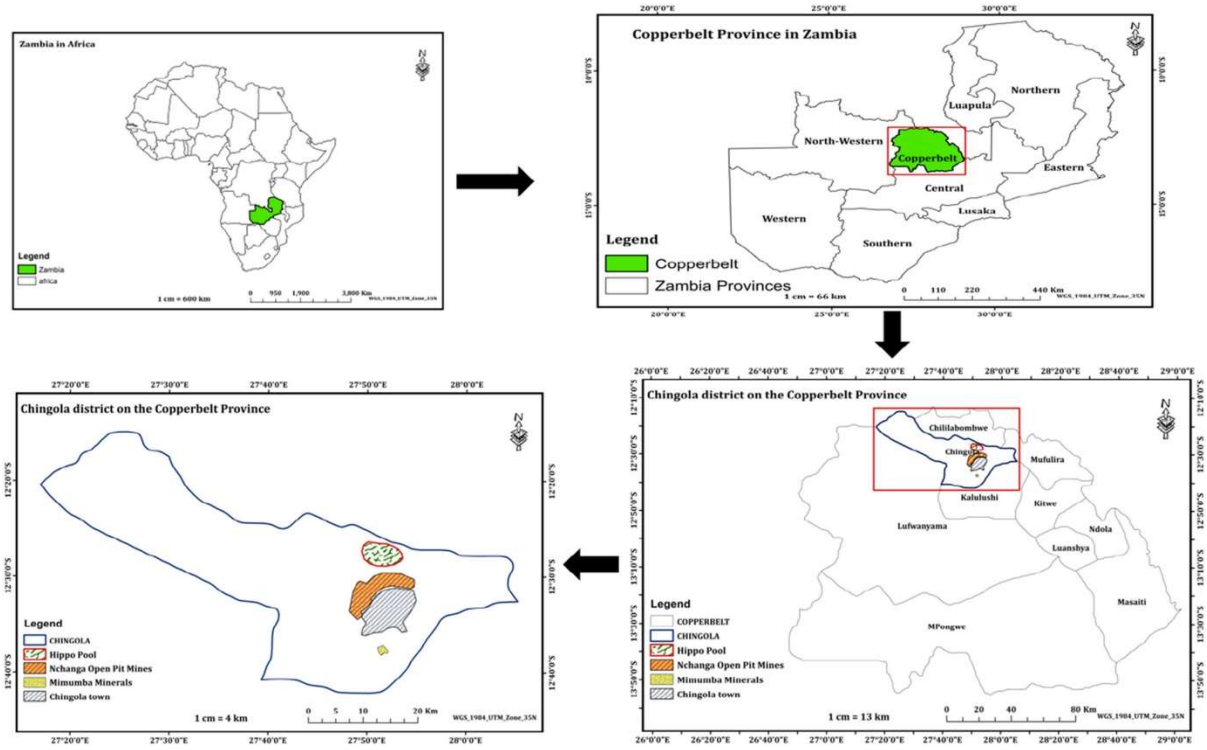

Figure 1. Location map of Chingola District in the Copperbelt Province of Zambia.

2.1.1. The choice of the study area

Chingola district in the Copperbelt province owes its existence to the copper and cobalt mining industries, which began in the late 1920s in Luanshya District with the establishment of the first commercial mine (Munene, 2020). The district is a host to one of the largest mining companies in Africa, the Konkola Copper Mines (KCM). KCM exploits 228 Mt of copper–cobalt deposit with an average grade of 3.6 wt% Cu in the Copperbelt province (Vedanta,

2010). KCM serves as one of the gauges for the mining industries and, by implication, the Zambian economy's health, contributing to GDP for about 90% of the total (Money, 2019).

The study chose the Chingola district as a case study to better understand the concept of social sustainability in mining regions and how CSR initiatives have contributed. It remains to be seen whether the historical context of copper mining, and the socioeconomic contribution of mining activities through CSR initiatives, taxes, royalties, and license fees have resulted in a well-established social sustainability profile.

Africa in general and Zambia in particular have very limited studies that focus specifically on the social sustainability of mining communities, with implications on how to enhance CSR initiatives. In the Chingola district of Zambia's Copperbelt province, it remains to be seen whether the historical context of copper mining, as well as mine contributions through CSR initiatives, taxes, royalties, and license fees, have resulted in a well-established social sustainability profile. Although an analysis based on this one mining district will not make a *"national"* or *"universal"* statement, it can open up new perspectives for further analysis, comparison, and discussion. Furthermore, Chingola shares several similarities in terms of history, planning, development, socio-cultural structures, and physical characteristics with several mining districts in Zambia's Copperbelt Province.

2.2. Methodological Approach

It was recently discovered that the traditional technical-rational model of assessing social sustainability using only objective indicators and assuming that this is the only way to make better decisions was theoretically, politically, and practically inadequate (Stagl, 2007). As a result, Stagl (2007) and Keogh (2006) proposed using subjective indicators in addition to objective indicators to institutionalize social choice.

2.2.1. Objective and Subjective indicators of social sustainability

Since its inception, the concept of objective and subjective indicators has been inextricably linked to social indicators research.

Objective indicators depict the state or condition of the environment in which people live and work. Health, income, crime, housing, education, security, and governance are examples of conditions. Pioneering work with objective indicators has been reported by Liu (1975).

Subjective indicators describe how people perceive and evaluate the world around them. According to Marc Abrams, a pioneer in the study of subjective social indicators, the

"objective world" is filtered through individual perceptions and weighted based on their expectations, experiences, attitudes, and current circumstances" (Abrams, 1973). Pioneering works with subjective social indicators are found in (Gurin *et al.* 1960; Campbell *et al.*1976).

Perception is a dynamic process of interpreting the external world, guided by an individual's experience, sense and knowledge about specific issues or phenomena which in turn determine how he will react, select, choose, organize, and interpret information (Wossink & Boonsaeng, 2003). Attitude is a settled way of thinking or feeling (viewpoint, perspective) about something (Arbuckle *et al.* 2013).

Subjective indicators enable community participation and a greater sense of ownership over the appraisal and the indicators developed.

The *"objective indicator"* is *"hard statistical facts"* from an official information provider or a third party, and it is presumed to be disconnected from emotions, while subjective indicators are considered to be *"soft information".* From such a point of view, which seems to be shared by the majority of *Quality-of-Life* researchers, the combination of objective and subjective indicators is considered compensatory, and inclusive, and has been widely used (Sullivan, 2002; Davidson and Wilson, 2009; Colantonio, 2010; Yoo and Lee, 2016).

Subjective indicators describe how people perceive and evaluate the world around them, based on their expectations, experiences, attitudes, and current circumstances" (Abrams, 1973). Pioneering works with subjective social indicators are found in (Gurin *et al.* 1960; Campbell *et al.*1976). Perception is the dynamic process of interpreting the external world, while attitude is a settled way of thinking or feeling about something (Wossink & Boonsaeng, 2003). Subjective indicators enable community participation and a greater sense of ownership over the appraisal and the indicators developed. They are addressed as individuals with specific needs, emotional states, personal experiences, value orientations, preferences, and so on, rather than as just information providers.

2.2. Data sampling and collection methods

An informed consent form describing the purpose of the study, the confidentiality that upholds the questionnaire and their responses, as well as the purpose for what the information provided will be used were declared and presented to the respondents before the interview to obtain permission. A mixed method of data collection technique was used to collect both qualitative and quantitative data. This technique has the advantage of being inclusive and eliminating biases in the quantitative and qualitative methods taken individually (Creswell, 2003). It comprises face-to-face semi-structured interviews, key informants' questionnaires, cross-

sectional surveys, observations for primary data, and desk research for secondary data. The choice of these methods stems from the fact that they could help to get in-depth information about the mining activities, and their impacts toward achieving a socially sustainable mining community, but most importantly, they offer the possibility to probe the information received from the respondents. The performance of each social construct was assessed using a 5-point Likert scale with scores, of *(0 = Very Low), (1= Low), (2 = Average), (3= Good),* and *(4 =Very Good)*. The questionnaire also included binary questions, with 1 indicating Yes and 2 indicating No. A full description was given to each indicator in the questionnaire and translated, into the local language for ease of understanding. Information on social constructs such as Education, Security and Safety, Social cohesion, Sense of belonging, Governance, Voice and Participation, Equity, Culture and heritage, Health, and Income were targeted by the data collection. These indicators were categorized into two: Objective and Subjective indicators. The subjective indicators are calculated based on individuals' perceptions, practices, and attitudes towards social sustainability (Shin and Johnson, 1978; Diener & Suh, 1997). For example, the subjective health indicators comprise information such as (residents' degree of satisfaction with the available number of health facilities, the satisfaction of health services, the affordability of medication, their perception of the resilience of the available health facilities to withstand health crises (Ebola, Cholera etc).

The Objective indicators are statistical facts obtained from government officials and third parties (miners, civil servants, and policymakers). For example, objective indicators of health comprise (the number of health facilities per ward, available bed spaces per hospital per capita, number of medical doctors per capita etc). In some rare cases, proxies were used when the information cannot be obtained locally. For instance, the case of the Gini coefficient of the income distribution. The methodology used to calculate the composite social sustainability indicators is summarised in Figure 2 below.

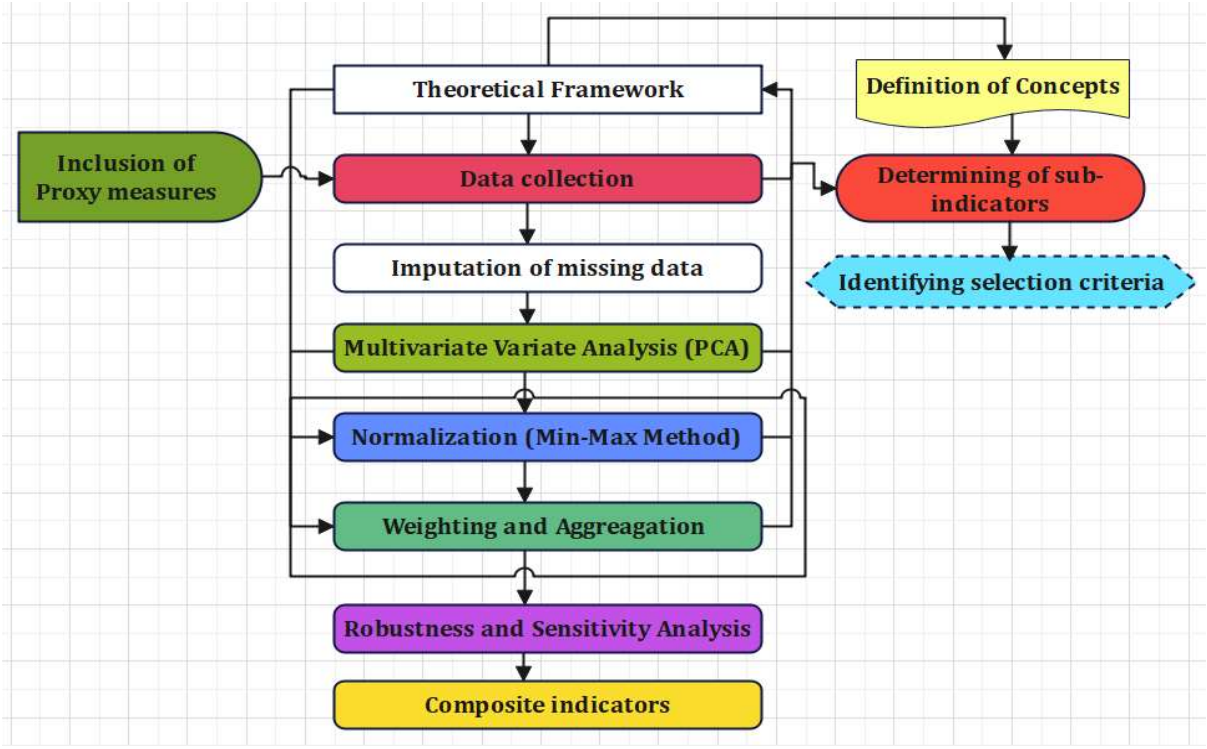

Figure 2. Methodological flowchart

2.2.1. Sampling

Ten out of 28 wards were purposively selected to conduct the survey. The selection was based on population size, availability of basic infrastructure, and distance from the mines. The selection of households was done using a systematic random sampling (with a sampling unit of 10) of which 49 households were selected to cover a total of 500 households. In each of the 49 households, 490 respondents and 10 key informants were purposively selected based on their age (20 years and above), their level of education, their availability and willingness to participate in the interview, their length of stay (minimum of 5 years) in Chingola and understanding of the major societal issues. This approach ensured that only those with knowledge of particular issues were interviewed. Tables 7 and 8 in the supplementary file show the dataset used for this research.

2.2.2 Sampling for Key Informants

A total of 10 key informant interviews were conducted with experts from the Chingola District Health Board (CDHB), the Chingola District Education Board (CDEB), Nchanga Mine, Chingola Central Police, the Community development commissioner, the Department of Planning, Chingola Municipal Council, Mulonga Water and Sewerage Company, Zambia Electricity Supply Corporation (ZESCO), district's department of Culture and tourism.

2.2.3. Appraisal of mining industry CSR contribution to social sustainability

To evaluate the contribution of CSR initiatives on social sustainability, the researchers only managed to obtain information on the most important mining company in Chingola, the Konkola Copper Mine, which willingly under certain conditions, accepts to disclose information. However, there are three more foreign mining companies operating in Chingola, namely (Mimbula Minerals Limited, Zumran Mining Exploration and China Copper Mines Limited) that rejected our requests to survey their premises. Therefore, this evaluation is mainly focused on the contribution of KCM toward achieving social sustainability, although the respondents make no specification and difference when referring to the impacts of the mining industry on their lives, the environment, and their livelihoods.

2.2.4. Observations

A field survey was used to probe the respondents about the impacts of mining activities on their livelihoods. Among other impacts, are air pollution affecting farmlands, noise due to the blasting of rocks, and the cracking of houses very close to the mining areas such as Maiteneke, and Nchanga North where both underground and open cast mining operations are ongoing. These areas are built on top of underground mining areas and as such can be considered a high-risk zone. A similar observation was made earlier by Lusonde & Mubanga, (2019).

2.2.5 Desk Research

Annual reports on CSR and KCM operational activities were reviewed. When necessary, a triangulation of information was done between mine's stakeholders to probe the information obtained from the literature or the respondents.

2.3. Data Analysis

The Sphinx Plus V.5 was used to develop and analyze the questionnaires. Further descriptive statistics to analyse quantitative data were done using Stagraphics V.19 and SPSS v.26. Microsoft Excel 2019 (Microsoft Corporation, 2019) was used to analyze the qualitative data obtained from the semi-structured interviews with the key informants and the information gathered through observations and the appraisal of CSR initiatives.

Figure 2 explains the methodological flowchart used to generate the composite social sustainability index. Information is analyzed by summarizing them into key themes, sub-indicators, and social indicator types, then normalize and aggregated to form a thematic indicator. The score obtained from the aggregation and normalization of the emerging themes, sub-indicators, and indicators in each indicator type (objective and subjective) class depicts the

overall score of the social sustainability indicators. The sub-indicators generated from the two indicators were aggregated to develop a holistic and inclusive composite index.

Table 1 shows the classification scheme used to differentiate the strength levels of each social sustainability component.

Table 1. Sustainable city classification scheme (OECD, 2004; Van Dijk and Mingshun, 2005).

Score	Definition	Score	Definition
< 0.25	Unsustainable	**< 25**	Unsustainable
0.25≤X<0.50	Weak sustainability	25≤X<50	Weak sustainability
0.50≤X<0.75	Moderate sustainability	50≤X<75	Moderate sustainability
≥ 0.75	Strong sustainability	≥ 75	Strong sustainability

5. Yale Center for Environmental Law & Policy **6.** Center for International Earth Science International

2.3.2. Mathematical calculation

In the calculation of indicators, all metrics, including percentages, were normalised to a scale of (0-100) or a scale of (0-1) (Tanguay, 2010; Choon, 2011; Yang, 2017). A risk-based approach was utilised to minimise the effect of weak scores. Each component of social sustainability was analysed as to whether it contributed positively or negatively to the total score of the indicators. Using this method, the value of indices varies from 0 to 1, where a value closer to 1 denotes strong social sustainability, while a value closer to zero indicates weak social sustainability. The same was applied to the (0-100) scale. To convert the actual levels of a positive variable into normalised indicators, first, subtract the minimum values from the actual values and then divide the gap by the range. In terms of positive indicators (see equation 1 below).

$$Dimension\ Index\ (Yi)pos = \frac{Actual\ value\ (Zi) - Minimum\ value\ (a)}{Maximum\ value\ (e) - Minimum\ value\ (a)} \quad (1)$$

For a negative indicator of infant mortality, the actual value is deducted from the maximum value, and the gap, if any, is divided by the range (see equation 2 below)

$$Dimension\ Index\ (Yi)neg = \frac{Minimum\ value\ (a) - Actu\quad value\ (Zi)}{Maximum\ value\ (e) - Minimum\ value\ (a)} \quad (2)$$

The above indicators are normalised to allow comparison between different dimensions of sustainability using equation 3:

$$Average\ value\ (Zi) = \frac{Average\ (Yi) - \mu}{\sigma} \quad (3)$$

where Z_i denotes the normalised value of each indicator in each sustainability dimension, Average (Y_i) is the average value of each indicator for all respondents, μ is the

aggregated value for each sustainability dimension, σ denotes the standard deviation of each sustainability dimension. We used an equal weighting method to examine each sustainability dimension index and overall sustainability index for the Chingola district (Roldan & Valdes, 2002; YCELP & CIESIN, 2005; 2006). For the calculation of each sustainability dimension, standardised sub-indicators were combined using Wilson The selection of households was done using a systematic random sampling (with a sampling unit of 10) of which 49 households were selected to cover a total of 500 households. In each of the 49 households, 490 respondents and 10 key informants were purposively selected based on their age (20 years and above), their level of education, their availability and willingness to participate in the interview, their length of stay (minimum of 5 years) in Chingola and understanding of the major societal issues Wu's (2017) formula (Eq. 3).

$$INDEXnorm = (Sub_{index1norm} + Sub_{index2norm} + \cdots \ldots \ldots \ldots + Sub_{indexnnorm})/N \quad (4)$$

Where: Sub_index1norm, ... Sub_indexnnorm is the normalised value of each sub-indicator from 1 to n; N is the total number of sub-indices.

To calculate the composite social sustainability index, the sub-indicators of the 11 subjective indicators (Education, Sense of belonging, social cohesion, Security and safety, Equity, Governance, Voice and Participation, Income, Resilience to shocks, Health, and Culture and heritage) and 8 objective indicators (Education, Social cohesion, Security and safety, Equity, Governance, Voice and participation, Health, Sense of belonging) were normalised, aggregated, and averaged. The indicators of each dimension of social sustainability and the composite social sustainability were calculated based on Wilson & Wu (2017) (Equation 5):

$$CSSI = \frac{I_{educ} + I_{Health} + I_{SocCohesion} + I_{SecSafet} + I_{Govern} + I_{equity} + I_{voice\&Part} + I_{Sensebelong} + I_{cultherit} + I_{resilshock} + I_{inc}}{N} \quad (5)$$

where CSSI represents the overall Composite social sustainability Index; "I_{edu}" the Composite Education sub-index."I_{Heal} "the composite Health sub-index"$I_{SocCohesion}$"the composite sub-index for social cohesion, "$I_{SecSafet}$"the composite security and safety sub-index"I_{Govern}"the composite sub-index of governance"I_{equity}"the composite Equity sub-index, "$I_{voice\&Part}$"the composite sub-index of voice and participation, "$I_{Sensebelong}$"the composite sub-index of Sense of belonging"$I_{cultherit}$"the composite sub-index of culture and heritage"$I_{resilshock}$"the composite sub-index of resilience to shocks an"I_{inc}"stands for the composite sub-index of Income (Table 2).

Table 2. Selected social sustainability indicators and definitions

Indicator	Definition and signification
Household	A household was defined as a group of persons who eat and lived together. These people may or may not be related by blood but made common provision for food and other essentials for living. A household comprised several members and, in some cases, had only one member
Education	It profiles the school attendance rate, Gross attendance rate, and the Net attendance rate in the district. It also comprises the level of the adult population with ages ranging (from 20-64 years) captured through formal educational qualifications (≥ secondary degree) (Assefa & Frostell, 2007). Number of training opportunities offered in the district for capacity building (von Geibler, 2006) and number of students per teacher (Ceyhan, 2010) and number of supporting educational institutions (Sarkis, et al., 2010).
Health	The Health indicators cover the quality of health services provided to the people (von Geibler, 2006), the number of health problems, health risks, and health practices reported in the community (Sarkis, et al., 2010). Among the health sub-indicators used: are availability and access to drinking water; child mortality rate; percentage of workers with health benefits; contribution to healthy and safe food; voluntary health measures (McMichael & Powles, 1999; Heller & Keoleian, 2003).
Governance	A local government promotes decentralisation, establishes the rule of law, and encourages participation, civic engagement, transparency, responsiveness and accountability. This also includes all conditions that foster governmental laws and initiatives and peoples' trust in them (Magee, et al., 2012)
Voice & Participation	The voice and influence factor can be seen in participation in collective groups and networks in the community (Bramley & Power, 2009) and social participation (Kefayati & Moztarzadeh, 2015) It is believed that a district participating in community groups and associations and participating in democratic matters (election) to elect and be elected for decision-making positively contributes to local governance and local social sustainability as a whole (Colantonio, 2008; 2009).
Household income	This is the monthly earnings of a household from engaging in economic activities such as the production of goods and services and the ownership of assets. Household monthly income is the sum of all incomes of household members (Alam *et al.* 2009; Manos, 2013).
Security and safety	Refers to the quality of security and safety system available in the district; this comprises (proximity of police station and their effectiveness, traffic control, firefighters, streetlights, availability of surveillance cameras, crime rate, juvenile arrests, property crime, suicide rate, homicide rate) and the way the residents feel confidents about their security and safety.
Resilience to shock	Resilience refers to the communities' adaptability, ability, and capacity to resist and recover from shocks such as floods, social crises, droughts, pests and diseases (Chan & Lee, 2008).
Social cohesion	Refers to the quality of the interaction amongst peoples, which comprises social networks and ties between community members and their feelings of involvement in decision-making, respect for cultural difference and diversity, social norms, tolerance for minority and cultural diversity, mutual respect and trust, without which living together in peace and harmony to pursue share values and objectives is impossible.
Sense of belonging	This is related to how people perceive and feels about their neighbourhood and the district in general. It encompasses five other criteria overlapped (social networks, residential stability, assurance of security and safety, accountability and transparent decision-making process, freedom of movement and expression, free participation in collective community services and pride to belong to the district (Bramley & Power, 2009; Dempsey et al. 2009; Landorf, 2011).
Culture and heritage	**Culture** includes traditions, history, traditional dances, clothing, food, drink, arts, museum, customs, spiritual beliefs, rites, rituals, ceremonies, indigenous knowledge, social customs and traditions, history, sport, and religion (Manik, et al., 2013). **Heritage** includes physical, archaeological, and historical artefacts such as sites, old monuments, and practices a society regards as necessary and worthy of preserving and conserving (Liu, 2013).
Equity	Refers to social justice, intra-generational and inter-generational equity, fairness, and equal opportunities for all citizens. It includes indicators that should reveal equality measures to everyone regardless of age, gender, ethnicity, and social status. **Gini Coefficient:** This measures household income distribution using an index of inequality. The coefficient gives the numerical degree to which the Lorenz curve diverges from the equi-income distribution line. The Gini coefficient always ranges from 0 to 1. A coefficient of 0 represents total equality in income distribution, while a coefficient of 1 represents total inequality. A coefficient such as 0.66 can be considered to represent a high incidence of inequality in income distribution, while a coefficient such as 0.15 represents a more equitable income distribution

Source. www.oecdbetterlifeindex.org

2.4. Human Development Index (HDI)

The HDI is a composite index that depicts a country's progress in the progress made by a country in three key areas of human development: a long and healthy life, access to knowledge, and a decent standard of living. Life expectancy is a measure of how long and healthy a person lives. The adult population's knowledge level is measured by mean years of schooling, which is the average number of years of schooling received in a lifetime by people aged 25 and older, and access to learning and knowledge is measured by expected years of schooling for children

of school-entry age (18 years). The standard of living is measured by Gross National Income (GNI) per capita expressed in constant 2017 international dollars converted using purchasing power parity (PPP) conversion rates (Morse, 2003; UNDP, 2021). The estimated HDI used primarily local and national data and, of course, compared them to international data from the United Nations Development Programme (life expectancy data), the United Nations Educational, Scientific, and Cultural Organization Institute for Statistics (Mean years of schooling and expected years of schooling data), and the World Bank (GNI per capita data). The indices are formulated based on the minimum and maximum values (goal posts) for indicators expressed in different units to be transformed into indices between 0 and 1. These goalposts act as "the natural zero" and "aspirational target", respectively, from which component indicators are standardised (equations 1 and 2 above). They are set at the following values in Table 3.

Table 3. HDI components

Dimension	Indicator	Minimum	Maximum
Health	Life expectancy (2021)	20	85
Education	Expected years of schooling (2021)	0	18
	Mean years of schooling (2021)	0	15
Standard of living	GNI per capita (2021 PPP$)	100	75,000

The historical data that no country in the Twentieth Century had a life expectancy of fewer than 20 years supports the natural zero for a life expectancy of 20 years (Oeppen & Vaupel, 2002; Maddison, 2010). The maximum life expectancy has been 85 years, a realistic goal for many countries in the last 30 years. The maximum per capita income is $75,000. Kahneman & Deaton (2014) have shown that there is virtually no gain in human development and well-being from annual Income above $75,000 per capita. Only three countries (Liechtenstein, Qatar, and Singapore) have a ceiling per capita Income of $75,000. The HDI is the geometric mean of normalised indices for each of the three dimensions given by the mathematical expression (Eq.6):

$$\text{HDI} = \sqrt[3]{I_{healt}} * I_{Education} * I_{income} \quad (6)$$

2.4. Physical Quality of Life Index: Morris (1979) also used the arithmetic mean to compute the Physical Quality of Life Index (PQLI) from three indices: life expectancy, infant mortality, and adult literacy. The PQLI is given by the mathematical expression (Eq.7):

$$PQLI = \frac{Indexed\ Mortality\ rate + Lif\ \ expectancy + Literacy\ rate}{3} \quad (7)$$

HDI and PQLI classification is described in Table 4.

We used the same transformation techniques developed by Ganguli & Gupta, (1976) for estimating the level of living index, to calculate PQLI and HDI keeping the transformed variables in the range of 0–100 for PQLI and without 0–1, multiplying by 100 for HDI. However, the transformation remains sensitive to each the maximum and minimum values of each variable. In the case that two values do not fall in the general pattern of the intermediate values of a variable, there would be an undue influence over the transformation.

Table 4. Human Development Index and Physical Quality of Life Index classification schemes.

HDI	Categorisation	PQLI	Categorisation
Below 0.55	Low human development	0-49	Worst performance
0.55 - 0.69	Medium human development	50-70	Moderate performance
0.70 -0.79	high human development	71-80	High performance
0.80 and above	Very high human development	81-100	Best performance

3. Results and Discussion

3.1. *Socio-demographic characteristics of respondents*

The participant's ages range from 20 to 70 years, with 45.8% of the respondents ranging between 20 to 35 years with a length of stay in Chingola (≥5 years). A total of 500 respondents of whom 61% were female and 39% male. The gender imbalance was in no way based on any biased assumptions about gender equality or inequalities, but only female respondents were mostly available at home during the survey. The socio-demographic characteristics are summarised in Table 5.

Table 5. Socio-economic characteristics of respondents (Sample size, N=500)

Socio-economic Profile of Respondents	Frequency	Percent (%)
Gender		
Male	195	39
Female	305	61
Marital status		
Married	240	48
Single	195	39
Divorced	60	12
Widowed	5	1
Main occupation		
Small business	120	24
Jobless	100	20
Agriculture, livestock keeping	60	12
Carpentry and construction	15	3
Government employment	65	13
Mining	20	4
Entrepreneurship	40	8
Students (secondary and tertiary levels)	55	11
Other informal sectors (mechanic, masonry, welding, etc.)	25	5
Levels of Education		
Illiterate	15	3
Primary school	145	29
Secondary school	240	48
Professional training	40	8
Undergraduates	55	11
Postgraduate	5	1
Resident length of stay in Chingola		
5-9 years	65	13
10-15 years	100	20
16-20 years	130	26
21 years and above	205	41

Source. Field survey, 2021

3.2. Contribution of CSR initiatives to social sustainability in Chingola

Our study Positive impacts of CSR initiatives observed through major social and structural changes in Chingola on health, education, employment, businesses, and infrastructural development. Huge investments have been made directly and indirectly by the government and the mining industry. For example, between 2005 and 2015, over US$ 150 million has been invested by KCM in education, health, sustainable livelihoods, environment, and biodiversity projects (KCM, 2015). KCM owns and operates the Chingola Trust School as part of its contribution to social sustainability. This school provides quality primary education to over 1,000 children of both mine employees and non-mines employees and stands out as one of the best schools in Zambia (Dymond *et al.* 2007; Lusonde, 2019). However, the school fees are so high that it is not affordable for average Chingola residents.

The company also supports local businesses through partnerships and contracts that allowed some of them to provide goods and services. However, our study found a drastic decrease in KCM expenditure on CSR by about -75% between 2010 to 2018. This trend has continued to date given that the expenditure on CSR for the fiscal years (FY 2019-2020), and (FY2020-2021) are respectively USD 370,000 and USD 400,000, below that of the fiscal year (FY 2018-2019) USD 450,000 (Figure 3).

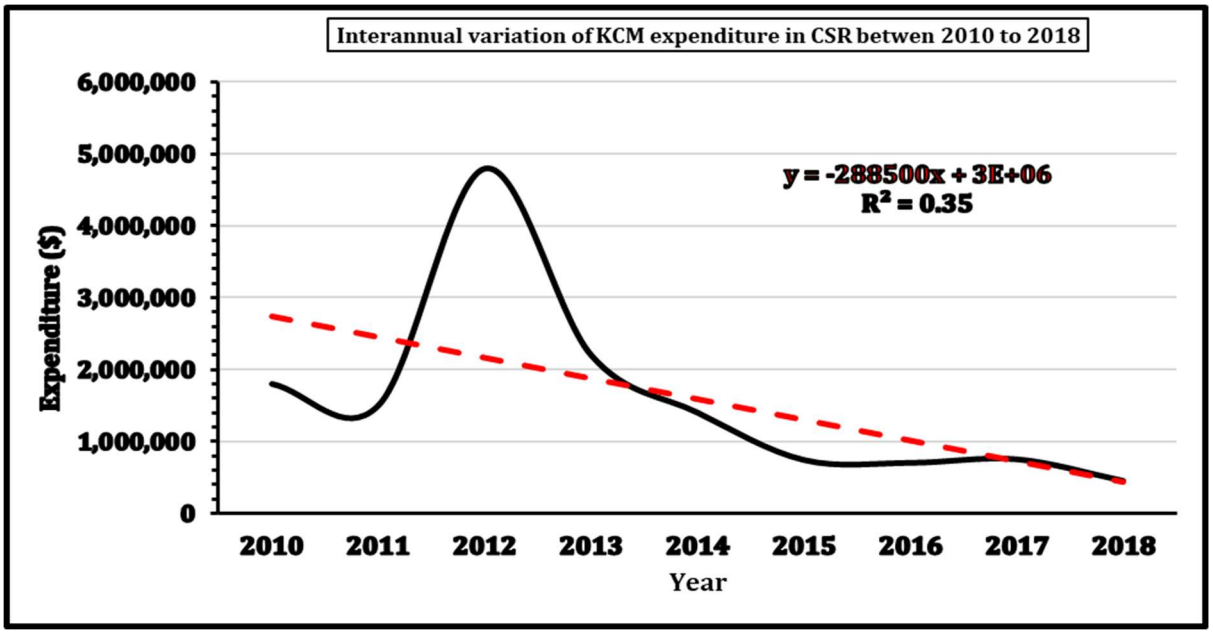

Figure 3. Interannual variation of KCM expenditure in CSR between 2010 to 2018

However, KCM remains the second largest employer in Zambia after the government. By 2017, the company had 16,000 employees, with 10,000 directly and 6,000 employed through subcontracted firms (KCM, 2017). Although Lusonde (2019) claimed that KCM is the major employer in Chingola, employing about 75% of the total workforce. However, this figure might have drastically declined by the time we undertook this study, probably due to a change in management and ownership. Thus, by the time we conducted this study, it was reported that KCM has 5203 direct employees. Nationals' employees account for 5200 (4337 male and 863 female) and 3 expatriates. However, the drastic change that has occurred since 2017, was interpreted differently by the respondents. A total of 94.7% of respondents declared that it is extremely difficult to secure a job in Chingola and 78.7% declared that access to the job when available is very competitive and not fair, and 18.1% of respondents believe that many potential job seekers are inherently excluded. Among the major obstacles hindering job access pinpointed by the respondents are corruption (61.2%), lack of communication concerning the available jobs (11.7%), inadequate level of education (8.5%), discrimination (6.9%),

preference for foreigners and people from outside the district (5.3%) no match between available specialization and offered jobs (4.8%).

Two factors could explain the viewpoint of the respondents. KCM is at the development stage, and at this stage, the capacity of the mining company to recruit is very little. Moreover, the profit margin of the company has been reduced drastically by the entry of several competing firms and the construction of new smelting facilities in Mufulira and Kansanshi, the increased cost of production and the reduction in the ore grade. Consequently, it's possible to invest in CSR as well as provide new employment has been altered and this must be clearly explained to the average resident in a form and way that can be digested and understood. Although this should not be used as an excuse by the mining companies to decline their corporate social responsibility, despite the difficulties, copper mining is still profitable in Zambia.

Several weaknesses of the CSR initiatives have been identified through this study in Chingola. Firstly, CSR does not cover issues about enhancing social cohesion, governance, equity, culture, and heritage. Secondly, our study also found that despite the huge investments in CSR in Chingola, it is done haphazardly without considering the communities needs and priorities. It was observed that the company lacks effective indicators of performance to evaluate the effectiveness of its initiatives. Continuing with such a method is a total waste of money and energy. Thirdly, the investments are also limited geographically. The residents from the wards far away from the mining operating centres such as Mutenda and Musenga are directly excluded from any benefit. A total of 93.7% of respondents argued that the current number and quality of infrastructures and social services are not sufficient to absorb the current demands.

We considered that the reason CSR initiatives are failing to contribute effectively to social sustainability is that, they are straightforward and do not consider several constructs of social sustainability such as people's needs, psychology and context-specific priorities, sociology, local governance, and institutions (Littig & Griessler, 2005; Dempsey *et al.* 2009). Additionally, the lack of shared understanding and definition among decision-makers and planners at the operational levels is also one of the biggest obstacles (Littig & Griessler, 2005; Olofsson *et al.* 2016). A study by Mwakesi (2020) in the mining community of Taita Taveta in Kenya, ascertained that mining is carried out with little government regulation and control, with practically no rule on sharing royalties and benefits among the mining stakeholders. Gurská & Válová, (2013) ascertained that CSR programs are used as mere charity programs that have nothing to do with sustainable development and the aim of creating a shared value for both the company and the community. To solve this, we recommended together with

Marsden *et al.* (2010; 2017) adopting a participative and integrated approach in defining and developing CSR initiatives that should be built upon context-specific priorities and pre-defined sustainability indicators. The social sustainability indicators developed through this study could be good references for this aim. Integrating the needs and priorities of stakeholders in the planning and development process through consultations has been found to better the quality of life (Feng & Hsieh, 2009).

3.2. Analysis of the social constructs of sustainability

3.2.1. Education

The results show that 48% of respondents have a secondary level of education, 29% have a primary level 12% are graduated students and 8% have a professional training certificate and 0.5% have pursued a postgraduate study. In primary school, on average, each household in Chingola has 3 literates, 1 person with a professional qualification and 1 person with a paid job. However, 58% of the respondents indicated that the district lacks experts in many scientific domains and 37% estimated that they are not enough to meet the demands, as a result, 71% of the respondents demand capacity development opportunities.

The analysis of respondents' education profile showed a high score of household literacy (0.93), a high level of satisfaction (0.84) with the national education system, and the delivery of lessons by teachers. However, a low score (0.05) was obtained for the availability of technical expertise per household (Fig.4A). Our query covers experts in technical domains such as GIS, Modelling, Geology, mechanic, electrical engineering etc., usually needed by the mining industry. We argue that the high unemployment rate (20%) in Chingola is somehow due to the lack of technical expertise in the mining district. Besides casual work, the mining industry is usually forced to import skills elsewhere, which was interpreted as importing foreigners to take jobs from the locals. However, a high score (0.71) displayed a willingness to learn new skills and knowledge, even though these opportunities are scarce (Figure 4A). The pupil-teacher ratio was found acceptable, 31 pupils/teacher, compared to the national standard of 42 pupils/teacher (Fig.4 B). The overall score for education was moderately sustainable for both subjective (0.52) and objective (0.51) indicators. The moderate sustainability of the education system can be explained by the contribution of Konkola Copper Mine (KCM) through its corporate social responsibility that has, in the past, provided learning facilities as well as scholarships to pupils in the district. This finding lends credence to the works of Mayondi (2014), Kumar (2016) and Mutale (2019), who in separate studies align with our findings on the contribution of mine CSR to Education. Despite the efforts from both the

government and the mining company, the children and youth of Chingola do not have equal access to schooling opportunities. Access to quality education is still highly dependent upon household income, which prevents many children from their willingness to learn. Many studies have demonstrated that a high level of education is positively associated with a better health conditions and longer life (Elo & Preston, 1996; Zajacova &Lawrence, 2018).

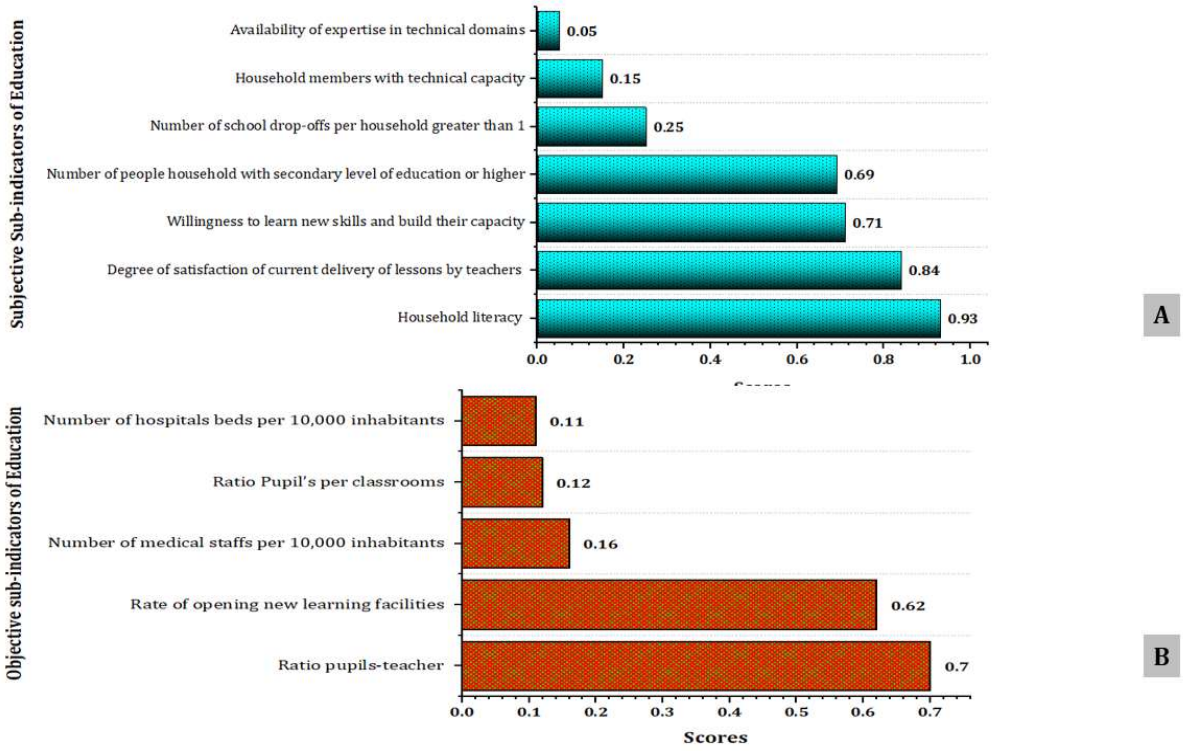

Figure 4. Performance of Subjective (A) and Objective (B) Sub-indicators of Education

3.2.2. Resilience to shocks

The result yielded a relatively moderate resilience to social and political crises with a score of 66/100. Residents reported having in-place committees policing, which has proven very effective in managing minor conflicts and serving as an early warning system. However, their resilience to extreme climatic conditions such as drought and natural hazards like locust plague remains weak, with scores of 41/100 and 34/100, respectively (Figure 5) due to their high dependence on external reliefs and donations instead of developing their adaptation strategies. Previous studies have revealed that relying on government support is limited and unsustainable (Jordaan, 2012; Muyambo *et al.* 2017).

The analysis shows weak social resilience to drought and locusts and moderate resilience to floods and social and political crises. The majority claimed to have no other adaptation strategies to drought and locusts than to rely on help and assistance from the Government and donors. According to experts, high reliance on external support from donors

or the government is not sustainable in the long run, and it impairs people's creativity and capacity to develop adaptation strategies to cope with shocks. The Great Recession of 2008 and the COVID-19 pandemic taught the world that nothing could be taken for granted, and the sooner each country or community develops its resilience system to deal with any shock, the better. Among other solutions to cope with drought, Bayliss-Smith (1991) proposed market integration as a reliable option to provide an opportunity for livelihood diversification and drought-proofing strategies. Our study found that resilience to social and political crises is influenced by the strength of social cohesion rather than a household's economic status which aligns with Pelling & High (2005) that regard social cohesion as a community's best resource for maintaining its capacity to build social resilience and change collective direction.

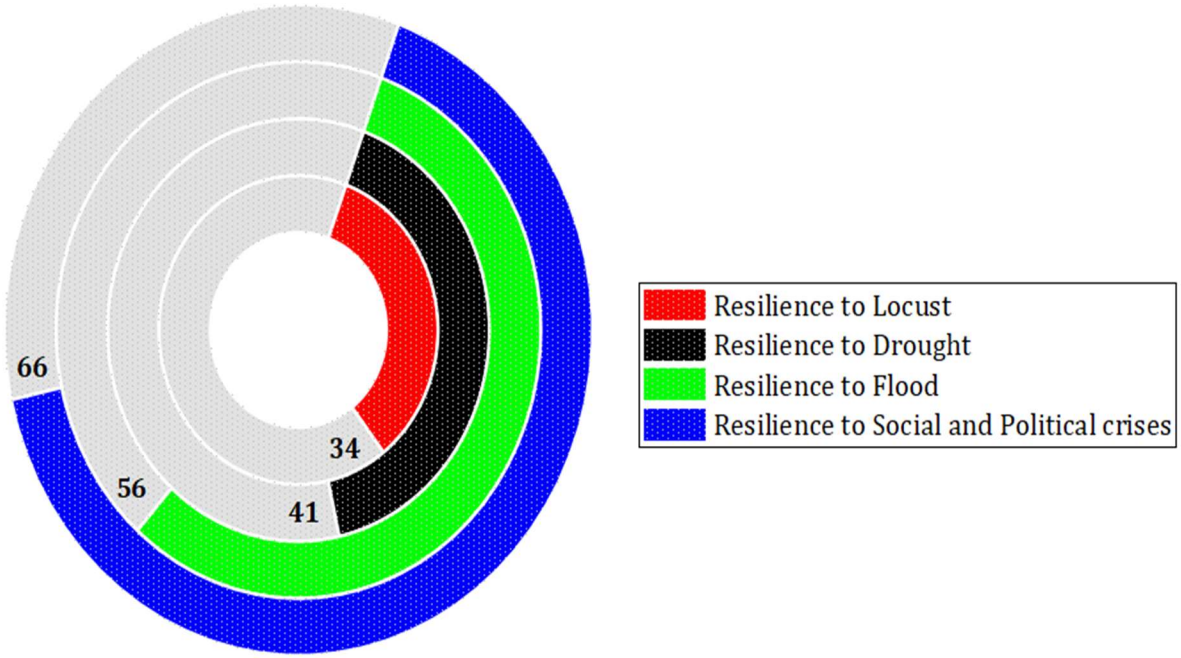

Figure 5. social resilience to shock (scores on a scale of 0-100).

3.2.3. Security and Safety

Security and safety issues in Chingola are rated as "moderately sustainable" but still alarming. The analysis of security and safety indicators ranges from weak to moderately sustainable. For instance, the scores for robberies and assaults stood at 50/100, while the score for drug sales and consumption and topophobia (feelings of unsafeness) among residents both stood at 69/100 (Figure 6A). The entire district has only one fire emergency response truck, which is usually inoperable. A common observation across the study area found that security and safety issues are taken with great care within and around mine premises compared to the surrounding communities where a slight increase in criminal activity is observed (Figure 6B). The rampant

poverty explains this increase in illegal activity among the residents. The suicide rate is relatively low (0.24) compared to the national homicide rate (5.4), and the suicide rate in Chingola is as low as 0.01 compared to 11.85 at the national level. A total of 52% of the respondents claimed that the land tenure and customary law are unsure and certain claimed that it is not like before.

A relatively high number of road accidents and deaths, have been observed from 2018 to 2021, given a traffic security score as low as (28/100) (see Figure 6b). despite the decreasing trend observed in the number of accidents and deaths (671) in 2018 to (466) in 2021 (Table 6).

Chingola security and safety composite index is *"moderately sustainable.*

Table 6: Recorded number and categories of road accidents in Chingola District

	2018	**2019**	**2020**	**2021**
Slightly injured	125	152	151	138
Seriously injured	86	72	53	51
Vehicles damaged only	420	323	289	252
Fatal	40	24	26	25
TOTAL	**671**	**571**	**519**	**466**

Source: Chingola Central Police

Security and safety are central to social sustainability (Barton, 2000; Eizenberg & Jabareen, 2017). Our research suggests a collaboration between mining companies and local governments to address these security issues while they are still manageable, though the Government remains solely responsible. According to our findings, social cohesion significantly impacts residents' feelings of security and safety. This observation is supported by Dekker & Van Kempen (2009), which found that a cohesive society can improve feelings of security.

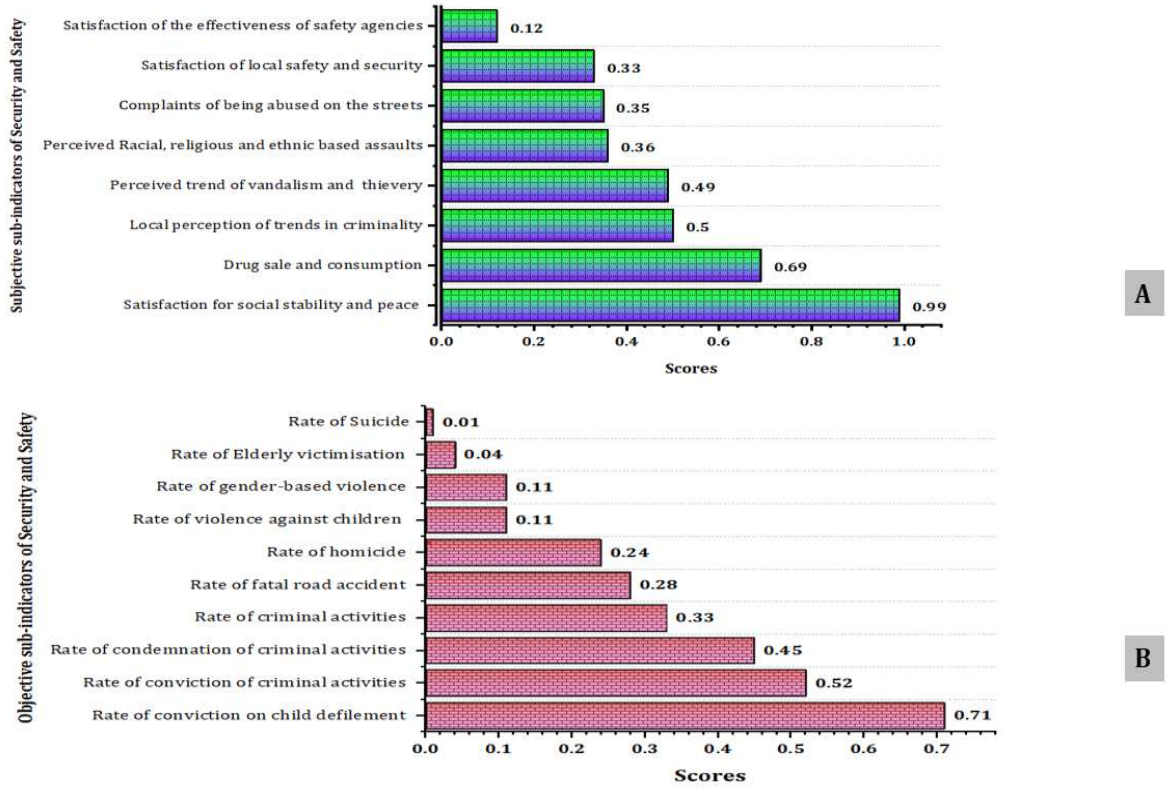

Figure 6. Performance of Subjective (A) and Objective (B) security and safety sustainability.

*3.2.4. **Voice & Participation, and Governance***

Voice & Participation

The current mode of participation does not promote local democracy; even if they are consulted by the local Government or the mining company, they do not feel that their voices are heard, given that the outcomes of these processes do not address the needs and demands of the public.

Although residents participate massively in elections, as shown by the score of potential and eligible voters (69/100) and a relatively moderate satisfaction with their freedom of expression (62/100), there are still very few opportunities given to them to occupy a leadership position (9.6/100) (Figure 7A). This observation is in line with (Innes & Booher, 2004; Agyeman, 2005; Fainstein, 2010). The apparent form of participation in Chingola is what Swanepoel & De Beer (2012) considered that it was as good as placing the citizen in a position of a subject that is only useful when needed to vote, a sort of subject that is given a role to play, a task to execute without any power to decide. Experiences have shown that by not providing opportunities for community participation, development initiatives worldwide have been delayed, interrupted by conflicts, and many difficulties in their implementation (Devine-Wright, 2010; Krütli, 2010; Cowell, 2011). Whitton *et al.* (2014) indicated that public

participation, perception of fairness, trust and inclusion are the central components that justify an industry's acceptance, success, or failure, and Bronfman *et al.* (2012) argued that involving the community in the decision-making processes of large-scale mines developments could have a positive return on the social, environmental and economic fabrics.

Governance

A lingering governance performance was observed by analysing governance indicators in Chingola (Figure 6). Residents considered that local government officials are far from responsive in addressing their demands. Unanimously, corruption, bribery, disregard for community concerns, lack of transparency in management, and bureaucracy were pointed at the forefront of significant issues impairing governance in Chingola. About 78% of the respondents argued assertively that the surface rents and taxes paid annually to the government are not reflected or reinvested in local development. About 82% of the respondents ascertained that the local resources are poorly managed. The perception that only local authorities are the ones reaping the benefits of the mining operations is widespread. The high score (99/100) of the perceived level of corruption, denotes the dissatisfaction with the local governance and the extent to which the trust of residents has been eroded. Marshall *et al.* (2001) demonstrated that corruption has a corrosive effect on the public's confidence in legal processes and encourages a lack of accountability and lawlessness. The community's perception of government accountability and responsiveness is as low (29/100) (Figure 7B), resulting in a local governance score as low as (5.3/100). Many scholars have reported similar observations from different mining areas (Dev, 2013). Mwakesi (2020) explained that the selfishness of local authorities with a weak institution is a fertile ground for poor accountability in mining areas.

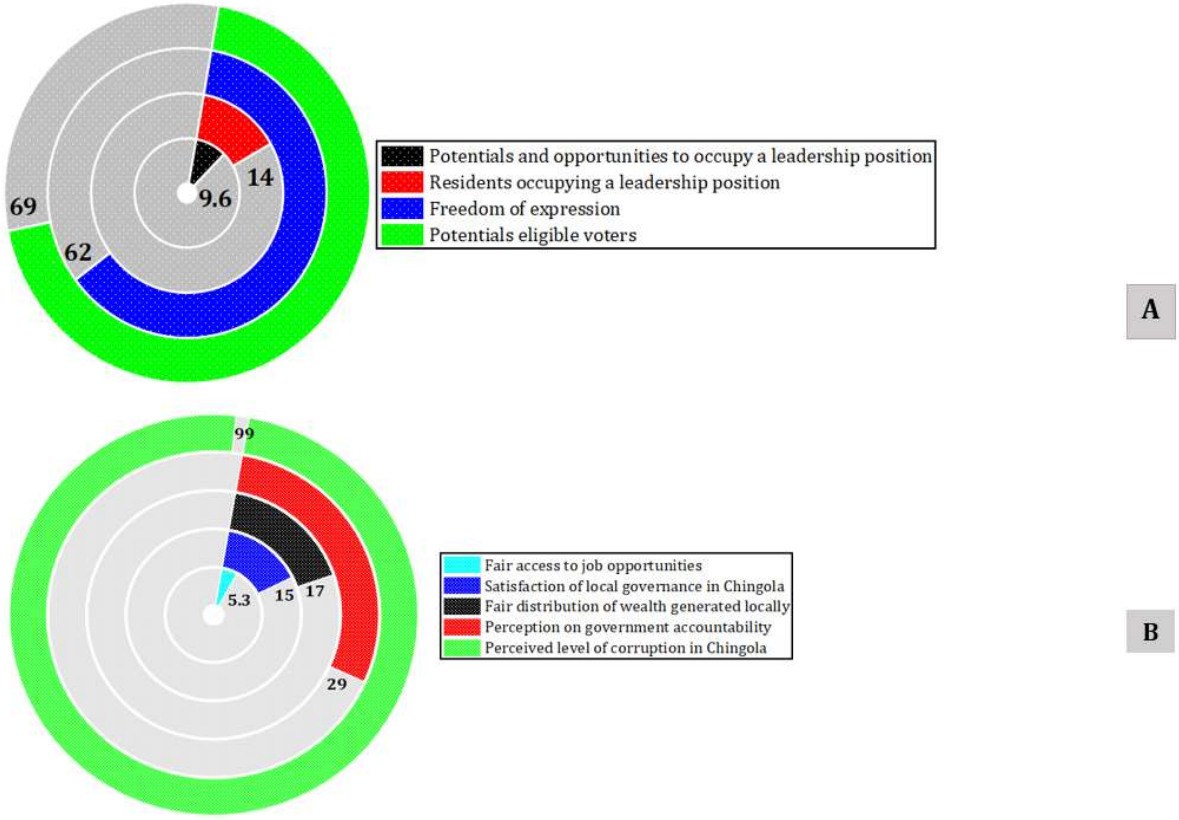

Figure 7. Voice and Participation (A) and Governance (B) sustainability performance (0-100) scale.

3.2.5. Social cohesion and Equity

Social cohesion

Chingola can be considered a cohesive society, given the highest social cohesions scores obtained from subjective (70/100) and objective (62/100) indicators. The social interaction among the communities living in the same neighbourhood is almost perfect (95/100). The respect for social norms and elders, which is essential in African Society, displayed a high score (86/100), and the solidarity among residents through mutual aid and assistance increased (73/100), despite the hardship and the level of poverty. A strong score for capital trust (68/100) was observed among the residents (Figure 8A).

According to Helliwell & Wang (2011), improved social cohesion among citizens boosts their confidence in decision-makers with the same effect on life satisfaction as an increase by two-third in household income. Delhey &Dragolov (2016) discovered that the more a society is cohesive, the happier it becomes. Furthermore, a study covering 39 states in the USA found that social cohesion improves physical and mental health and minimises the effect of economic disparity on mortality. A common observation made through this study is that cleavages across ethnic groups are not pronounced in Chingola. Despite the cohabitation of

diverse ethnic groups, most speak Bemba for communication, a dialect from the largest ethnic group (21%) in Zambia, also dominant in Chingola. Cleavages across ethnic groups are one of the main obstacles to social cohesion (Easterly *et al.* 2006). The highest score for social cohesion can be explained by the fact that in Southern Africa in general, and Zambia in particular, people's relationships and societal norms are rooted in the Ubuntu philosophy. Ubuntu is a philosophy that holds that an individual exists only in relation to a community: "*I am because we are, and because we are, therefore I am*" (Mbiti, 1970; Monson, 2012). Ubuntu is thus a means of achieving social cohesion or a condition of social cohesion itself. We believe that the long-lasting, peaceful, and thriving environment for the success and long-term operations of local businesses and the mining industry can be partly attributed to the strength of this social cohesion. The success or failure of local development projects could be also determined by the strength of the social cohesion in the host community (Mathonsi, 2016). Helliwell (2007) ascertained that a family or city with a good educational system would have strong social cohesion, which aligns with our findings. Forrest (2001) and Dekker (2009) indicated that the proneness of a city or place to experience social unrest and armed conflict is determined by the strength of its social cohesion. According to these authors, the greater the social cohesion, the lesser the risk of conflict in a community. A similar conclusion was made later by Langer, (2013). Alesina and La Ferrara (2002) found a negative correlation between diversity and trust between people of the same geographic setting. The author argued that the more a society becomes diverse, the lower the level of trust. In our case, the capital trust among Chingola residents is high, not because it is less varied, but because the cleavages across ethnic groups do not impair this diversity. Moreover, the fact that almost all the people living in Chingola and Copperbelt Province despite the diversity, speak Bemba, a local language of the same tribe has played a crucial role in this social cohesion.

Nevertheless, we believe the threats to this social cohesion would be increased poverty, economic crises, increased demands for job seekers with relevant and adequate qualifications, and the sudden closure of KCM which constitutes the heart of Chingola. A study by Fainstein (2001) revealed that when a cohesive society is faced with increasing competitiveness and demand for more excellent skills, the social cohesion within that society fades rapidly, giving space to social exclusion, social fragmentation, inequality, and tension. Additionally, Atkinson (2016) ascertained that a *"rapid influx of people tends to loosen social ties and cohesion"*.

Moreover, Kawachi & Berkman (2001) and Uslaner (2002) demonstrated that income inequality negatively affects social cohesion by waning the trust and optimism amongst residents of the same neighbourhood with different social statuses.

Equity

Chingola is yet to ensure intra-generational and inter-generational equity (21/100). About 52% of the respondents believe not much is done to ensure intra-generational equity and 50% ascertained if business continues as usual, nothing much will be left for the generation to come.

Among other obstacles to equity in Chingola is poverty (26.3%), social status (22.7%), level of education (20.6%), and corruption (14.2%). A non-negligible number of respondents (11.1%) believed that tribalism and politics (4.5%) are worryingly becoming important obstacles to equity. A massive disparity in access to job opportunities (4/100) (Figure 8B). It can be predicted that population growth, and persistent economic recession, combined with a need for a highly qualified workforce, would surely alter the chance to ensure intra-generational equity.

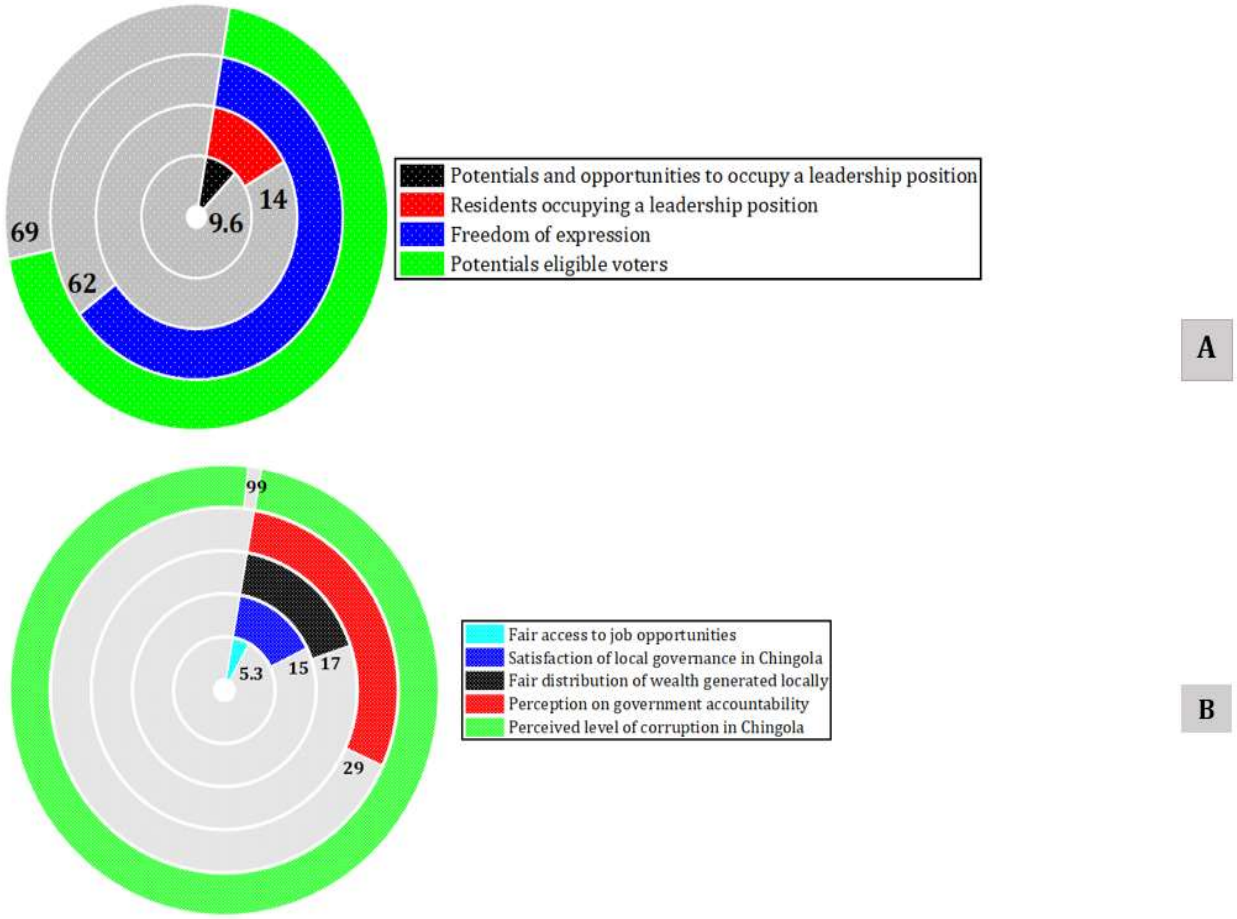

Figure 8. social cohesion (A) and Equity (B) performance.

3.2.6. Health and Income

Health

Health is one of the most valuable assets a person can need in life. Together with jobs, health constitutes the main factor of human quality of life.

Chingola performs very poorly in health system sustainability, scoring respectively 0.21 and 0.24 for subjective and objective health indicators. A high infant mortality rate of (44.4/1000) for children in their first 28 days of life and (79.75/1000) for children under five, pointing directly toward low satisfaction with the number of health facilities (0.31) and the quality of health services provided (0.25), insufficient medical staff, and poor sanitation and sewerage conditions (Figure 9A). Chingola had 185 246 inhabitants in 2010, and it is predicted to grow by roughly 27.6 %, and 25.3 % in 2025 and 2035, respectively (Housing, 2015), and the district still has two hospitals (Nchanga North and Nchanga South Hospitals) owned by KCM and the government, 34 medicals staff with only four (4) medical doctors unevenly distributed in the 35 health centres and health posts and clinics. However, 74.5% of respondents are not satisfied with the health care services, or the medical staff and 69% declared that the number of health infrastructures was insufficient to cope with the demands. Remote areas such as Mutenda and Musenga wards have no ambulance, are understaffed and under-equipped, with no maternity ward. The availability of clean tap drinking water is a significant health issue, with the Mulonga Water and Sewer Company failing to provide potable water for at least half of the population. Only 24,504 households receive water daily, for 10 hours out of 24, and the peri-urban areas such as Mutenda and Musenga are not meant to receive tap drinking water anytime soon, in a district subject to industrial pollution.

For health services to be sustainable, Olsen (2003) indicated that its organisational system has to be reinforced with sufficient resources (social, financial, and human capital) to meet individual and public health needs.

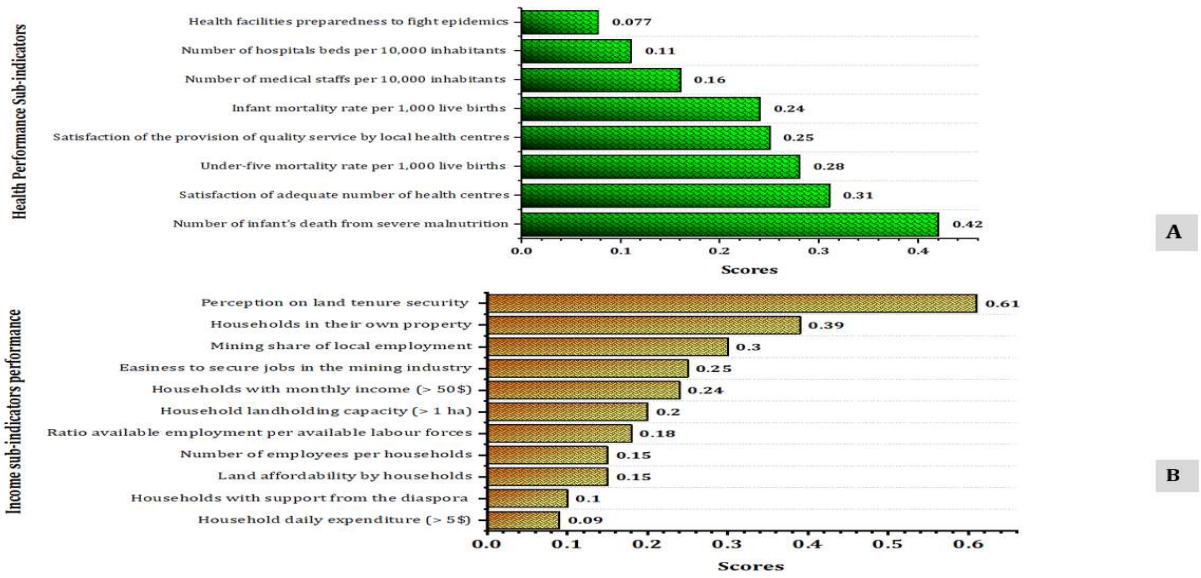

Figure 9. Sustainability performance based on Health (A) and Income (B)

Income

The Chingola composite income index, which stands at 0.21, shows a change and worsening of all indicators considered for the same. The majority of Chingola residents are poor with 76% having a monthly income of between 90 to 900 Zambian Kwacha. Only 0.5% have revenue of 12,000 and above Zambian Kwacha and 38.8% lived in their own houses of which (15.4% build it, 11.2% purchased it, 10% through inheritance, and 2.1% through lease).

Household landholding capacity is as low as (0.20), with 80% of the respondents possessing less than 1.0 ha of land. The financial capability to purchase a plot of land within the district is as low as (0.15) (Figure 9B). With the increasing population, these factors need to be addressed quickly to prevent housing shortages and the growth of slums for those who cannot afford decent accommodation or plots of land. The local planners should proactively initiate peripheral development and limit urban sprawl toward forest reserves and water resources.

Moreover, strict measures should be taken to implement specific building codes, monitor land sales and pricing to reduce the inflationary land pressure and keep the price affordable for the poorest. This will minimise urban sprawl, unplanned and informal settlements, and a relatively manageable population density in each district ward, preserve sufficient agricultural lands, and plan and implement short, medium, and long-term development initiatives. Muraoka (2018) established that a community with several constraints to accessing land would be impeded from operating long-term land investments, consequently

decreasing productivity, and negatively affecting national food security. Moreover, cities' structural socioeconomic conditions, level of resilience to shocks, population density, and rate of urbanisation have been brought to light at the outset of the COVID-19 pandemic (OECD, 2020; Matsumoto & Crook, 2021).

In fine, our study found a weak health system in Chingola, coinciding with an unsustainable household income, meaning numerous households cannot afford quality education and health. The apparent underperformance reflects the inherent poverty in Chingola. It is hard to say if the boom that followed the privatization of mines, generated fiscal revenues and dividends income that could benefit the Zambian population. The slight improvement in living standards is more a result of mines' spillover effects, and market linkages rather than that derived from CSR initiatives, reinvestment of fiscal revenue or rents from resource extraction. The number of people at risk of poverty, social exclusion, or material deprivation will continue to grow without significant change.

3.2.7. Cultural heritage and Sense of belonging

Cultural heritage

Our study found that Chingola is not culturally sustainable. In other words, the cultural identity in this district is not given proper attention, thus fading away and, with time, might disappear. A weak sociocultural setup explained by the abandonment of traditional values and practices might with time negatively affect social cohesion. A total of 87.9% of the respondents are not aware of the existence of the cultural heritage, 87.4% claimed that even if there are some cultural heritage sites in Chingola, they might not be well maintained and 76.8% of the respondents indicated that they have never observed cultural activities in the district. The extent to which the presence of the mining industry explains this decline has not been explored in this study. However, in the past, both the mining companies and 8.4% of the respondents, mainly the elders concurred that the Konkola Copper Mines used to sponsor cultural activities, but the current financial situation of this company has halted such funding with no institution to take over. Consequently, the status of cultural heritage remains very poor, with almost no cultural activity organised annually and despite the willingness of Chingola residents to conserve and preserve their Culture and traditions expressed by 39.5% of the respondents. A study by (Mwakesi, et al., 2020) in line with our findings reported a loss of traditional values and norms and a decrease in the rate of social interaction in the mining community of Taveta in Kenya.

A mining company attracts immigrants and expatriates seeking for jobs with different lifestyle and traditions that can influence local communities behaviour, culture and ways of life. The strength of these impacts will be determined by the management styles of the mining companies, the way the local community is attached to its culture and tradition. The impact of mining on the local culture refer to any of its influence on cultural norms and practices, on tangible and intangible cultural heritage as well as the extent to which it intrudes into the cultural facilities.

In the Philippines, Brawner (2011) indicated that large-scale mining negatively influences the cultural ties of indigenous communities, which leads to the loss of their Culture and identity.

The only cultural heritage site identified through this study in Chingola was the *"Kapisha hot spring",* a potential place for ecotourism (Figure 10A). Sadly, this site is abandoned and not utilised by the city council. Experts in Ecotourism believe that if fully utilised, Kapisha hot spring could stand out as an asset for ecotourism with a positive impact on Chingola's economic development. A study by Bwalya-Umar & Mubanga, (2018) highlighted the great contribution of the tourism industry to the general improvement of the city of Livingston, Zambia. The lack of interest in developing the Kapisa hot spring denotes a lack of awareness about the environmental benefits that conservation projects will be able to produce through ecotourism. Over the years from 2007 to 2016, the tourism sector accounted for 9–10% of GDP globally, and in 2016, it supported over 200 million jobs (direct, indirect, and induced impacts) (UNWTO, 2016). It employs 1 in every 11 people globally (WTTC, 2017). Furedi (2007) found that a community with a strong cultural setting has better resilience to shocks.

Sense of belonging

The sense of belonging to Chingola ranges from moderate to high, except for the low degree of satisfaction with the current status and quality of infrastructure (0.4). The pride in belonging to Chingola was moderately high (0.7), and the willingness to voluntarily participate in any development activity was relatively high (0.78) (Figure 10B). A high score (74/100) was observed for residents' accountability to the district. Hurtado & Carter (1997) found that participation in community activities enhances the sense of belonging to a community. It was also probed by experimental evidence that individuals belonging to associations displayed more prosocial motivations than others (Degli, 2016).

We found social cohesion and a sense of belonging has the potential to foster social networks and connections.

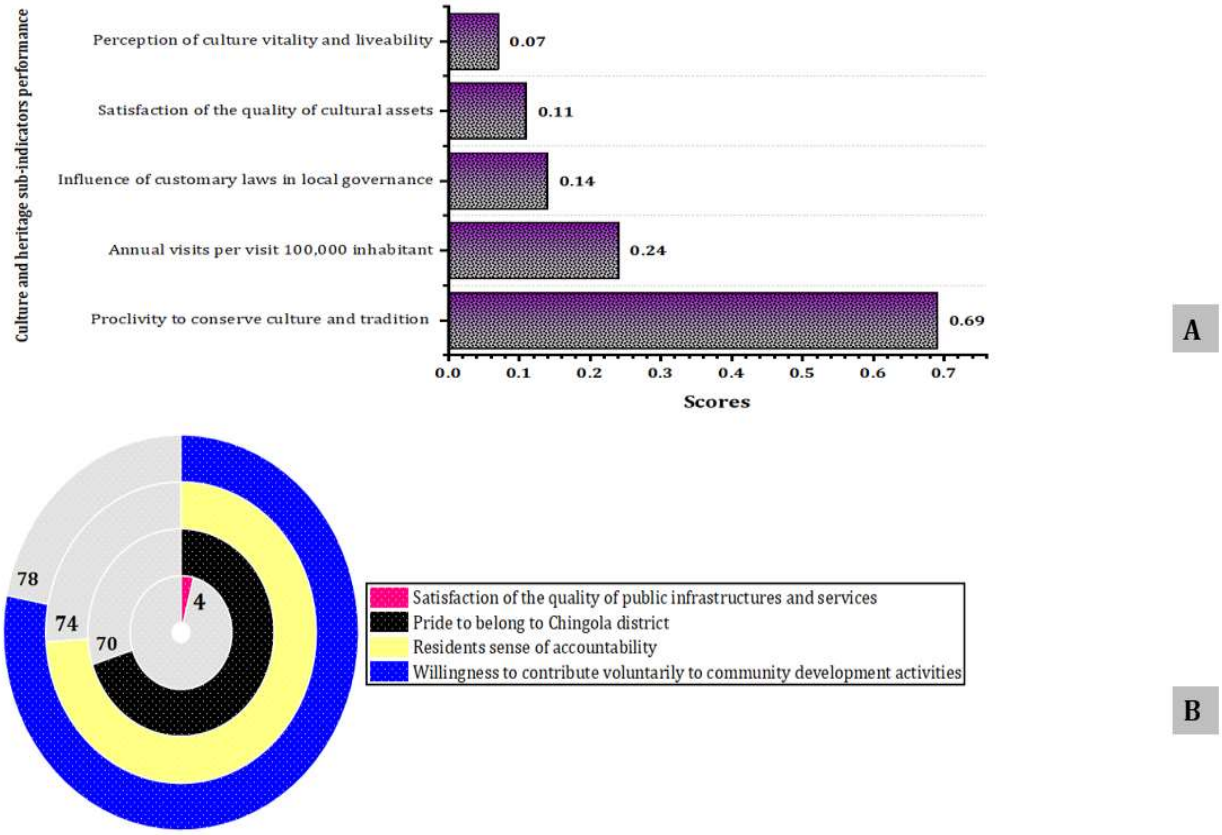

Figure 10. Chingola's sustainability performance of Cultural heritage (A) and Sense of belonging (B).

3.3. Analysis of human development indicators

3.3.1. Human Development Index (HDI)

The HDI was calculated based on its three components: (a) life expectancy at birth, (b) Average [(Expected years of schooling (years) + Mean years of schooling (years)], and (c) GDP per capita (US$).

a. Life expectancy Index: Life expectancy at birth for Zambia for the year 2021 was estimated as 63.9 years (UNDP, 2021), and calculated as given below:

$$\boldsymbol{Life\ expectancy\ Index} = \frac{63.9 - 20}{85 - 20} = \frac{43.9}{65} = \mathbf{0.675}$$

b. Education Index: Average [(Expected years of schooling (years) + Mean years of schooling (years)] were estimated as follows:

$$Expected\ years\ of\ schooling\ index = \frac{11.5 - 0}{18 - 0} = 0.638$$

$$Mean\ years\ of\ schooling\ Index = \frac{7.2 - 0}{15 - 0} = 0.48$$

$$\boldsymbol{Education\ Index} = \frac{0.638 + 0.48}{2} = \mathbf{0.559}$$

c. **The GDP Index:** The GDP per capita or the Purchasing Power Parity (PPP US $) of Zambia for the year 2021 is 1114.52$, with a maximum standing at 75,000 US $; the GDP index was calculated as follows:

$$\boldsymbol{GDP\ Index} = \frac{\log(1114.52) - \log(100)}{\log(75{,}000) - \log(100)} = \frac{3.047 - 2}{4.784 - 2} = \frac{1.047}{2.784} = \mathbf{0.376}$$

HDI is, therefore, the sum of these three (3) components or indices divided by 3.

$$\boldsymbol{HDI} = \frac{1}{3}(0.675) + \frac{1}{3}(0.63) + \frac{1}{3}(0.376) = 0.225 + 0.21 + 0.125 = \mathbf{0.56}$$

$$\boldsymbol{HDI} = \mathbf{0.56}$$

3.3.2. Physical Quality of Life Index (PQLI)

PQLI is used in this study to measure the impact of social, economic, and political policies on the overall living standard of Chingola residents (0.67). The Indexed Mortality rate and PQLI were calculated based on Morris's (1979) formula, and the steps are given below.

*Indexed Infant Mortality rate = (166 - actual mortality rate) *0.625*

*Indexed Infant Mortality rate = (166-44.4) *0.625 =**76***

*Life expectancy = (63.9 - 42) *2.7 = **59.13***

Population with at least some secondary education (% ages 25 and older) = ***44.4*** (UNDP, 2021).

$$PQLI = \frac{Indexed\ Mortality\ rate + Life\ expectancy + Literacy\ rate}{3}$$

$$\boldsymbol{PQLI} = \frac{1}{3}(76) + \frac{1}{3}(59.13) + \frac{1}{3}(44.4) = 25.3 + 19.7 + 14.8 = 59.8$$

$$\boldsymbol{PQLI} = \mathbf{59.8}$$

The HDI value (0.56) obtained in this study reflects that of Zambia (0.565) categorized as medium. The weak scores obtained for health and governance and the moderate score for education might have been influenced by HDI and PQLI. Using the Pearson Correlation and Trend analysis on Good Governance Indicators and Human Development Index for the period covering 1996-2014, Baha (2016) found a positive relationship and trend between Governance Indicators and *Human Development index.* Human Development Index (HDI), Physical Quality of Life Index (PQLI) can help governments understand the overall impact of national welfare policies on the wellbeing of the communities, compare the performance with that of other countries and take corrective measures to improve the standards of living. However, over the decades, HDI and PQLI have been criticized for their limited dimensionality, and their failure to consider many social constructs that would make them reflect human development more accurately (Kovacevic, 2010; Alkire & Foster, 2011; Ramli *et al.* 2015). The two indices have been found not sufficient and adequate to account for the quality of life, as well as

problems related to basic needs such as health, housing, freedom, justice, security, nutrition, and sanitation (Aziz, et al., 2015).

3.3.3. Key implications of the study

Mining is a district in a geographic location with various stakeholders with different perspectives, expectations, and interests in mineral development. A mining community is sustainable when it receives a net benefit from the mining activities from the opening to the closure and far beyond. From the public policymakers' perspective, the corporate industry must adopt a holistic and integrated approach that renders the host communities economically viable, socially responsible, conservational of natural resources, and environmentally healthy.

Our study found that social cohesion is one of the most important indicators to preserve in the community. A decreasing social cohesion, interpersonal trust and confidence in government institutions reduce the ability for collective actions, reduce cooperation and collective actions for development and increase the risks of undue preferential treatment in the allocation of resources. The observed level of poverty will increase corruption, power imbalance, gender inequality and other forbidden activities (drugs, prostitution, alcoholism, and theft).

This study was initiated after observing that most development initiatives either lacked a guiding framework and indicators to monitor progress or performance or were based on a framework that was insufficiently taking into consideration only material and physical aspects of development. This study developed a structured, user-friendly framework for assessing urban social sustainability from residents' subjective and objective perspectives. Top-down and bottom-up approaches were used to provide an opportunity for residents' input and dialogue.

However, although the framework and indicators proposed in this study may not reflect and encompasses all the dynamics and social components of development, it is robust and comprehensive enough to provide a viable direction and insight for policies makers, mine's stakeholders, decision-makers and NGOs operating in Chingola about which elements of the social sustainability to focus on through the social policies, and communities' development projets. The bottom-up and top-down approaches used in this study engage and involve citizens to obtain their viewpoint and perspective on the impacts of mining and its contribution to social sustainability (Castillo, 2007; UNPACS, 2008; DESA, 2009).

This study found that the Chingola district's social and economic development and stability are over-dependent on mineral resources and that implementing corporate social responsibility and achieving social sustainability in mining districts is a challenge.

3.4. Overall social sustainability performance based on objective and subjective indicators

The analysis of the health sector indicators showed that it is not sustainable. The overall health composite indices were 0.21 and 0.24 respectively for subjective and objective indicators.

The education system is moderately performant with composite indices of 0.52, against 0.559 respectively for subjective and objective indicators.

Chingola was found a moderately cohesive society, given the scores obtained from both the subjective (0.61) and objective indicators (0.62). The Gini coefficient of income distribution is based on proxies' data, while the Equity index based on subjective indicators is an aggregation of several components of Equity as perceived by the residents of Chingola (Table A1 and Table A2 in the supplementary file).

Table 7: Overall social sustainability performance of Chingola.

Subjective social sustainability indicators performance			
Unsustainable	**Weak sustainability**	**Moderately sustainable**	**Strong sustainability**
< 0.25	0.25≤X<0.50	0.50≤X<0.75	≥ 0.75
Culture and heritage Health Income	Equity Resilience to shock Voice and Participation Governance	Education Sense of belonging Security and safety Social cohesion	None
Composite Subjective Social Sustainability Index 0.42			
Objective social sustainability indicators performance			
Unsustainable	**Weak sustainability**	**Moderately sustainable**	**Strong sustainability**
< 0.25	0.25≤X<0.50	0.50≤X<0.75	≥ 0.75
Culture and heritage Health	Voice and Participation Income	Education Equity Security and safety Social cohesion	None
Composite Subjective Social Sustainability Index 0.43			
Composite Local Social Sustainability Index 0.425			

The overall score of Equity for the district as measured by the Gini coefficient of income distribution for the fiscal year (2020-2021) had a score of 0.57 (moderately strong), while the overall equity index based on the subjective indicators is 0.38 (weak) (Table 7) and the summary of subjective and objective indicators are found in (Tables A3 and A4).

Chingola Composite Local Social Sustainability Index is weak for subjective and objective indicators, with a score of 0.42 and 0.43, respectively (Figure 11A and Figure 11B). The radar diagram below compiles and summarises the relationship among the indices.

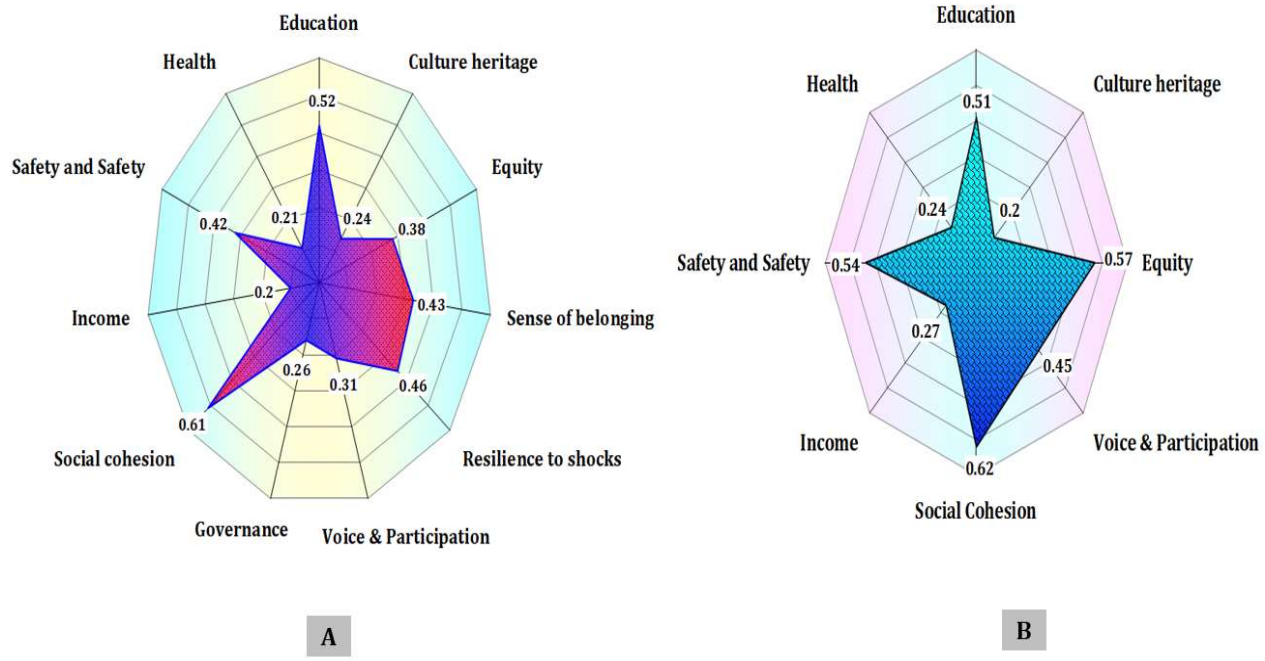

Figure 11. Radar diagram of Chingola social sustainability with benchmarking based on subjective (A) and objective (B) social indicators.

The composite social sustainability index (CLSSI) developed through this study was inspired by Seers (1969) who argued that if in a given country, poverty, inequality, and unemployment become less severe, then ultimately it would have experienced economic development. Several others were scrutinized as references to developing social sustainability indicators. Among others, the Social Development Index (SDI) is based upon 13 physical factors developed by Ray (1989), the level of living index of Ganguli and Gupta, (1976) the HDI of Morse, (2003), and PQLI Morris (1979).

3.5. Limitations of the study

The proposed evaluation framework was applied to one pilot case study, but the indices developed are context-specific and need to be tested in more diverse geographical, sociocultural, and spatial settings. The study did not cover some very important aspects of social sustainability such as the transportation of transportation system as well as the sustainability of the local infrastructures and buildings but was all included in the resident sense

of belonging indicator. The study also failed to obtain relevant data on mineral rent and how it has contributed to fostering inclusive developmental outcomes, and there is a lack of political consensus over the place of mining in the district development strategy. The perception and feedback from respondents may have been influenced by two factors: the COVID-19 pandemic and the 2021 General elections.

4. Conclusion

This study assessed the urban social sustainability pattern in mining areas using the Zambian district of Chingola as a case study. It evaluated the performance of 11 subjective and 8 objective indicators of social sustainability and developed a composite indicator of social sustainability that was compared and discussed with the district's Human Development Index (HDI) and the Physical Quality of Life Index (PQLI). Of the 11 subjective indicators, 3 were unstainable (culture and heritage, health, income), 4 were weak (equity, resilience to shock, voice, participation, and governance), and 4 were moderately sustainable (education, equity, security and safety, and social cohesion).

The study found that social cohesion is the most important component of the social sustainability construct, as it enhances the social resilience to shocks, a sense of belonging, Culture and heritage, voice and participation, governance, and security & safety.

The current approach to corporate social responsibility (CSR) in mining areas is hindered by a lack of theoretical framework, corruption, weak accountability, conflict of competence, a top-down approach, and weak engagement with the community. A top-down approach has been ineffective in addressing structural poverty, equity, and justice. Critical components of social constructs are not considered by CSR initiatives, such as social cohesion, equity, local governance, voice and participation, and a sense of belonging. CSR initiatives should have a holistic approach, integrating at most all social sustainability indicators and using a bottom-up approach to be effective and efficient in contributing to social sustainability.

The study recommends providing education programs to residents, encouraging the formation of organisations to strengthen social networks and social cohesion, and collaborating with local governments and the mining industry to improve security and safety.

Henig (1984) and Bernett (2006) found that the Neighbourhood Watch initiative could boost people's sense of security and serve as a valuable exercise in direct democracy. There is a need to improve community participation and engagement to have veto power over projects that affect their land and livelihood by moving further toward mandatory and legally binding social, environmental, and human rights standards. The voluntary approach, based on the

assumption that the mining industry knows what to do, has proven ineffective, insignificant, and complacent. This implies a paradigm to move from a principle-based approach to a rule-based approach to corporate governance.

The study also recommends significant investment in the health sector, including the construction and equipping of hospitals, recruiting, and training of medical physicians and clinical disease specialists. Local governance should be improved by focusing on factors such as integrity, efficacy, responsiveness, and combating bribery and corruption. Investing in cultural activities and the promotion of cultural heritage such as *Kapisha hot Springs* are vividly recommended.

CONFLICTS OF INTEREST: None

ACKNOWLEDGEMENT : This work was supported by The Copperbelt University Africa Centre of Excellence for Sustainable Mining (CBU-ACESM) and the University of Pretoria who provided the fund and support necessary to conduct this research.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

This study aligns with the 1964 WMA Declaration of Helsinki. The authors obtained an ethical clearance and the mandate to conduct research in the country from the ethics committee for social sciences of the Copperbelt University of Zambia (No. 2021-098). Moreover, at each office and firm, permission was duly requested to conduct a survey within each establishment upon filling in an ethical clearance. The data collection, approach and methodology of this study were guided by senior scientists and mine stakeholders to ensure compliance with best practices. An oral informed consent was attached to each questionnaire.

The questionnaire was anonymous, and the participants can skip or not give an opinion on specific questions.

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Appendices:

Table A3: Summary of subjective indicators and sub-indicators of social sustainability.

Criterion	Indicator	Sub-indicators	Index	Observed	Target
Basic needs	**Education**	Household literacy (Number of literates greater than 1)	0.93	Very high	High
		Household technical capacity (Number skilled people per household greater than 1)	0.15	Very low	High
		Availability of expertise in technical domains	0.05	Very low	High
		Degree of satisfaction of current delivery of lessons by teachers	0.84	Very High	High
		Willingness to learn new skills and build their capacity	0.71	High	High
		Number of school drop-offs per household greater than 1	0.25	High	Low
		Number of people household with a secondary level of education or higher	0.69	High	High
	Health	Resident's score of satisfaction of the provision of quality health service by local health centers	0.25	Low	High
		Resident's score of satisfaction of an adequate number of health centers	0.31	Low	High
		Resident's perception score of health facilities preparedness and fitness to fight any epidemic outbreak	0.077	Very low	High
	Safety and security	Resident's perception and satisfaction score of local safety and security	0.33	Low	High
		Resident's perception score of trends in criminality	0.50	Moderate	Low
		Resident's perception score of local social stability and peace	0.99	Very High	High
Governance	Fair distribution of wealth generated locally	Resident's perception score of redistribution of wealth is fair and just	0.17	Very Low	Very High
	Perception on national government accountability	Resident's perception score of local and national government accountability	0.29	Low	High
	Perceived degree of corruption in Chingola	Resident's perception score of level of corruption in Chingola	0.99	Very High	Low
	Satisfaction of local governance in Chingola	Resident's perception score of transparency and accountability in managing the local natural resources	0.15	Very Low	High
	Fair access to job opportunities	Resident's perception and satisfaction score of local jobs accessibility by Chingola residents	0.053	Very Low	High

Table A4: Summary of objective indicators and sub-indicators of social sustainability.

Criterion	Indicator	Sub-indicators	Index	Observed	Target
Social Cohesion	Degree of satisfaction of the current quality of social interaction	Household heads satisfaction score of current social interaction	0.95	High	High
	Perceived trust capital between residents	The score of trust capital among Chingola residents	0.68	High	High
	Degree of satisfaction of mutual aid between residents	The score of satisfaction with existent mutual aids among households' members	0.73	High	High
	Degree of satisfaction of the respect of social norms and elders by residents	The score of the status and respect for the societal norms and elders by Chingola residents	0.86	High	High
	Participation in active community association	The score of resident's participation in community's group	0.28	Low	High
Voice and Participation	Residents taking part in the election for a leadership position	The score of residents occupying or aspiring for a leadership position	0.096	Low	High
	Residents occupying a leadership position	The score of residents occupying a leadership position	0.14	Low	High
	Participation in election as an elector	The score of residents voting for a candidate to a leadership position	0.69	High	High
Equity	Social inclusion	The score of residents who think all residents have equal access to public facilities	0.73	High	High
	Attitude towards inter-generational equity	The score of residents who believed that Chingola residents are preserving and protecting the natural resources for the future generations	0.21	Low	High
	Equal and fair access to job	The score for the resident perception of equal and fair access to a job in Chingola	0.04	Low	High
	Availability of sustainable jobs	Perception score about the availability of sustainable jobs opportunities	0.56	Medium	High
Sense of belonging	Degree of satisfaction of status and number of public infrastructures	Perception score of the number of people satisfied with the current status and quality of existent public infrastructures	0.04	Low	High
	Resident attitude towards accountability	Perception score of resident's accountabilities	0.74	High	High
	Resident attitude towards community services	Perception score of resident's willingness to take part in voluntary activities or community services	0.78	High	High
	Pride to belong to the district	Perception score of residents proud to belongs to Chingola district	0.70	High	High
INCOME	Number of household members with a stable and paid job	The score of households with several employees	0.15	Low	High
	Number of households with acceptable natural capital	The score of household's landholdings capacity (Land area greater than 1 ha)	0.20	Low	High
	Level of income versus land affordability	The score of land affordability by households within the district of Chingola	0.15	Low	High
	Household daily expenditure	The score of household daily expenditure (household head able to spend more than $5 for food)	0.09	Low	High
	Household Monthly Income	The score of household monthly income (Household with a monthly income greater than $50)	0.24	Low	High
	Household heads living on their property	The score of households living on their own property	0.39	Low	High
	Mining share of local employment	Local residents' perception score of easiness and fairness to obtain a job from the mines	0.25	Low	High