

Beyond Environmental Compliance: Environmental Stewardship, Community Expectations and Social Licence to Operate at Lumwana Mine, Zambia

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Abstract:

➤ *Background:*

Environmental stewardship is increasingly recognized as a critical factor in securing and maintaining a Social Licence to Operate (SLO) in the mining sector, particularly where mining activities generate significant environmental and socioeconomic concerns among host communities. At Lumwana Mine in Zambia, concerns about environmental impacts and community expectations may influence the extent to which mining operations are socially accepted and perceived as legitimate. This study examined the role of environmental stewardship in achieving and maintaining a Social Licence to Operate at Lumwana Mine. Specifically, it assessed the mine's environmental stewardship practices, examined host-community perceptions and expectations, evaluated the alignment between stewardship initiatives and community expectations, and determined the implications of inadequate environmental stewardship for the mine's SLO.

➤ *Methodology:*

The study adopted a mixed-methods research design involving a population of 330 participants selected through simple and purposive sampling techniques. Data were collected using structured questionnaires, interviews, and focus group discussions. Quantitative data were analyzed using descriptive and multivariate statistical techniques, while qualitative data were analyzed thematically.

➤ *Results:*

The findings showed high community recognition of environmental stewardship measures, particularly waste management and land rehabilitation, which were rated as strongly implemented ($M = 4.03$ and $M = 4.05$, respectively), while mine closure planning was perceived as moderately implemented ($M = 3.76$). However, 87.9% of respondents reported being affected by mining activities, and 58.2% expressed negative attitudes towards mining operations. Using 3.00 as the neutral midpoint of the five-point Likert scale, community expectations regarding environmental stewardship were significantly higher than the neutral benchmark ($t = 48.6$, $p < 0.001$), while perceptions of environmental stewardship were significantly lower than the benchmark ($t = -22.4$, $p < 0.001$). These findings indicate that community expectations were high, whereas perceptions of the mine's environmental stewardship were comparatively less favorable. A direct comparison of expectation and stewardship perception scores through a paired-samples analysis further provides a more appropriate assessment of the expectation–performance gap. Environmental stewardship perceptions were positively associated with attitudes towards the mine ($r = 0.62$, $p < 0.001$), while perceived environmental impacts were strongly associated with negative attitudes towards mining operations ($r = 0.71$, $p < 0.001$). Regression analysis further demonstrated that Environmental stewardship perception was the strongest statistical predictor of SLO perceptions ($\beta = 0.41$, $p < 0.001$). The study concludes that effective environmental stewardship, supported by transparency, meaningful community participation, livelihood restoration, and credible mine closure planning, is essential for strengthening community trust, acceptance, and the long-term legitimacy of mining operations.

Keywords: Environmental Stewardship, Social Licence to Operate, Mining, Host Communities, Corporate Social Responsibility, Community Perceptions, Lumwana Mine, Zambia.

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I. INTRODUCTION

Natural resources, including land, forests, water and minerals, are fundamental to human well-being, livelihoods and economic development. In Zambia, their importance is particularly evident given the central contribution of agriculture and mining to the national economy (Mayondi, 2014; Lusonde and Mubanga, 2019). The mining and quarrying sector remains an important contributor to economic output, with copper serving as the country's principal mineral commodity and a major source of foreign exchange earnings (Zambia Statistics Agency, 2025; U.S. Geological Survey, 2025). However, mining activities can also generate substantial environmental and social pressures, including deforestation, land degradation, water pollution, biodiversity loss and competition over natural resources. These impacts may disproportionately affect host communities whose livelihoods and well-being depend on surrounding land, water and other environmental resources. A key challenge for sustainable mining is therefore to realise economic benefits while managing environmental impacts in ways that maintain community acceptance and support.

The need to maintain community acceptance has increased attention to the Social Licence to Operate (SLO) in extractive industries. SLO refers to the continuing acceptance and approval of a company's activities by communities and other stakeholders within its area of influence. Unlike a statutory licence, SLO is not formally granted by a regulatory authority but is socially constructed through perceptions of legitimacy, credibility, trust, fairness and corporate responsiveness (Prno, 2013; Moffat et al., 2015). SLO is particularly important in mining because community opposition can contribute to conflict, operational disruptions, reputational risks and delays in development projects. Environmental performance is an important component of this relationship because communities may assess mining companies not only according to regulatory compliance but also according to their perceived responsibility for environmental protection and responsiveness to environmental concerns. Omotehinse et al. (2024) demonstrate the importance of SLO in addressing environmental concerns and conflicts associated with mining-related water impacts, while research in Zambia identifies trust, community engagement, procedural fairness and responsiveness as important influences on relationships between mining companies and host communities (Mazyopa and Chileshe, 2021).

Within this context, environmental stewardship represents an important mechanism through which mining companies may strengthen SLO. Environmental stewardship refers to the responsible protection, conservation and management of the environment by individuals, communities

and organizations (Bennett, 2018; Mumbi and Kasonde, 2025). In mining, it includes pollution prevention, responsible waste management, water conservation, biodiversity protection, land rehabilitation and mine closure planning. Environmental stewardship extends beyond technical compliance because it also encompasses corporate transparency, responsiveness and the credibility of environmental commitments as perceived by affected communities. Effective stewardship may strengthen trust, legitimacy and community acceptance, whereas perceived environmental degradation or inadequate responses to environmental concerns may undermine SLO. Zambia's Minerals Regulation Commission Act, 2024, reinforces the importance of prudent mineral resource utilization, environmental protection, prevention of adverse environmental effects and development of communities surrounding mining areas (Republic of Zambia, 2024). Environmental stewardship is therefore both a regulatory responsibility and an important component of socially sustainable mining.

These issues are particularly relevant to Lumwana Mine in Kalumbila District, North-Western, Zambia. Since commencing operations in 2007, the Mine has developed a substantial environmental, economic and social footprint in surrounding communities. The approval of the Lumwana Super Pit Expansion Project in 2024 has further increased the significance of environmental and community considerations because of the expansion of the operational footprint and the associated resettlement programme affecting households in the Kamisengo area. The Environmental and Social Impact Assessment for the expansion was approved by the Zambia Environmental Management Agency in November 2024 (Barrick Gold Corporation, 2025). Although the Mine reports implementing environmental management systems, monitoring programmes, audits and other measures to manage environmental and social impacts (Barrick Gold Corporation, 2026), concerns relating to environmental impacts, forest clearing and community displacement continue to attract attention. This creates a potential divergence between corporate environmental commitments and community perceptions and experiences.

Despite increasing scholarship on environmental management and SLO, empirical evidence concerning the relationship between specific environmental stewardship practices, community expectation and SLO remains limited in Zambia. Existing research has largely emphasized trust, procedural fairness, stakeholder engagement and community relationships, with less attention to whether specific environmental stewardship practices translate into community acceptance when environmental impacts, community expectations and corporate responsiveness are considered together. This gap is particularly important in the

context of a major copper mine undergoing substantial expansion, where environmental and social pressures may intensify interactions between the company and host communities.

This study addresses this gap by examining the significance of environmental stewardship practices in maintaining the SLO of Lumwana Mine from the perspective of host communities. It specifically examines community perceptions of environmental stewardship, satisfaction with corporate social responsibility, perceived environmental impacts and transparency, and their relationship with SLO. The study contributes to the literature by providing empirical evidence on environmental stewardship and SLO within the Zambian copper-mining context and by examining these relationships during a period of major mine expansion. Practically, the findings provide insights that may assist mining companies in strengthening environmental management, transparency and community engagement, while informing communities, regulators and policymakers seeking to promote environmentally responsible and socially sustainable mineral development.

➤ Research Questions

This study was guided by the following research questions:

- What environmental stewardship measures are implemented at Lumwana Mine?
- How do host communities perceive and what do they expect from Lumwana Mine's environmental stewardship initiatives?
- To what extent are Lumwana Mine's environmental stewardship initiatives aligned with host-community expectations?
- What are the perceived consequences of inadequate environmental stewardship on the Social Licence to Operate at Lumwana Mine?

II. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

➤ Social Licence to Operate

The concept of Social Licence to Operate (SLO) emerged in response to increasing conflicts between extractive companies and host communities and refers to the continuing acceptance and approval of an organization's activities by local communities and other stakeholders (Thomson and Boutilier, 2011; Prno, 2013). Unlike a statutory licence, SLO is socially constructed and depends on how stakeholders perceive the legitimacy, credibility, trustworthiness and responsiveness of a company (Moffat et al., 2015). Boutilier (2014) conceptualizes SLO as a continuum ranging from withdrawal and acceptance to approval and psychological identification, with increasing levels reflecting stronger relationships between companies and communities.

Stakeholder theory (Freeman, 1984) and legitimacy theory (Suchman, 1995) provide important theoretical foundations for understanding SLO. Stakeholder theory

emphasizes the need for organizations to consider the interests of groups affected by their activities, while legitimacy theory suggests that organizational survival depends partly on maintaining alignment with societal expectations and norms. In mining, these perspectives imply that community acceptance is influenced not only by economic benefits but also by environmental performance, fairness, communication and corporate responsiveness. Research indicates that environmental impacts, trust, engagement and procedural fairness are significant determinants of community attitudes towards mining (Moffat and Zhang, 2014; Mazyopa and Chileshe, 2021). Thus, maintaining SLO requires mining companies to demonstrate responsible behavior that communities perceive as legitimate and credible.

➤ Environmental Stewardship in Mining

Environmental stewardship refers to the responsible protection, conservation and management of natural resources and ecosystems (Worrall et al., 2009; Bennett, 2018). In mining, stewardship extends beyond regulatory compliance to include responsible environmental practices throughout the mining lifecycle. Key practices include waste management, land rehabilitation and mine closure planning. Effective waste management is important because mining waste, particularly tailings, can create significant risks to water, soil and human health if inadequately managed (Adiansyah et al., 2015). Land rehabilitation involves restoring disturbed land to productive and sustainable uses, while closure planning addresses environmental and social risks after mining operations cease (Hancock et al., 2020; Laurence, 2006).

Evidence from Zambia and other African mining contexts indicates that implementation of environmental stewardship remains affected by weak enforcement, institutional capacity constraints and inadequate stakeholder engagement (Mukuka, 2020; Lisse and Verma, 2019). At Lumwana, Kaonda and Nsontaulwa (2024) found limited community awareness of rehabilitation activities, partly due to insufficient communication and engagement. These findings suggest that environmental stewardship can influence SLO not only through actual environmental outcomes but also through how environmental practices are communicated, understood and experienced by communities.

➤ Environmental Justice, Trust and Procedural Fairness

Environmental stewardship is closely connected to environmental justice, particularly where mining activities affect access to land, water, forests and other resources. Environmental justice requires attention to the distribution of environmental benefits and burdens, participation in environmental decision-making and recognition of affected communities' concerns. Perceived environmental injustice may weaken trust and undermine SLO.

Studies demonstrate that mining communities frequently report negative environmental and social impacts. Nachalwe and Bwalya (2024) identified pollution of air, water and land and associated health concerns in Zambian mining communities, while Lusonde and Mubanga (2019)

reported community concerns about dust, noise and water contamination. Importantly, perceptions of environmental risk may influence community acceptance even where some technical environmental indicators remain within regulatory limits.

Trust and procedural fairness are therefore central to the environmental stewardship-SLO relationship. Communities are more likely to accept mining activities when they perceive decision-making processes as transparent, inclusive and fair. Conversely, inadequate communication, limited participation and perceived disregard for community concerns can create distrust. Moffat and Zhang (2014) and Mazyopa and Chileshe (2021) demonstrate the importance of trust, procedural fairness and engagement in shaping relationships between mining companies and communities.

➤ *Community Expectations and Livelihood Impacts*

Host communities evaluate mining activities against expectations concerning environmental protection, employment, social investment, infrastructure and livelihood security. Research shows that mining companies may implement CSR and sustainability initiatives without fully meeting community expectations. Gideon and Boahen (2024) found strong community expectations for improved environmental and social outcomes, while Mumbi and Kasonde (2025) reported that the effectiveness of sustainability initiatives in Zambia was influenced by participation, responsiveness and alignment with community priorities.

Livelihood impacts are particularly important where communities depend on land and natural resources. Mining-related land disturbance, displacement and environmental degradation can affect agriculture, water access and other livelihood activities. At Lumwana, the expansion of mining activities and associated resettlement create an important context for examining whether corporate environmental practices are aligned with community expectations. Where perceived environmental costs outweigh benefits, dissatisfaction may reduce trust and weaken SLO.

➤ *Conceptual Model and Hypotheses*

This study is underpinned by Social Licence to Operate (SLO) Theory and Stakeholder Theory which together provide a basis for explaining how environmental stewardship influences the relationship between a mining company and its host community. SLO Theory suggests that the continued acceptance and legitimacy of mining operations depend largely on community perceptions of the company's performance, responsiveness, and adherence to locally valued expectations. Stakeholder Theory, on the other hand, emphasizes the importance of recognizing and responding to the interests and expectations of stakeholders, particularly communities directly affected by organizational activities.

Within this study, environmental stewardship is conceptualized as a key organizational practice through which the mine manages environmental impacts and demonstrates responsibility towards its host community. Effective stewardship practices, including waste management, land rehabilitation, pollution control, biodiversity management, and mine closure planning, are expected to improve perceived environmental performance. Positive perceptions of environmental performance can enhance community trust and organizational legitimacy, thereby strengthening the mine's Social Licence to Operate.

Conversely, where mining activities are perceived to generate significant environmental harm, communities may experience adverse livelihood impacts, including effects on land, water resources, agricultural activities, and other sources of livelihood. Such impacts can reduce community trust in the mining company and weaken perceptions of its legitimacy, ultimately resulting in a diminished SLO.

The framework further recognizes transparency, community participation, and procedural fairness as important contextual factors that can influence these relationships. Transparency can improve access to information and reduce uncertainty concerning environmental performance, while meaningful community participation can enhance perceptions that community concerns are heard and incorporated into decision-making. Procedural fairness can strengthen perceptions of equitable and respectful treatment, thereby reinforcing trust and legitimacy. These factors may therefore strengthen the positive relationship between environmental stewardship and SLO and mitigate the negative effects of perceived environmental harm.

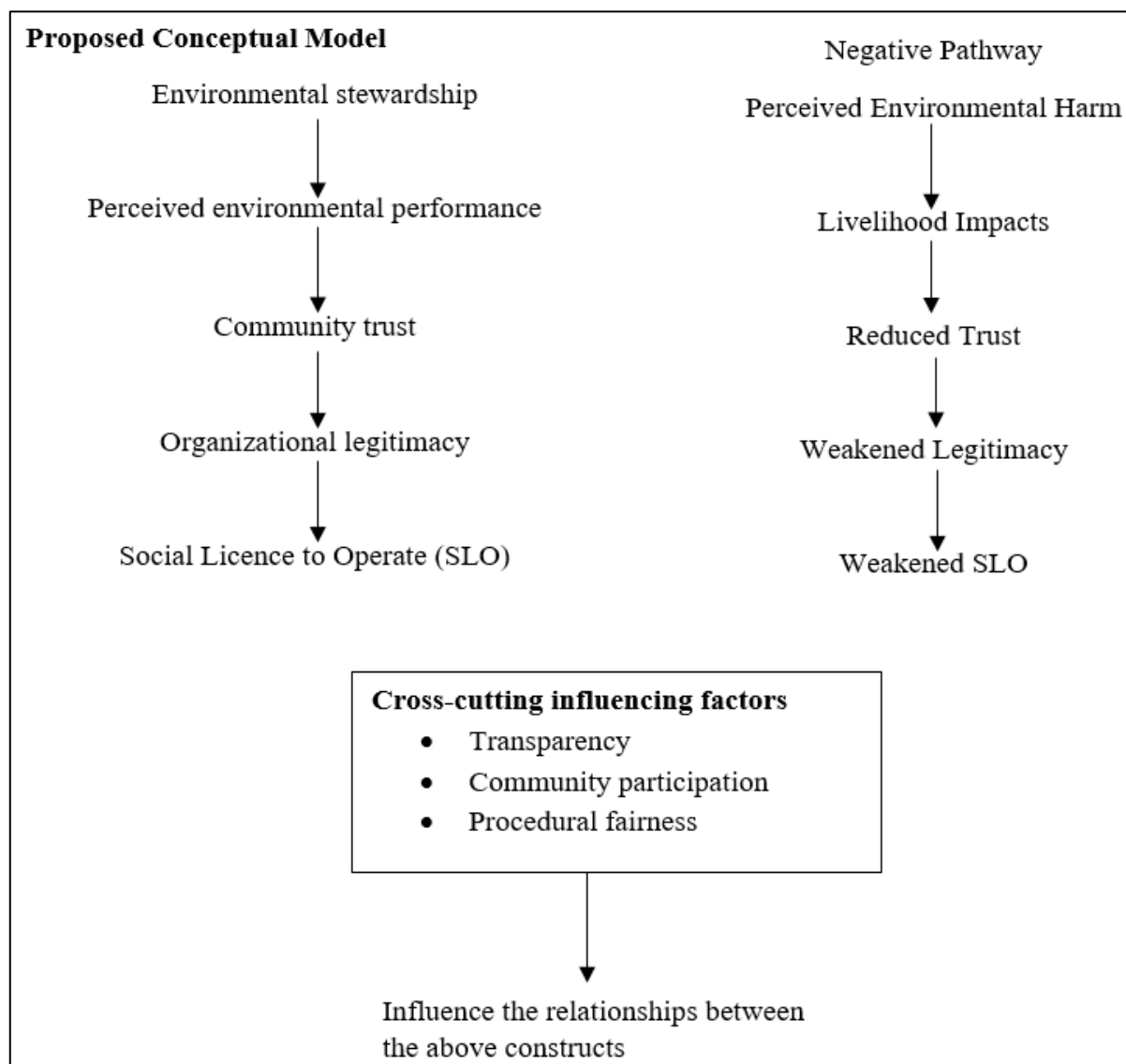


Fig 1 Conceptual Framework Linking Environmental Stewardship, Community Perceptions, Trust, Legitimacy and Social Licence to Operate

Accordingly, the conceptual model proposes two complementary pathways. The first is a positive pathway, in which effective environmental stewardship improves perceived environmental performance, which builds community trust and legitimacy and ultimately strengthens SLO. The second is a negative pathway, in which perceived environmental harm contributes to livelihood impacts, reduces community trust, weakens perceived legitimacy, and consequently undermines SLO.

• Link to the Theoretical Foundations

The framework provides a clear basis for interpreting the study findings through the two theoretical perspectives. From an SLO Theory perspective, environmental stewardship influences whether the host community perceives the mining operation as acceptable, legitimate, and trustworthy. From a Stakeholder Theory perspective, the framework demonstrates that SLO is influenced by the extent to which the mine responds to the environmental concerns, expectations, and livelihood interests of its host community. Transparency, participation, and procedural fairness

represent mechanisms through which the mine can respond to stakeholder expectations and strengthen the legitimacy of its operations.

The following hypotheses were tested:

- H1: Positive perceptions of environmental stewardship are positively associated with SLO.
- H2: Perceived environmental impacts are negatively associated with SLO.
- H3: Transparency is positively associated with SLO.
- H4: Satisfaction with CSR is positively associated with SLO.

III. METHODOLOGY

➤ Study Area/Context

The study was conducted in communities surrounding Lumwana Mine in North-Western Province, Zambia, with particular attention to communities located within approximately 10 km of the mining operation. The study area

was selected because communities within this boundary have relatively direct exposure to, or interaction with, mining activities and their associated environmental and socioeconomic effects. The study focused on the relationship between environmental stewardship practices and the maintenance of the Social Licence to Operate (SLO), particularly from the perspective of communities affected by or interacting with mining operations.

The study context was considered relevant because environmental performance, community participation, transparency, livelihood effects and perceptions of corporate responsibility can influence community acceptance and support for mining activities. The selected communities were identified based on their proximity to the mine and their potential exposure to mining-related environmental and socioeconomic impacts.

➤ *Research Design*

The study adopted a pragmatist research philosophy and an explanatory sequential mixed-methods design. The design was appropriate because it enabled the study to combine quantitative evidence on community perceptions, expectations and attitudes with qualitative explanations of participants' experiences and concerns.

The quantitative phase involved the administration of structured questionnaires to community residents. The findings from this phase provided evidence regarding patterns and relationships between environmental stewardship and SLO. The qualitative phase subsequently involved semi-structured interviews with key informants and focus group discussions (FGDs) to explain and contextualize the quantitative findings. Integration of the two strands occurred during interpretation, allowing statistical results to be complemented by participants' experiences and perspectives.

➤ *Population and Sampling*

The target population for the quantitative component comprised approximately 30,000 residents living in the selected host communities. The required sample size was determined using Yamane's formula at a 5% margin of error:

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the required sample size, N is the population size and e is the margin of error. For a population of 30,000 and a 5% margin of error, the estimated sample was approximately 395 respondents.

A combination of stratified and simple random sampling was used to select quantitative respondents to ensure representation across the selected communities. Eligibility was restricted to residents aged 18 years or older who had sufficient knowledge or experience of local environmental and socioeconomic conditions to provide informed responses concerning mining activities. Of the questionnaires distributed, 330 were completed adequately and constituted the final quantitative sample.

For the qualitative component, 20 key informants were purposively selected based on their knowledge and involvement in environmental management, sustainability, community relations, livelihood issues and/or mine closure planning. In addition, 3 FGDs, comprising approximately 8–10 participants each, were conducted. Participants were purposively selected to provide variation in gender, age, livelihood activities and community location. Qualitative data collection continued until thematic saturation was reached.

➤ *Instruments and Measurement*

Data were collected using a structured questionnaire, semi-structured interview and FGD guides, and documentary evidence. The questionnaire consisted of demographic items and Likert-scale measures assessing perceptions of environmental stewardship and SLO. Environmental stewardship was measured through indicators relating to environmental protection, pollution control, rehabilitation, waste management, community participation and environmental transparency, while SLO was assessed through indicators of community acceptance, trust, legitimacy, support and willingness to coexist with mining operations.

The qualitative interview and FGD guides were developed from the research objectives and relevant literature and focused on environmental stewardship, environmental impacts, livelihood effects, community participation, transparency, trust and expectations regarding the mine's SLO. Interviews and FGDs were conducted in English or Kaonde where appropriate, with translation and back-translation used to preserve meaning. Relevant mine reports, environmental compliance documents and regulatory records were also reviewed using a structured document-analysis checklist.

➤ *Reliability and Validity*

The research instrument was reviewed for clarity, relevance and alignment with the study objectives before the main data collection. Content and face validity were assessed through expert/supervisory review and pilot testing. A pilot study was conducted with respondents similar to the target population but excluded from the final sample.

Internal consistency of the questionnaire constructs was assessed using Cronbach's alpha. The reliability coefficients obtained for the study constructs were used to determine whether the measurement scales demonstrated acceptable internal consistency. The qualitative component was strengthened through systematic development of interview guides, consistent data collection procedures, accurate transcription, systematic coding and comparison of themes across data sources.

➤ *Quantitative Analysis*

Quantitative data from the 330 valid questionnaires were coded and analyzed using SPSS Version 26. Data were screened for completeness and consistency before analysis. Descriptive statistics, including frequencies, percentages and mean scores, were used to summarize respondent

characteristics and perceptions of environmental stewardship and SLO.

Chi-square tests were used to examine associations between relevant categorical variables, while Pearson correlation was used to determine the strength and direction of relationships between environmental stewardship and SLO. Multiple regression analysis was employed to assess the predictive relationship between environmental stewardship and SLO while accounting for relevant explanatory variables. Statistical significance was assessed at the 5% level ($\alpha = 0.05$).

➤ Qualitative Analysis

Qualitative data from interviews and FGDs were transcribed and analyzed thematically following Braun and Clarke's six-phase approach. The process involved familiarization with the data, generation of initial codes, development and review of themes, definition and naming of themes, and production of the final analysis. NVivo was used to organize and code the qualitative data.

The analysis focused on themes concerning environmental stewardship, environmental impacts, livelihood effects, community participation, transparency, trust and expectations regarding SLO. Findings from interviews and FGDs were compared to identify areas of convergence, divergence and complementary explanations. Analysis continued until thematic saturation was achieved.

➤ Mixed-Method Integration

Integration occurred at the interpretation stage. Quantitative findings provided evidence of patterns and statistical relationships, while qualitative findings explained and contextualized these results. Particular attention was given to significant, unexpected or important quantitative findings requiring further explanation. Convergence between datasets strengthened interpretation, whereas divergence was examined in relation to differences in experiences and perceptions. Joint displays were used, where appropriate, to connect quantitative results with corresponding qualitative themes.

➤ Ethics

Ethical approval was obtained from the Mulungushi University Research Ethics Committee (MUREC) and approval /reference number: MU/DRI/REC/2026/177 and permission to conduct the study was obtained from relevant authorities. Participation was voluntary and based on informed consent. Participants were informed about the study purpose, procedures, potential risks and benefits, confidentiality measures, and their right to decline or withdraw without penalty.

For interviews and FGDs, audio recording was undertaken only with participants' explicit consent. Identification codes were used instead of names, and questionnaires, recordings, transcripts and other research records were securely stored with access restricted to the research team. Data were used solely for research purposes and handled in accordance with the conditions of the ethical approval.

IV. RESULTS

➤ Demographic Variables

A total of 395 questionnaires were distributed to respondents in Lumwana District, of which 330 were successfully completed and returned, giving a response rate of 83.5%. The demographic characteristics of the respondents are presented in Table 1. The sample was relatively balanced by gender, with males accounting for 51.3% and females 48.7%. Most respondents were aged 35–44 years (33.3%), followed by those aged 25–34 years (23.3%). The demographic characteristics of the respondents are presented in Table 1. The sample was relatively balanced by gender, with males accounting for 51.3% and females 48.7%. Most respondents were aged 35–44 years (33.3%), followed by those aged 25–34 years (23.3%). Regarding education, 47.3% had secondary education, while 23.9% had primary education, 18.7% held diplomas, and 10.0% had degrees or other qualifications. Most respondents had lived in Lumwana for more than 10 years (63.3%), indicating substantial familiarity with mining activities and environmental changes in the area. The majority were married (73.3%), while farming was the most common occupation (39.7%). In terms of income, 82.4% earned less than K5,000 per month.

Table 1 Demographic Characteristics of Respondents (n = 330)

Variable	Category	Frequency	Percentage (%)
Gender	Male	169	51.3
	Female	161	48.7
Age	18–24	33	10.0
	25–34	77	23.3
	35–44	110	33.3
	45–54	66	20.0
	55+	44	13.3
Education	Primary	79	23.9
	Secondary	156	47.3
	Diploma	62	18.7
	Degree/Other	33	10.0
Residence	<5 years	33	10.0
	5–10 years	88	26.6

	11–20 years	121	36.7
	>20 years	88	26.6
Marital status	Married	242	73.3
	Unmarried	88	26.7
Occupation	Farmer	131	39.7
	Business/Self-employed	86	26.0
	Formal employment	58	17.6
	Unemployed	55	16.7
Monthly income	<K1,000	142	43.0
	K1,000–K5,000	130	39.4
	K5,000–K10,000	47	14.2
	>K10,000	11	3.3

➤ Environmental Stewardship Practices at Lumwana Mine

The findings show high community awareness of environmental stewardship practices at Lumwana Mine. As presented in Table 1, awareness was highest for waste

management (93.3%), followed by land rehabilitation (86.7%) and mine closure planning (80.0%). This indicates that most respondents recognized the Mine's major environmental management interventions.

Table 2 Awareness of Environmental Stewardship Measures (n = 330)

Environmental stewardship measure	Yes (%)	No (%)
Waste management	93.3	6.7
Land rehabilitation	86.7	13.3
Mine closure planning	80.0	20.0

Overall perceptions of implementation were positive, with land rehabilitation (M = 4.05) and waste management (M = 4.03) rated as strongly implemented, while mine closure planning (M = 3.76) was rated as moderately implemented (Table 3). Among individual practices, water management

and treatment (M = 4.41) and progressive rehabilitation (M = 4.35) received the highest ratings, whereas financial bonding (M = 3.44) and resource recovery (M = 3.58) received comparatively lower ratings.

Table 3 Composite Environmental Stewardship Performance

Category	Mean	Interpretation
Waste management	4.03	Strong implementation
Land rehabilitation	4.05	Strong implementation
Mine closure planning	3.76	Moderate implementation

A one-way ANOVA confirmed significant differences in perceptions across the three stewardship categories ($F = 18.62$, $p < 0.001$), with closure planning rated significantly lower than both waste management and rehabilitation ($p < 0.001$). Furthermore, regression analysis showed that the three categories significantly predicted overall environmental stewardship perceptions, $F(3,326) = 205.48$, $p < 0.001$, explaining 65.9% of the variance ($R^2 = 0.659$). Land rehabilitation was the strongest predictor ($\beta = 0.471$), followed by waste management ($\beta = 0.412$) and closure planning ($\beta = 0.228$), all $p < 0.001$. Overall, environmental

stewardship was perceived positively, although mine closure planning emerged as the comparatively weaker area.

➤ Host-Community Perceptions and Expectations

The findings indicate generally unfavourable community perceptions of mining activities. As shown in Table 4, 87.9% of respondents reported being affected by mining, while 58.2% expressed negative attitudes towards the Mine. Only 27.9% perceived environmental stewardship as high, compared with 44.2% who rated it moderate and 27.9% low. Livelihood impacts were also substantial, with 40.0% reporting high and 44.8% moderate impacts.

Table 4 Community Perceptions of Mining Activities (n = 330)

Indicator	Category	%
Affected by mining	Yes	87.9
	No	12.1
Livelihood impact	High	40.0
	Moderate	44.8
Attitude toward Mine	Positive	41.8
	Negative	58.2
Perceived stewardship	High	27.9
	Moderate	44.2
	Low	27.9

Community expectations were high, particularly regarding zero harm and transparency ($M = 4.71$), water and air protection ($M = 4.68$), accountability ($M = 4.67$), rehabilitation ($M = 4.62$), and environmental compliance ($M = 4.60$). Expectations significantly exceeded the neutral benchmark ($t = 48.6$, $p < 0.001$), while perceived stewardship was significantly below it ($t = -22.4$, $p < 0.001$). Perceived stewardship was positively associated with attitudes toward the Mine ($r = 0.62$, $p < 0.001$), whereas perceived environmental impacts were strongly associated with negative attitudes ($r = 0.71$, $p < 0.001$).

➤ Alignment Between Stewardship and Community Expectations

The findings indicate generally strong recognition of Lumwana Mine's environmental stewardship initiatives, with awareness highest for waste management (93.3%), land rehabilitation (86.7%) and mine closure planning (80.0%). As shown in Table 5, progressive rehabilitation demonstrated the strongest alignment with community expectations (gap = +0.08), followed by acid mine drainage (AMD) treatment (+0.12). However, notable negative gaps were observed for social transition planning and livelihood restoration (−0.37), water and air protection (−0.15), decision-making involvement (−0.07), and transparency and accountability (−0.05).

Table 5 Alignment Between Stewardship Measures and Community Expectations

Stewardship initiative	Stewardship M	Expectation M	Gap
Progressive rehabilitation	4.69	4.61	+0.08
Community consultation	4.58	4.65	−0.07
Native revegetation	4.61	4.76	−0.15
AMD treatment	4.67	4.55	+0.12
Post-closure monitoring	4.54	4.59	−0.05
Social transition planning	4.32	4.69	−0.37

Stewardship perceptions were strongly associated with support for the Mine ($\rho = 0.62$, $p < 0.001$), while CSR satisfaction was positively associated with community trust ($\rho = 0.58$, $p < 0.001$). Attitudes also differed significantly by livelihood impact, $F(2,327) = 18.74$, $p < 0.001$, with the least favorable attitudes among respondents reporting high livelihood impacts ($M = 2.91$). Overall, the findings show stronger alignment in environmental management than in livelihood restoration and participatory governance.

➤ Environmental Stewardship and Social Licence to Operate

Environmental stewardship may be necessary for SLO, but the visibility or existence of environmental programmes is insufficient; community acceptance depends on perceived outcomes, procedural fairness, transparency, participation and livelihood consequences. Respondents identified water management stewardship ($M = 4.75$), transparent environmental data ($M = 4.68$), collaborative decision-making ($M = 4.64$), and progressive rehabilitation ($M = 4.61$) as the most important strategies for maintaining SLO.

Table 6 Key Predictors of Social Licence to Operate

Predictor	β	p-value	Direction
Environmental stewardship perception	0.41	<0.001	Positive
Transparency	0.35	<0.001	Positive
CSR satisfaction	0.32	<0.001	Positive
Environmental impact perception	−0.28	<0.01	Negative

The regression model was statistically significant, $F(4,325) = 127.4$, $p < 0.001$, and explained 61% of the variation in SLO perceptions ($R^2 = 0.61$; adjusted $R^2 = 0.59$). Environmental stewardship perception was the strongest positive predictor of SLO ($\beta = 0.41$, $p < 0.001$), followed by transparency ($\beta = 0.35$, $p < 0.001$) and CSR satisfaction ($\beta = 0.32$, $p < 0.001$). In contrast, perceived environmental impact had a significant negative effect ($\beta = -0.28$, $p < 0.01$). Chi-square tests further confirmed significant associations between stewardship level and attitude toward the mine ($\chi^2 = 18.72$, $df = 2$, $p < 0.001$), environmental impact and livelihood effects ($\chi^2 = 22.41$, $df = 2$, $p < 0.001$), CSR perception and community support ($\chi^2 = 16.35$, $df = 2$, $p = 0.001$), and stewardship perception and SLO ($\chi^2 = 19.88$, $df = 2$, $p < 0.001$).

➤ Consequences of Inadequate Environmental Stewardship on SLO

The findings show that inadequate environmental stewardship is associated with adverse consequences for Lumwana Mine's Social Licence to Operate (SLO). As shown in Table 7, persistent environmental impacts ($M = 4.25$), visible environmental degradation ($M = 4.18$), and low confidence in remediation ($M = 4.10$) were the most prominent concerns. Respondents also identified water management stewardship ($M = 4.75$), transparent environmental data ($M = 4.68$), and collaborative decision-making ($M = 4.64$) as the most important strategies for maintaining SLO (Table 8).

Table 7 Key Consequences of Inadequate Environmental Stewardship

Consequence	Mean
Persistent environmental impact	4.25
Visible environmental degradation	4.18
Low confidence in remediation	4.10

Table 8 Key Environmental Strategies for SLO

Strategy	Mean
Water management stewardship	4.75
Transparent environmental data	4.68
Collaborative decision-making	4.64

Chi-square tests (Table 9) showed significant associations between stewardship perceptions and attitudes towards the Mine ($\chi^2 = 18.72$, $p < 0.001$) and SLO perceptions ($\chi^2 = 19.88$, $p < 0.001$). Environmental impacts were

significantly associated with livelihood effects ($\chi^2 = 22.41$, $p < 0.001$), while CSR perceptions were associated with community support ($\chi^2 = 16.35$, $p = 0.001$).

Table 9 Chi-Square Test Results (n=330)

Relationship Tested	χ^2 value	df	p-value	Interpretation
Stewardship level vs Attitude toward mine	18.72	2	< 0.001	Significant
Environmental impact vs Livelihood effect	22.41	2	< 0.001	Significant
CSR perception vs Community support	16.35	2	0.001	Significant
Stewardship level vs SLO perception	19.88	2	< 0.001	Significant

The multiple regression analysis (Table 10) revealed that the model was statistically significant, $F(4, 325) = 127.4$, $p < 0.001$, and explained 61% of the variance in Social Licence to Operate (SLO) ($R^2 = 0.61$; adjusted $R^2 = 0.59$). Stewardship perception was the strongest positive predictor of SLO ($\beta = 0.41$, $t = 6.83$, $p < 0.001$), indicating that higher perceptions of responsible corporate stewardship were associated with higher levels of SLO. Transparency was also a strong positive predictor ($\beta = 0.35$, $t = 5.83$, $p < 0.001$), while CSR satisfaction significantly and positively predicted

SLO ($\beta = 0.32$, $t = 5.33$, $p < 0.001$). Conversely, perceived environmental impact had a significant negative relationship with SLO ($\beta = -0.28$, $t = -4.67$, $p < 0.001$), suggesting that greater perceptions of negative environmental effects were associated with lower social licence to operate. The 95% confidence intervals for all four predictors excluded zero, further supporting their statistical significance. The VIF values ranged from 1.54 to 1.82, suggesting that multicollinearity was not a serious concern among the predictors.

Table 10 Regression Analysis: Predictors of Social Licence to Operate

Predictor	B	SE	β	t	p	95% CI	VIF
Stewardship perception	0.41	0.06	0.41	6.83	<0.001	[0.29, 0.53]	1.82
CSR satisfaction	0.32	0.06	0.32	5.33	<0.001	[0.20, 0.44]	1.67
Environmental impact	-0.28	0.06	-0.28	-4.67	<0.001	[-0.40, -0.16]	1.54
Transparency	0.35	0.06	0.35	5.83	<0.001	[0.23, 0.47]	1.73

➤ Qualitative Results from Key Informant Interviews

Qualitative interviews with mine management personnel and community stakeholders provided contextual explanations for the quantitative findings on environmental stewardship and Social Licence to Operate (SLO). Six major themes emerged: institutionalization of environmental stewardship; environmental performance and perceived impacts; trust and transparency; community participation and procedural fairness; livelihood security and mine closure; and environmental challenges and future sustainability.

• Institutionalization of Environmental Stewardship

Management participants reported that environmental stewardship is integrated into operational planning, risk management, environmental assessments, monitoring and corporate sustainability systems. Routine monitoring of water quality, air emissions, waste facilities, tailings and rehabilitation sites was highlighted. Community stakeholders

also recognized visible rehabilitation, tree planting and waste management initiatives. These findings support the quantitative results showing strong perceptions of waste management ($M = 4.03$) and land rehabilitation ($M = 4.05$), as well as high ratings for water management and treatment and progressive rehabilitation.

• Environmental Performance and Perceived Impacts

Despite recognizing environmental initiatives, community participants continued to express concerns about land disturbance, vegetation loss, dust and water quality. These concerns were particularly associated with agricultural land and water resources. The findings provide contextual support for the quantitative results indicating that 87.9% of respondents were affected by mining and 58.2% expressed negative attitudes towards the Mine. Persistent environmental impacts ($M = 4.25$) and visible environmental degradation (M

= 4.18) were prominent concerns, while water and air protection recorded high community expectations ($M = 4.68$).

- *Trust, Transparency and SLO*

Both management and community participants linked environmental performance to trust and social acceptance. Participants indicated that effective environmental management strengthens confidence in the Mine, whereas unresolved environmental concerns weaken trust. Transparency was also considered essential, with participants calling for more frequent, accessible and understandable environmental information. These findings reinforce the quantitative results showing that environmental stewardship perception was the strongest predictor of SLO ($\beta = 0.41$, $p < 0.001$), while transparency was also a significant predictor ($\beta = 0.35$, $p < 0.001$).

- *Participation and Procedural Fairness*

Although consultation mechanisms such as stakeholder meetings, grievance systems and community liaison structures were reported to exist, community participants desired greater influence over environmental decision-making. They distinguished between being consulted and having their views incorporated into decisions. Greater community participation in environmental monitoring was also recommended. This finding corresponds with the quantitative consultation-expectation gap of -0.07 and the high importance attached to collaborative decision-making ($M = 4.64$).

- *Livelihood Security and Mine Closure*

Livelihood security emerged as a major concern. Participants expected the Mine to support sustainable livelihoods, skills development and economic opportunities beyond mining. These concerns correspond with the finding that 40.0% of respondents reported high livelihood impacts and 44.8% moderate impacts. Social transition and livelihood restoration recorded the largest negative alignment gap (-0.37). Community participants also reported limited understanding of mine closure and post-mining land-use plans, consistent with the lower quantitative rating for closure planning ($M = 3.76$).

- *Environmental Challenges and Future Sustainability*

Management identified increasing community expectations, financial and technical demands, climate-related risks and closure planning as continuing challenges. Environmental innovation, including water recycling, improved tailings management, progressive rehabilitation and real-time monitoring, was viewed as important for future sustainability.

➤ *Qualitative Themes*

Overall, the qualitative analysis demonstrated that environmental stewardship is institutionalized within mine operations but is assessed by communities through both environmental outcomes and lived experiences. Trust and transparency, meaningful participation, livelihood security and credible closure planning emerged as critical conditions for maintaining SLO.

➤ *Integrated Mixed-Method Findings*

The integration of quantitative and qualitative findings demonstrated substantial convergence. Environmental stewardship perception was the strongest quantitative predictor of SLO ($\beta = 0.41$), while interview participants consistently described environmental performance as central to trust and acceptance. Similarly, the positive effects of transparency ($\beta = 0.35$) and CSR satisfaction ($\beta = 0.32$) were supported by qualitative evidence emphasizing communication, responsiveness and visible corporate action.

Conversely, perceived environmental impacts negatively predicted SLO ($\beta = -0.28$), consistent with community accounts of land disturbance, water concerns, dust and persistent environmental risks. Both datasets identified water management and rehabilitation as relatively strong areas, while closure planning, livelihood restoration, transparency and participation remained areas requiring improvement. Overall, the findings indicate that maintaining SLO depends not simply on implementing environmental programmes, but on their perceived effectiveness, transparency, fairness, responsiveness and alignment with community expectations.

V. DISCUSSIONS

The findings demonstrate that environmental stewardship is central to the Social Licence to Operate (SLO) at Lumwana Mine, but they also reveal an important distinction between the visibility of environmental initiatives and their contribution to legitimacy and community acceptance. Despite high levels of community awareness of waste management (93.3%), land rehabilitation (86.7%) and mine closure planning (80.0%), only 27.9% of respondents perceived environmental stewardship as high, while 58.2% expressed negative attitudes towards the Mine. This divergence suggests that the presence or visibility of environmental programmes does not, in itself, secure community acceptance. Rather, SLO appears to depend on whether communities perceive environmental interventions as effective, credible, fair and responsive to their concerns. This finding is consistent with Moffat and Zhang (2014), who demonstrate that community acceptance of mining is shaped not only by perceived impacts but also by trust, procedural fairness and the quality of company–community relationships.

The first contribution of this study is its demonstration that recognition of environmental stewardship initiatives does not necessarily translate into legitimacy or social acceptance. The strong ratings for land rehabilitation ($M = 4.05$) and waste management ($M = 4.03$) indicate that communities generally recognize and view these operational environmental practices favorably. Water management and treatment and progressive rehabilitation were also prominent, suggesting that communities attach value to stewardship measures that produce tangible and observable environmental outcomes. In contrast, mine closure planning received a comparatively lower rating ($M = 3.76$), with ANOVA confirming significant differences among the three stewardship categories ($F = 18.62$, $p < 0.001$). The lower

rating may partly reflect the less visible and longer-term nature of closure commitments compared with operational environmental activities.

More importantly, positive assessments of specific stewardship practices coexisted with concerns about persistent environmental impacts. Respondents reported relatively high perceptions of environmental degradation ($M = 4.18$), environmental impacts ($M = 4.25$) and limited confidence in remediation ($M = 4.10$). This suggests that communities evaluate environmental stewardship primarily through its perceived outcomes, rather than simply through awareness of the existence of environmental programmes. In other words, a company may be highly visible in implementing environmental initiatives while still experiencing legitimacy challenges if communities believe that environmental harm persists or that remediation is inadequate. This finding reinforces Prno's (2013) argument that communities increasingly expect mining companies to demonstrate responsible and sustainable development rather than merely comply with statutory environmental requirements.

The finding also contributes to the SLO literature by highlighting the distinction between programme visibility, perceived performance and legitimacy. Awareness of environmental initiatives represents an important starting point, but it is the credibility of their outcomes that appears more consequential for community acceptance. The positive association between stewardship community acceptance. The positive association between stewardship perception and mine support ($p = 0.62$, $p < 0.001$), together with the finding that stewardship was the strongest predictor of SLO ($\beta = 0.41$, $p < 0.001$), provides empirical evidence that perceived environmental performance has a substantive role in determining the strength of the mine's social licence.

The second contribution is that the findings challenge a narrow understanding of environmental stewardship as being concerned exclusively with ecological outcomes. The substantial expectation gap identified in the study indicates that host communities understand environmental responsibility in broader terms that incorporate livelihood security, social transition, participation and long-term wellbeing. Community expectations were particularly high regarding water and air protection, zero harm, transparency, accountability and rehabilitation. Notably, the largest negative gap occurred between social transition planning and livelihood restoration (-0.37). This finding suggests that communities do not necessarily distinguish between environmental stewardship and socioeconomic wellbeing in the way these issues may be separated institutionally within mining companies. The results suggest that community members perceived existing measures as insufficient to address the longer-term socioeconomic consequences of mining. The qualitative findings provide further insight into this perception. Participants indicated that although environmental and rehabilitation activities were visible, concerns remained about the restoration of livelihoods affected by mining activities, particularly where access to land, agricultural activities, water resources or other

livelihood opportunities had been disrupted. As one community participant explained:

"Since the mining activities started, some of us have lost access to land where we used to cultivate. Rehabilitation of the land is important, but what we need is also support to restore the livelihoods that were affected. It is not enough to rehabilitate the land without considering how families will survive during and after mining." (FGD participant)

This account illustrates that community expectations extend beyond the physical rehabilitation of mined land to include restoration of the economic and social conditions that support household wellbeing. Another participant similarly observed:

"We hear about rehabilitation and plans for the future, but there is still uncertainty about what will happen to our livelihoods when mining activities change or come to an end. We would like to be involved in decisions about how people will be supported and what opportunities will be available to replace the livelihoods that have been affected." (FGD participant)

"The environmental issues are also livelihood issues for us. When access to land or water is affected, it directly affects farming and household income. Therefore, when the company talks about environmental rehabilitation, the community also expects to see how people's livelihoods will be restored." (FGD participant)

"The community wants to be part of the planning, not only to be informed after decisions have already been made. If livelihood restoration is planned together with the people affected, the solutions are more likely to respond to what the community actually needs." (FGD participant)

The qualitative evidence therefore helps explain the quantitative expectation–performance gap by showing that communities assess environmental stewardship not only in terms of ecological restoration but also in terms of whether mining-related disruptions to livelihoods are adequately addressed. This finding suggests that environmental stewardship and socioeconomic transition are closely interconnected in the community's understanding of responsible mining. It is consistent with Prno and Slocombe (2012), who argue that mining-affected communities increasingly expect participation, benefit sharing and assurances of sustainable development. For Lumwana Mine, strengthening livelihood restoration and social transition planning alongside environmental rehabilitation may therefore be important for improving perceptions of fairness, responsiveness and, ultimately, Social Licence to Operate.

The implication is that environmental impacts can have consequences that extend beyond physical environmental degradation to affect livelihoods, household wellbeing and community perceptions of fairness. This interpretation is supported by the significant association between environmental impacts and livelihood effects ($\chi^2 = 22.41$, $p < 0.001$). Furthermore, respondents experiencing high

livelihood impacts reported the least favorable attitudes towards the Mine ($M = 2.91$). These findings indicate that where environmental change affects access to land, water, agricultural activities or other livelihood resources, communities may interpret the resulting effects as evidence of inadequate corporate responsibility. The -0.37 gap between social transition planning and livelihood restoration is therefore particularly important. It indicates that the environmental stewardship expectations of affected communities extend into questions of how communities will sustain their livelihoods during and after mining. This finding is consistent with Prno and Slocombe (2012), who argue that mining-affected communities increasingly function as important governance actors and demand greater participation, benefit sharing and assurances of sustainable development. The present findings extend this argument by showing that livelihood restoration can form part of how communities judge the adequacy of environmental stewardship itself.

Consequently, environmental management and socioeconomic transition should not be treated as entirely separate dimensions of mining responsibility. Effective stewardship should incorporate credible livelihood restoration, social transition planning and community participation, particularly where environmental impacts directly or indirectly affect local sources of livelihood. Such integration is likely to strengthen perceptions of fairness and responsiveness and, consequently, contribute to stronger community acceptance. The third contribution concerns the factors through which SLO appears to be established and maintained. The regression findings show that stewardship perception was the strongest predictor of SLO ($\beta = 0.41$, $p < 0.001$), followed by transparency ($\beta = 0.35$) and CSR satisfaction ($\beta = 0.32$), while perceived environmental impact had a negative effect ($\beta = -0.28$, $p < 0.01$). Collectively, the model explained 61% of the variation in SLO perceptions ($R^2 = 0.61$). These findings suggest that SLO is not generated by a single corporate activity but emerges from the interaction of environmental performance, transparency, stakeholder engagement and perceived impacts.

The stronger standardized coefficient for environmental stewardship relative to CSR satisfaction is particularly noteworthy. It suggests that CSR expenditure or development initiatives, although valued by communities, may not compensate for perceived weaknesses in environmental performance. Communities may appreciate social investments such as infrastructure and community development programmes while simultaneously withholding broader acceptance where environmental harm remains unresolved. Thus, CSR should not be viewed as a substitute for credible environmental stewardship. Rather, its contribution to SLO is likely to be strengthened when it occurs alongside demonstrable environmental responsibility. Transparency was the second strongest predictor of SLO ($\beta = 0.35$), highlighting the importance of accessible information, openness and accountable communication. This is particularly significant given the high expectations expressed by communities regarding transparency and accountability. However, transparency alone is unlikely to create legitimacy

where environmental outcomes remain poor. Its importance lies in enabling communities to understand environmental risks, assess corporate responses and participate meaningfully in decisions affecting their interests.

The findings therefore point towards a broader conception of SLO in which performance, transparency and participation operate together. The significant association between stewardship and attitudes ($\chi^2 = 18.72$, $p < 0.001$) and between stewardship and SLO ($\chi^2 = 19.88$, $p < 0.001$) reinforces the importance of perceived environmental performance. At the same time, the negative relationship between perceived environmental impact and SLO demonstrates that continuing environmental harm can undermine acceptance even when other corporate initiatives are present.

The findings provide empirical support for Social Licence to Operate Theory, particularly the proposition that sustained community acceptance depends on legitimacy, credibility and trust. Parsons, Lacey and Moffat (2014) conceptualize SLO as closely connected to organizational legitimacy and stakeholder relationships. The Lumwana findings reinforce this perspective by demonstrating that environmental stewardship is the strongest predictor of SLO, while perceived environmental harm negatively influences acceptance. This indicates that SLO is not secured simply by maintaining relationships or communicating corporate initiatives; it must be continually reinforced through credible organizational performance.

The findings also support stakeholder Theory by demonstrating that community expectations and perceptions of environmental performance, transparency, participation and livelihood outcomes shape perceptions of the legitimacy of mining operations. The expectation–performance gap, particularly in relation to livelihood restoration and social transition, suggests that communities evaluate mining operations according to a broader set of interests than environmental compliance alone. This supports Prno and Slocombe's (2012) observation that affected communities increasingly play a governance role in mining. The findings further suggest that participation should move beyond information provision towards meaningful engagement, procedural fairness and collaborative decision-making. Where communities perceive that they have limited influence over decisions affecting their environment and livelihoods, the legitimacy of corporate environmental initiatives may be weakened. Transparency, participation and fairness can therefore be understood not merely as communication or engagement strategies but as mechanisms through which environmental stewardship becomes more credible and legitimate in the eyes of stakeholders.

Taken together, the findings demonstrate that SLO depends less on the presence of environmental stewardship programmes than on whether communities perceive their outcomes as credible, fair and responsive to local priorities. Despite high recognition of environmental interventions at Lumwana Mine, social acceptance remains weak where communities perceive continuing environmental harm,

inadequate livelihood restoration, limited participation and insufficient transparency. The study therefore contributes to the literature by linking environmental stewardship to SLO through three interconnected insights. First, stewardship visibility is not equivalent to legitimacy; visible programmes must produce outcomes that communities regard as credible and effective. Second, environmental stewardship and socioeconomic wellbeing are intertwined; communities assess environmental responsibility partly through its implications for livelihoods and long-term community wellbeing. Third, SLO emerges from a combination of environmental performance, transparency, participation and perceived impacts rather than CSR expenditure alone. The stronger predictive effect of environmental stewardship relative to CSR satisfaction is particularly important because it suggests that social investment cannot fully compensate for unresolved environmental concerns.

For mining practice, the findings imply that maintaining SLO requires an integrated approach that combines credible environmental prevention, mitigation, remediation and monitoring with transparent communication, meaningful participation, procedural fairness and effective livelihood restoration. Such an approach can strengthen trust and legitimacy by demonstrating that the concerns and priorities of host communities are not only acknowledged but incorporated into environmental and socioeconomic decision-making.

VI. CONCLUSION

This study concludes that environmental stewardship is a fundamental determinant of the Social Licence to Operate (SLO) at Lumwana Mine. The findings demonstrate that host communities are highly aware of key environmental management practices, particularly waste management, land rehabilitation, water management, pollution control, and progressive rehabilitation. These initiatives are generally perceived as positively implemented and contribute to perceptions of responsible mining. However, awareness and recognition of environmental programmes do not necessarily translate into strong community trust or social acceptance.

A significant gap exists between community expectations and perceived stewardship performance. Communities place particularly high importance on water and air quality protection, transparency, accountability, livelihood restoration, meaningful engagement, and participation in environmental decision-making. Although positive alignment was evident in progressive rehabilitation and acid mine drainage treatment, substantial gaps remain in social transition planning, livelihood restoration, water and air protection, and participatory governance. These shortcomings are important because environmental impacts can directly affect livelihoods, wellbeing, and perceptions of mining legitimacy.

The statistical results further establish the central role of environmental stewardship in sustaining SLO. Environmental stewardship perception was the strongest positive predictor of SLO ($\beta = 0.41$, $p < 0.001$), while

perceived environmental impacts exerted a significant negative influence ($\beta = -0.28$, $p < 0.01$). Transparency ($\beta = 0.35$) and CSR satisfaction ($\beta = 0.32$) also contributed positively. The findings therefore indicate that community acceptance depends not merely on the existence of environmental initiatives, but on their perceived effectiveness, transparency, and relevance to community priorities.

RECOMMENDATIONS

Based on the findings, the study recommends that Lumwana Mine should strengthen environmental monitoring and provide accessible, transparent information on water and air quality, rehabilitation progress, environmental incidents, and closure planning. Community engagement should move beyond consultation towards meaningful participation in environmental monitoring, planning, and decision-making. Greater emphasis should be placed on livelihood restoration and social transition through agriculture, entrepreneurship, vocational training, and alternative income-generating programmes. The mine should also improve community understanding of closure objectives, post-mining land use, rehabilitation targets, and post-closure monitoring. Government and regulatory institutions should enhance compliance monitoring, enforce adequately funded closure requirements, and promote participatory environmental governance. Host communities should actively engage in monitoring and stakeholder forums while maintaining constructive dialogue. Future research should compare multiple mines and adopt longitudinal designs to assess changes in SLO over time.

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