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Integrated Impact of Zoning Compliance, Monitoring, Participation, Multi-Stakeholder Support, and Technology Support on Spatial Policy Implementation and ESG Sustainability in the North Kolaka Mining Sector

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ABSTRACT

This study aims to analyze the influence of zoning compliance, monitoring, community participation, multi-stakeholder support, and technology support on the successful implementation of spatial planning policies and Environmental, Social, and Governance (ESG) performance in the mining sector of North Kolaka Regency. Using a quantitative approach, data were collected through a survey of 371 respondents using proportional random sampling. Data analysis was conducted using structural equation modeling (SEM-PLS) with the help of SmartPLS 4. The results showed that zoning compliance, community participation, government role, community role, and technology support had a significant effect on spatial planning policy, while the frequency of monitoring and the role of the private sector did not show a significant effect. In addition, the roles of government, the private sector, the community, technology support, and spatial planning policy proved to have a positive effect on ESG performance, while community participation had no significant effect. This research contributes to the literature on the implementation of ESG-based spatial planning policies in the mining sector, as well as providing strategic recommendations to improve policy effectiveness through multi-stakeholder synergies and technology optimization.

1. INTRODUCTION

Spatial policy implementation plays a strategic role in promoting Environmental, Social, and Governance (ESG) sustainability. Effective spatial planning is not only a legal instrument to regulate land use and resource management but also serves as a means to minimize environmental degradation and support sustainable development goals [1]. Appropriate spatial policy implementation can enhance natural resources management while reducing pressure on ecosystems [2].

In addition, inclusive spatial planning encourages public involvement in the planning process. Active community participation contributes to the quality of decisions, increases ecological awareness, and strengthens governance structures [3]. In addition, inclusive spatial planning encourages public involvement in the planning process. Active community participation contributes to the quality of decisions, increases ecological awareness, and strengthens governance structures [4]. In Indonesia, the acceleration of regional growth often overrides spatial planning, resulting in insufficient attention to environmental aspects [1].

Thus, while spatial policies have great potential in supporting ESG sustainability, the complexity of governance and socio-economic dynamics demands adaptive and collaborative implementation strategies. This requires zoning compliance, consistent monitoring mechanisms, active community participation, multi-stakeholder support, and the utilization of technology support to ensure effective policy implementation. Overcoming these obstacles is an important step in realizing long-term sustainability goals.

North Kolaka Regency is one of the regencies with mining potential in Southeast Sulawesi Province, specifically for nickel and chromite commodities [5]. According to the Central Statistics Agency of North Kolaka Regency, Southeast Sulawesi Province, 2022, more than 20 mining companies operate in this region [6]. The intensity of mining activities in these areas is relatively high because most companies have obtained Mining Business Permits (IUP) and are conducting exploitation. However, mining activities in North Kolaka also bring economic growth and environmental and spatial planning issues. Mining activities have caused forest degradation, changes in land cover, and increased sedimentation in river basins due to soil erosion [7]. These conditions require the implementation of sustainable mining management policies, particularly in the context of post-mining land reclamation (RRP) and the strengthening of ESG-based governance. The North Kolaka region is a good case study because it is a strategic border with South Sulawesi Province and has a lot of potential to be used as a model for implementing sustainable spatial policies in the mining sector.

This is in line with national policies that encourage nickel downstreaming [8]. This makes North Kolaka not only an area with high economic value but also a policy laboratory in balancing the exploitation of natural resources with environmental and social sustainability principles.

2. LITERATURE REVIEW

The implementation of spatial planning policies is affected by various factors, ranging from compliance with zoning, community participation, the role of the private sector and government, to technological support. Zoning serves as the regulatory framework that governs land use and the direction of urban development. Strong zoning enforcement is integral in maintaining the integrity of city plans and preventing the spread of irregular land uses [9]. Good zoning practices can also ensure equitable access to urban resources and services, thereby helping to reduce socio-economic disparities, while facilitating sustainable urban growth by aligning land use with community needs and environmental considerations [10]. However, traditional zoning practices often face tensions with spatial justice imperatives, particularly in addressing inequalities arising from uneven urban development [11].

Community participation plays a central role in the effectiveness of spatial planning policies. The active involvement of citizens can increase the legitimacy and acceptance of policies, as it provides space for local stakeholders to contribute directly to the planning process [12]. Participation is multifaceted: on the one hand, it empowers citizens, but on the other hand, it can hinder equitable development if not managed wisely [13]. Technological advancements have expanded access to public participation, with digital platforms enabling more inclusive two-way interactions between the government and the public [14]. It opens up opportunities for more transparent, responsive, and participatory decision-making. The private sector also plays an important role through investment and infrastructure development that is aligned with spatial policies. Molfetas and Wille [15] mentioned that private sector involvement can drive local economic growth while ensuring compliance with zoning regulations through collaboration with the government. In this context, cross-sector collaboration is crucial given the government's limited fiscal capacity to finance the entire urban development agenda.

The government itself acts as the primary regulator that sets and enforces zoning policies, ensuring that they reflect community interests and sustainability goals [12]. Government utilization of technology, such as online licensing systems, can streamline administrative procedures, reduce bureaucratic barriers and speed up project implementation [15]. Furthermore, technology plays a role in improving transparency, efficiency, and data-driven decision-making in spatial policy and has the potential to bridge the gap between planning intentions and ground realities [16]. While these factors collectively strengthen spatial policy implementation, a number of barriers remain. Challenges include limited access to equitable participation, potential conflicts of interest between actors, and the complexity of integrating technology in established governance [17]. Therefore, a balance between zoning compliance, community participation, government and private roles, and technological support is an important prerequisite to achieve the goal of spatial policy implementation.

Zoning compliance and monitoring play an important role in the Environmental, Social, and Governance (ESG) framework by ensuring land use is in line with environmental regulations, maintaining ecological balance, and reducing environmental risks. Community participation, such as in mangrove forest management, reflects local knowledge-based zoning that is adaptive to community needs [18]. Zoning regulations also facilitate green development, while continuous monitoring is key to maintaining accountability and transparency of urban development [19].

The private sector contributes through corporate social responsibility (CSR) programs and compliance with zoning regulations. Integration of biodiversity monitoring in business strategies is increasingly being done to meet global standards [20]. However, challenges such as a lack of leadership and the need for reliable indicators of progress remain prominent [21].

Technology supports the effectiveness of zoning monitoring. Technology in the agricultural sector optimizes operations and reduces environmental impacts through sensor data and predictive analysis [22]. Civic technology platforms expand public participation channels in urban planning [23], while smart city technologies improve resource efficiency and spatial alignment with ESG objectives [24, 25]. At the community level, increased ecological literacy promotes community engagement in monitoring zoning-related environmental projects [18]. This engagement strengthens regulation and builds a sense of collective ownership. The synergy of government, private sector, community, and technology is key to the success of ESG implementation. Challenges such as non-uniformity of social standards and limited participation must be overcome to achieve effective and equitable integration of ESG in sustainable urban development.

Zoning compliance and continuous monitoring are key foundations for the successful implementation of spatial policies that align with ESG principles. Clear zoning regulations ensure land use alignment with environmental sustainability goals, while an effective monitoring system maintains transparency, accountability, and responsiveness to violations or changes in field conditions. Community participation and the role of the private sector are collaborative pillars that strengthen policy implementation. Ecological literacy-based participation encourages social oversight and strengthens ownership of policies, while the private sector contributes through regulatory compliance, CSR implementation, and integration of ESG targets into business strategies. The role of society at large ensures the social legitimacy of policies, while the role of government includes law enforcement, facilitation of cross-sector collaboration, and development of regulatory frameworks that are adaptive to sustainability challenges. Technology support accelerates and deepens the effectiveness of all these components, whether through data analytics, sensor-based monitoring systems, public participation platforms, or smart city technology. The synergy between regulation, monitoring, participation, private sector contribution, the active role of the community and government, and technological innovation forms a solid ecosystem to realize spatial policy implementation that is inclusive, adaptive, and aligned with ESG goals.

From the conceptual review of the research problem above, it is necessary to confirm the path of influential factors in the implementation of spatial policies and ESG sustainability in the mining sector in North Kolaka Regency. This research aims to analyze the influence of zoning compliance,

monitoring, participation, multi-stakeholder support, and technological support on the successful implementation of spatial planning policies and ESG performance in the mining sector of North Kolaka Regency.

This research is essential to fill the theoretical gap in the development of confirmatory pathways to understand the successful implementation of spatial planning policies and ESG performance in the mining sector of North Kolaka Regency. Using a multivariate analysis method based on structural equation modelling (SEM-PLS), this research focuses on the mining sector in North Kolaka Regency. The urgency of this research lies in the need to strengthen effective spatial policy implementation in Indonesia's mining sector to ensure ESG sustainability through regulatory synergy, community participation, multi-stakeholder collaboration, and technology utilization.

3. MATERIAL AND METHODS

This study employs a quantitative research design within a positivist paradigm [26]. This concept begins by strengthening theories and concepts that align with the research object being studied, examining the relationship between variables [27], and employing multivariate statistical analysis for data collection and analysis.

Figure 1. A. Research location, B. Site survey, C. Mining location

3.1 Study area

The research location, which is a district located in Southeast Sulawesi Province, has tremendous mineral resource potential with a population of 370,695 people (Figure 1). The researcher's sampling approach totaled 371 respondents. Figure 1(C) shows the location map and mining activity documentation. In 2022, the North Kolaka Regency Central Statistics Agency reported that this area has potential mineral resources. Most companies here mine nickel in the sub-districts of Tolala, Porehu, Batu Putih, Lasusua, North Pakue, and Porahu. The selection of the research locations was based on some basic considerations, as follows:

- It is an area of great mineral potential;
- It is a strategic border area of South Sulawesi Province;
- The importance of spatial policy implementation and ESG sustainability;
- The research location can be used as a prototype of spatial policy implementation and ESG sustainability in the mining sector in Indonesia.

3.2 Data collection

The data sources in this study were obtained through field observations, document reviews, and questionnaire surveys. The data sources include (a) observations and documentation in this study, which were used to fulfil the need for contextual data and visualisation related to community participation, government involvement, the role of the mining sector, social dynamics, and technological support in the implementation of spatial planning policies and ESG principles; (b) the preparation of instruments based on theoretical constructs and indicators from various previous studies on the implementation of spatial planning policies, governance, and ESG principles.

The indicators were measured using a Likert scale through questions in the questionnaire and scored as follows: (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree; (5) strongly agree. Validity and reliability tests were conducted when measuring the outer model SEM [28] with the assumption that Cronbach's Alpha >0.70 and Average Variance Extracted (AVE) >0.50, which indicates good internal consistency and construct validity, with an average Cronbach's Alpha value of 0.917. This study involved 371 respondents selected through proportional random sampling, ensuring representation from each unit in the population. The main stakeholder groups were local communities (42%), government officials (18%), private sector actors (15%), and representatives of civil society organisations (25%). To reduce non-response bias, reminders were sent to respondents who had not returned the questionnaire, and the demographic characteristics of the initial and final respondents were rechecked.

3.3 Data analysis method

Data was collected cross-sectionally from March to June 2024 through the distribution of structured questionnaires using purposive sampling techniques, covering the variables of zoning compliance, monitoring, public participation, and the role of government, the private sector, the community, and technology support. This approach was chosen because

it is able to handle complex models and non-normal data, as well as small sample sizes, thus effectively evaluating the influence of these factors on the successful implementation of spatial planning policies and ESG performance. The analysis method uses structural equation modelling (SEM) through survey results with questionnaires with Smart-PLS 4.0 software. Structural equation models (SEM) can be used to analyze the relationship between variables simultaneously with measurement and structural processes to build models [28-31]. With this approach, we can understand how zoning compliance, frequency of monitoring, community participation, role of government, private sector role, role of society, and technology support affect the implementation of spatial planning policies and ESG sustainability in Kolaka Utara's mining sector.

4. RESULT

4.1 Measurement model analysis (outer model)

The validity and reliability test results show that all constructs in this study have excellent measurement quality. The AVE value for all variables is above 0.50; most of them even exceed 0.77, which indicates that convergent validity is fulfilled and indicators can explain construct variance optimally. Cronbach's Alpha values are all above 0.80; even some variables, such as Role of Government (0.963) and Private Sector Role (0.939), show very high internal consistency, indicating that respondents' answers are relatively uniform on the indicators measured. Similarly, the Composite Reliability (CR) value of all variables exceeds 0.85, strengthening the evidence of the reliability of the instruments used (Table 1). These findings confirm that the research instruments have strong validity and reliability, making them suitable for further analysis, strengthening the credibility of the hypothesis testing results related to the influence of zoning compliance, monitoring, participation, multi-stakeholder support, and technological support on the success of spatial planning policies and ESG performance in the mining sector of North Kolaka Regency.

Table 1. Internal consistency reliability

Variable	AVE	Cronbach's Alpha	Composite Reliability
Zoning Compliance (X1)	0.788	0.867	0.887
Frequency of Monitoring (X2)	0.774	0.854	0.859
Community Participation (X3)	0.867	0.923	0.942
Role of Government (X4)	0.771	0.963	0.963
Private Sector Role (X5)	0.645	0.939	0.94
Role of Society (X6)	0.664	0.937	0.938
Technology Support (X7)	0.812	0.884	0.886
Sustainable Spatial Planning Policy (Y1)	0.798	0.958	0.959
ESG Performance (Y2)	0.650	0.932	0.933

Notes: CR>0.70, AVE>0.50 [32]

4.2 Structural model analysis (Inner model)

Table 2 describes the results of the direct effect test between the research variables, including the size of the path coefficient (original sample), the significance level (T-statistics), and the probability value (P-values) to assess whether the effect is significant on spatial policies and ESG performance.

Table 2. Results of path coefficient values and p-values

Path	Original Sample (O)	T Statistics	P Vaues
Zoning Compliance ->Spatial Planning Policy	0,123	2,965	0,003
Frequency of Monitoring -> Spatial Planning Policy	0,021	0,390	0,696
Community Participation -> Spatial Planning Policy	0,307	5,216	0,000
Role of Government -> Spatial Planning Policy	0,195	3,040	0,002
Private Sector Role -> Spatial Planning Policy	0,069	1,000	0,317
Role of Society -> Spatial Planning Policy	0,135	2,861	0,004
Technology Support -> Spatial Planning Policy	0,139	2,204	0,028
Community Participation -> ESG Performance	-0,024	0,482	0,630
Role of Government -> ESG Performance	0,148	3,739	0,000
Private Sector Role -> ESG Performance	0,377	5,864	0,000
Role of Society -> ESG Performance	0,157	3,410	0,002
Technology Support -> ESG Performance	0,118	2,227	0,026
Spatial Planning Policy -> ESG Performance	0,286	4,754	0,000

Notes: **t-value is below 1.96 and *p<0.05. Source: Author elaborator

Based on the results of the structural model analysis, several statistically significant relationships were identified among the studied variables. In relation to spatial planning policy, zoning compliance (O=0.123; p=0.003), community participation (O=0.307; p=0.000), government role (O=0.195; p=0.002), community role (O=0.135; p=0.004), and technology support (O=0.139; p=0.028) were positively associated with the effectiveness of spatial planning policy implementation. In contrast, the frequency of monitoring (O=0.021; p=0.696) and the private sector role (O=0.069; p=0.317) showed no statistically significant relationship. Regarding ESG performance, the government role (O=0.148; p=0.000), private sector role (O=0.377; p=0.000), community role (O=0.157; p=0.002), technology support (O=0.118; p=0.026), and spatial planning policy (O=0.286; p=0.000) were positively correlated with improved ESG outcomes. Meanwhile, community participation (O=-0.024; p=0.630) did not show a significant relationship.

These results suggest that the success of spatial planning policies is mainly driven by compliance, participation, government and community roles, and technological support. Meanwhile, the achievement of ESG performance is highly dependent on the synergy of government, the private sector, the community, technology, and the implementation of the spatial policy itself.

The results of hypothesis testing show that of the seven variables tested on spatial planning policy, five of them have a positive and significant effect, namely zoning compliance, public participation, government role, community role, and technology support, while the frequency of monitoring and the role of the private sector are not significant. This indicates that policy effectiveness is more influenced by rule compliance, public involvement, government and community support, and technology utilization than by monitoring intensity or private sector contribution.

Meanwhile, in the relationship with ESG performance, variables that have a positive and significant effect include the role of government, the role of the private sector, the role of society, technological support, and spatial planning policies, while public participation does not show a significant effect. This finding confirms that ESG performance is more determined by the synergy between the government, private sector, community, technology utilization, and spatial policy implementation than simply the level of community participation.

Figure 2 illustrates the structural relationships between the latent variables in the model. The path coefficient (β) results, which describe the model of the relationship between sustainable spatial planning policies and their role as a mediating variable connecting governance factors, participation, and technology support to ESG performance. Based on the R-square value for the sustainable spatial planning policy variable, which is 0.447, it means that the variables of zoning compliance, frequency of monitoring, community participation, role of government, role of the private sector, role of society, and technology support can collectively explain 44.7% of the variation in sustainable spatial planning policies. Policy variations are determined by the factors studied, while the remaining 55.3% are explained by other factors outside the model. Meanwhile, the R-square value for ESG performance is 0.672, or 67.2%, which is determined by the same factors, plus the influence of implementing sustainable spatial planning policies, while the remaining 32.8% is influenced by other factors outside the model. This model demonstrates strong determination, particularly in explaining the dynamics between spatial planning policy implementation and ESG performance in the mining sector of North Kolaka Regency.

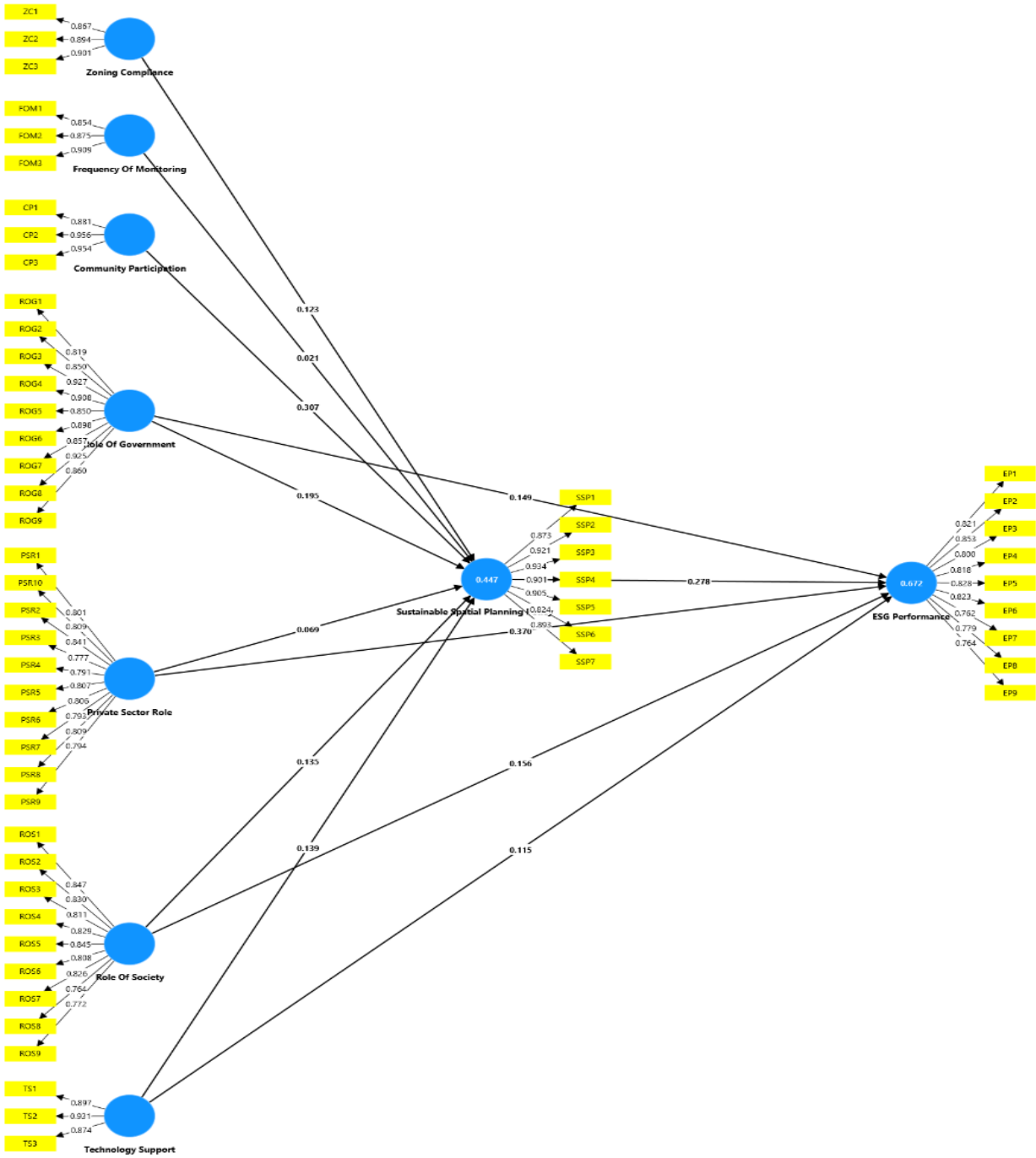

Figure 2. Results of the tests show the effects between variables and the contribution of each indicator to its respective variable

5. DISCUSSION

The results of this study are generally in line with basic theories on spatial policy implementation and ESG principles. The finding that zoning compliance has a significant effect on spatial planning policy supports the views of Jeffe [9] and Skuzinski [10], who emphasize the importance of zoning as a regulatory framework to maintain orderly land use, spatial equity, and sustainable development. This also reinforces the concept that clear and consistently enforced zoning is the foundation of effective urban planning.

The influence of community participation on spatial planning policy is also in line with the theories of Najmulmunir [12] and Lemar [13] which state that citizen involvement increases policy legitimacy and acceptance. This finding also develops the theory by showing that in the context of modern technology, as Pamungkas et al. [14], suggests, digital platform-based participation plays a role in expanding access and increasing transparency in decision-making. However, the insignificant effect of public participation on ESG performance indicates a gap between participatory contributions at the planning stage and the direct impact on ESG outcomes, thus enriching the understanding of the limits to the effectiveness of public participation.

Although monitoring frequency and private sector involvement were theoretically expected to strengthen spatial planning policy implementation, both variables did not show statistically significant relationships. This result may reflect institutional realities in North Kolaka Regency, where monitoring activities remain procedural and focus more on administrative reporting rather than substantive enforcement. As noted by Jaspers and Ankerstjerne, (2023), monitoring is an essential component of spatial governance, but its effectiveness depends on the quality of follow-up and institutional coordination rather than its frequency. Weak inter-agency coordination and limited technical capacity also reduce the tangible impact of monitoring on spatial governance.

Similarly, the insignificance of the private sector's role in spatial policy implementation suggests that corporate actors are still positioned as implementers of operational compliance rather than as partners in spatial decision-making. While the literature highlights the importance of cross-sector collaboration and CSR contributions [15, 20], private sector engagement in North Kolaka remains limited to meeting licensing and environmental obligations. Consequently, its contribution is more evident in ESG performance outcomes than in influencing spatial policy processes.

The significant role of government in spatial policy and ESG performance is in line with the theory that government serves as the main regulator of Najmulmunir [12] and controller of the direction of sustainable development. This finding reinforces Molfetas and Wille's [15] view of the government's use of technology to streamline procedures and improve governance efficiency. As well as developing this theory, which explains the influence of the role of the private sector on ESG performance, but is not significant for spatial policies. Although Molfetas & Wille's theory emphasizes the potential contribution of the private sector in supporting policy, the results of this study indicate that private sector involvement has a more direct impact on achieving ESG targets through investment, CSR, and biodiversity management Mackenzie et al. [20], than on the spatial policy formulation and implementation process itself.

Technological support influencing spatial policy and ESG performance is in line with the theories of Delitheou et al. [16], Kumar and Aithal [22] and Pisz et al. [24], which emphasize the role of technology in resource management efficiency, increased public participation, and zoning monitoring. The results of this study also develop the theory by underlining the importance of community ecological literacy as an amplifier of the effectiveness of technology in supporting regulation and public engagement.

Overall, the results of this study strengthen the underlying theory on the importance of synergies between zoning compliance, public participation, government and private roles, and technological support in spatial policy implementation and ESG achievement. In addition, certain findings provide conceptual enrichment, particularly on the limitations of public participation in directly influencing ESG outcomes and the dominant contribution of the private sector at the implementation stage of sustainability, rather than in spatial policy formulation.

In the context of Indonesia's mining sector, the successful implementation of spatial planning policies is strongly influenced by a combination of regulatory factors, participation, technological support, and multi-stakeholder collaboration. Adherence to zoning has proven to be an important foundation for controlling land use in mining areas, preventing overexploitation, and maintaining ecological balance, in line with sustainable management principles. Public participation has a clear influence on spatial policy formulation, but its impact on ESG performance is limited, indicating the need for mechanisms that link public engagement with measurable sustainability outcomes. The government plays a significant role in driving the achievement of spatial policies and ESG performance through clear regulations, effective supervision, and the adoption of technology such as data-driven monitoring systems. Meanwhile, the private sector makes a more dominant contribution to ESG performance than to policy-making, reflecting its focus on implementing social responsibility programs and operational sustainability. Technology support becomes an important driver, strengthening monitoring efficiency, enhancing transparency, and expanding channels of public participation. The findings confirm that synergies between government, the private sector, communities, and technology are key prerequisites for ensuring sustainable mining governance while addressing challenges such as disparities in social standards and limited access to equitable participation in mining areas.

6. CONCLUSIONS

The successful implementation of spatial planning policies and the improvement of ESG performance in the mining sector of North Kolaka Regency are strongly influenced by zoning compliance, community participation, government roles, community roles, technological support, and private sector contributions. Zoning compliance, community participation, government role, community role, and technology support have a significant influence on the implementation of spatial planning policies, while the frequency of monitoring and the role of the private sector have no significant direct effect on the planning stage. However, on ESG performance, the roles of government, the private sector, the community, technology support, and spatial policy implementation proved to be

significant, while community participation did not have a significant direct effect.

This research contributes to the literature by providing empirical evidence that spatial policy implementation in the mining sector can be improved through multi-stakeholder synergies, strengthening compliance mechanisms, and optimizing technology utilization. In addition, these findings can form the basis of policy recommendations for local governments and industry players in integrating ESG principles more effectively. However, this study has weaknesses, including the use of a cross-sectional design that only captures conditions at one point in time, so it cannot explain the dynamics of long-term changes, as well as limited generalizability due to the focus on one study area, namely North Kolaka Regency. In the future, a longitudinal study and expansion of the research area may provide a more comprehensive and in-depth picture. The unique contribution of this research lies in its simultaneous empirical testing of spatial policy implementation and ESG performance in the mining sector, integrating spatial governance variables (zoning, participation, and technological support) into a structural model that has not been widely studied or applied in Indonesia.

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