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Cost Governance in Volatile Commodity Environments: A Conceptual Model for Mining and Energy Firms

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Abstract
Cost governance in volatile commodity environments has become a strategic priority for mining and energy firms facing unpredictable price cycles, inflationary pressures, supply chain disruptions, regulatory uncertainty, and rising stakeholder expectations. In such settings, traditional cost control methods are often too static, reactive, and fragmented to support resilient decision-making. This paper develops a conceptual model for cost governance tailored to the operating realities of commodity-dependent firms, where profitability, capital allocation, and operational continuity are highly sensitive to market volatility. The model positions cost governance as an integrated system of structures, processes, capabilities, and behavioral disciplines that guides how costs are planned, monitored, challenged, and optimized across the enterprise. It emphasizes the need to move beyond periodic budgeting toward dynamic cost visibility, scenario-based planning, accountability mechanisms, and cross-functional coordination between finance, operations, procurement, engineering, and risk management. The proposed framework incorporates five interrelated dimensions: strategic cost alignment, real-time cost intelligence, governance accountability, adaptive decision controls, and continuous capability development. Together, these dimensions enable firms to distinguish between value-preserving expenditure, discretionary spending, and cost actions that may undermine safety, asset reliability, or long-term competitiveness. The model also recognizes the importance of leadership tone, incentive alignment, and transparent escalation pathways in preventing short-term cost responses that create hidden operational and financial risks. By integrating governance principles with operational responsiveness, the framework supports more disciplined trade-off decisions during periods of commodity price swings, project uncertainty, and margin compression. It is especially relevant for firms managing capital-intensive assets and long investment horizons. Expected outcomes include stronger cost resilience, improved capital efficiency, more consistent operational performance, and enhanced organizational capacity to respond to both downturns and upcycles. The paper contributes to current discussions in management control, risk governance, and strategic finance by offering a sector-relevant lens through which mining and energy firms can rethink cost management as a governance capability rather than a narrow accounting function. The study concludes that effective cost governance is essential for sustaining value, protecting critical assets, and enabling informed adaptation in highly uncertain commodity markets.

Keywords: Cost Governance, Commodity Volatility, Mining Firms, Energy Firms, Management Control, Strategic Cost Management, Risk Governance

1. Introduction

Cost governance has become an increasingly important concern in mining and energy firms because these sectors operate under conditions of high uncertainty, heavy capital commitment, and significant exposure to market fluctuations. Unlike many other industries where costs can be adjusted more flexibly and business models are less asset dependent, mining and energy firms must manage large fixed costs, long project cycles, complex supply chains, regulatory obligations, and operational risks that can significantly affect financial sustainability. In such environments, the way costs are governed is just as important as the level of costs themselves. Cost governance refers to the structures, processes, accountabilities, and decision disciplines

through which organizations plan, monitor, challenge, and optimize spending in alignment with strategic priorities (Adeleke, 2022, Kevin & Oluwasanya, 2022, Mbonu, *et al*., 2022). For mining and energy firms, this extends beyond accounting control to include how leaders and operational teams make trade-offs between efficiency, safety, asset reliability, environmental performance, and long-term value creation. As cost pressures intensify and external uncertainty becomes more persistent, firms in these sectors increasingly require governance systems that can ensure disciplined financial oversight without undermining operational continuity or strategic resilience (Adesiyan & Alaba, 2024, Liadi, 2024, Okonkwo, *et al*., 2024, Taiwo & Okosieme, 2024).

The nature of volatility in commodity-dependent industries makes this challenge particularly acute. Mining and energy firms are deeply affected by fluctuating prices for oil, gas, coal, metals, and other extractive resources, many of which are influenced by global demand cycles, geopolitical events, exchange rate movements, inflation, technological change, and regulatory developments. Because these firms depend heavily on commodity markets over which they have limited direct control, their revenues can rise and fall sharply within relatively short periods. At the same time, their cost structures often remain difficult to adjust quickly due to long-term contracts, specialized labor requirements, equipment maintenance needs, logistics constraints, and the capital-intensive nature of their operations (Aduwa, *et al*., 2025, Jacob, *et al*., 2025). This mismatch between volatile revenue conditions and relatively rigid cost commitments creates significant financial pressure. Furthermore, commodity volatility rarely occurs in isolation. It is often accompanied by supply chain disruption, rising energy and material input costs, environmental compliance demands, and shifting investor expectations around sustainability and governance. These layered uncertainties increase the complexity of financial management and expose the limitations of traditional cost responses that rely mainly on short-term cuts or reactive budget tightening (Akin-Oluyomi & Akhigbe, 2022, Ogbole, *et al*., 2022, Taiwo, 2022, Umoh, 2022).

In this context, cost governance becomes more critical than routine cost control. Routine cost control generally focuses on managing expenses against budget, monitoring variances, and containing spending within predetermined limits. While these activities remain necessary, they are often insufficient in volatile commodity environments where firms must make rapid yet disciplined decisions under uncertainty. Cost governance is broader and more strategic. It concerns how cost-related decisions are framed, who has authority to make them, what criteria guide spending choices, how trade-offs are evaluated, and how risks are managed when financial pressure intensifies (Sanni & Atima, 2021, Uzoka, *et al*., 2021). In mining and energy firms, poorly governed cost decisions can have serious consequences. Excessive cost cutting may weaken safety systems, delay maintenance, compromise environmental compliance, reduce workforce capability, or undermine the reliability of critical assets. Conversely, weak discipline during favorable market conditions can encourage cost expansion, inefficiency, and capital misallocation that become harmful when prices decline. Cost governance is therefore essential because it helps organizations distinguish between prudent efficiency measures and short-sighted cost actions that may erode long-term performance. It also provides a basis for aligning cost decisions with operational priorities, strategic objectives, and risk tolerance (Adeleke, 2023, Kevin, 2023).

Commodity price swings have a particularly strong effect on profitability and investment decisions in mining and energy firms. Because margins in these sectors are highly sensitive to price movements, even modest changes in market conditions can alter earnings performance, cash flow generation, and project economics significantly. During commodity upcycles, firms may experience improved revenues and expanded investment appetite, often leading to increased operating expenditure, accelerated project development, or reduced urgency around efficiency discipline (Saltz & Shamshurin, 2016, Sculley, *et al*., 2015). During downturns, however, the same firms may face margin compression, liquidity pressure, project deferrals, workforce restructuring, and intensified scrutiny over every category of expenditure. These cycles influence not only day-to-day spending decisions but also long-term capital allocation. Investment in exploration, production expansion, infrastructure, decarbonization initiatives, and technology upgrades must often be made under conditions of uncertain price outlooks and variable return expectations. Where cost governance is weak, firms may overinvest during high-price periods and cut too deeply during downturns, thereby amplifying rather than moderating the effects of volatility (Akomolafe, *et al*., 2023, Falemi, Akhigbe & Akin-Oluyomi, 2023). Strong cost governance helps firms respond to price swings with more disciplined and balanced decision-making, protecting both near-term financial performance and long-term strategic value.

The need for a conceptual model suited to capital-intensive sectors arises from the fact that mining and energy firms face governance challenges that differ in important ways from those found in less asset-heavy industries. Their operating models involve long asset lives, large upfront investments, high shutdown costs, stringent regulatory and environmental requirements, and interdependencies between technical, financial, and operational decisions. In such settings, cost decisions cannot be treated as isolated accounting matters (Grover, *et al*., 2018, Hashem, *et al*., 2015, Watson, 2017). They must be assessed in relation to project timelines, reserve uncertainty, production continuity, maintenance obligations, community expectations, and future market positioning. A conceptual model is needed to organize these interrelated issues into a coherent governance framework that reflects the realities of volatile commodity environments. Such a model can help clarify the dimensions of effective cost governance, including strategic alignment, accountability, information quality, adaptive control, and capability development (Aye and Tawose, 2015). It can also provide a structured basis for analyzing how firms can govern costs in ways that balance resilience, discipline, and long-term value preservation. Without such a model, responses to volatility may remain fragmented, overly reactive, or overly dependent on short-term financial measures.

This study is therefore aimed at developing a conceptual understanding of cost governance in volatile commodity environments, with particular attention to mining and energy firms. Its scope includes the nature of cost governance, the distinctive pressures created by commodity volatility, the limitations of routine cost control, and the broader organizational requirements for governing costs in a

strategic and resilient manner (Chen, Mao & Liu, 2014, Delen & Demirkan, 2013). The study is relevant because it addresses a practical and recurring challenge in sectors where financial performance is highly exposed to external shocks and where poor cost decisions can create lasting operational and strategic consequences. It is also relevant to current discussions in management control, strategic finance, and risk governance, especially in relation to firms operating under uncertainty, capital intensity, and increasing stakeholder scrutiny. By focusing on mining and energy firms, the study contributes a sector-specific perspective to the broader literature on cost management and organizational resilience. Ultimately, it seeks to provide a conceptual foundation for understanding cost governance not as a narrow cost-cutting exercise, but as an integrated capability that supports disciplined adaptation, stronger decision-making, and sustainable value creation in highly volatile commodity markets (Ajidahun & Abdulrazaq, 2025, Nii-Okai, 2025, Zaharia, *et al*., 2016).

2.1 Methodology

A suitable methodology for this study is a structured conceptual review designed to develop an integrated cost governance model for mining and energy firms operating in volatile commodity environments. This method is appropriate because the topic requires the synthesis of interdisciplinary insights on commodity volatility, financial planning, enterprise risk, procurement control, forecasting, operational resilience, and governance design rather than the testing of a single empirical hypothesis. The study is therefore positioned as a review-based model-building exercise that draws systematically from the supplied literature to identify the major drivers of cost instability, the governance mechanisms used to manage them, and the decision structures required to sustain financial discipline in high-uncertainty sectors. The review is anchored in foundational works on business intelligence, analytics capability, data-driven decision-making, and enterprise performance, which establish the broader logic for linking information quality, forecasting maturity, and managerial action to business value creation (Chen *et al*., 2012; Delen & Demirkan, 2013; Côrte-Real *et al*., 2017; Grover *et al*., 2018; Mikalef *et al*., 2020). It is further shaped by sector-relevant studies on cost management, predictive budgeting, procurement governance, energy risk oversight, cash flow control, and strategic finance architectures that are more directly applicable to mining and energy firms facing commodity price swings and supply-side disruption.

The methodology begins by defining the conceptual boundaries of the review. The problem is framed around the persistent difficulty mining and energy firms face in controlling costs when exposed to fluctuating commodity prices, inflation in input markets, logistics disruptions, exchange-rate movements, maintenance uncertainty, regulatory shifts, and capital allocation pressures. Within this context, cost governance is treated not simply as budget monitoring, but as an enterprise-wide capability that integrates cost visibility, predictive intelligence, control mechanisms, accountability structures, and coordinated managerial response. Four core review questions guide the methodology. The first asks which internal and external factors most strongly destabilize cost performance in volatile commodity settings. The second examines which governance mechanisms best support cost discipline under uncertainty. The third considers how analytics, dashboards, forecasting systems, and procurement intelligence improve responsiveness. The fourth seeks to determine how these elements can be integrated into a practical conceptual model for mining and energy firms. This framing allows the review to move beyond fragmented cost-control tactics and toward a systems-based governance perspective.

The evidence base is drawn from the user-provided reference list, which serves as the primary corpus for analysis. A purposive screening process is used to identify the most relevant studies for inclusion. References are retained where they contribute meaningfully to one or more of the following domains: cost governance, predictive budgeting, financial risk control, enterprise dashboards, procurement strategy, supply chain resilience, asset and inventory visibility, energy trading risk, working capital management, capital allocation, regulatory compliance, operational forecasting, or decision-support analytics. Sources that are highly technical but transferable in governance logic, such as those focusing on risk architectures, KPI-driven oversight, process optimization, or integrated data platforms, are also included where they strengthen the conceptual structure of the proposed model. By contrast, studies with no clear relevance to cost governance, enterprise finance, mining, energy, procurement, or analytics-driven decision systems are excluded from the synthesis. Duplicate citations are consolidated, while partially incomplete references are considered only where the title and thematic alignment clearly support the review aim.

After screening, the selected studies are organized into a structured evidence extraction matrix. For each retained source, the study records the author and year, sector context, central managerial problem, volatility dimension addressed, governance mechanism proposed, analytical or digital capability referenced, implementation conditions, and expected organizational outcomes. Additional extraction categories include the type of cost driver discussed, such as procurement cost, maintenance cost, working capital pressure, contract variability, inventory exposure, energy price fluctuation, or compliance cost. The matrix also captures whether the source emphasizes predictive techniques, scenario modeling, dashboards, supplier governance, enterprise controls, cross-functional visibility, resilience mechanisms, or capital efficiency. This approach allows the review to compare studies that differ in sector origin but converge around a similar logic of cost governance under uncertainty. References such as Adesuyi *et al*. (2021, 2023), Oduleye and Medon (2021), Lawal and Oduleye (2021, 2025), Walawalkar *et al*. (2025), and Taiwo and Amoah-Adjei (2022) are particularly important for the financial analytics dimension, while works by Okonkwo *et al*. (2018, 2019, 2024), Agbabiaka *et al*. (2019), Ogunwole *et al*. (2021), and Awanye *et al*. (2024) strengthen the sector-specific risk, procurement, and energy governance aspects.

The analytical procedure relies on thematic synthesis. In the first stage, open coding is applied to the extracted data to identify recurring concepts and mechanisms. Codes are expected to include commodity price exposure, cost inflation, demand and supply uncertainty, contract governance, predictive planning, supplier concentration risk, inventory visibility, operational uptime, cost-to-serve, compliance controls, scenario analysis, dashboard

transparency, and executive accountability. In the second stage, these codes are grouped into broader analytical themes that explain how cost governance functions in volatile environments. The major themes anticipated include external volatility sensing, internal cost driver visibility, predictive budgeting and scenario planning, governance and control architecture, procurement and supplier discipline, operational resilience, and performance monitoring. In the third stage, the relationships among these themes are interpreted to identify causal and reinforcing linkages. For example, price volatility may intensify cost risk, but the real severity of that risk depends on forecasting maturity, supply chain governance, capital flexibility, and the speed of managerial response. Likewise, dashboards may improve transparency, but without clear governance thresholds, escalation rules, and decision ownership, transparency alone may not lead to better cost outcomes. This stage therefore transforms the review from a descriptive catalogue of studies into an explanatory synthesis capable of supporting model development.

To improve methodological rigor, the review includes a conceptual appraisal process. Rather than scoring studies statistically, the appraisal examines each source in terms of relevance, conceptual clarity, practical transferability, and contribution to the emerging model. Foundational references on data infrastructure, decision science, process intelligence, and analytics transformation are used to provide theoretical stability and methodological grounding (Inmon, 2005; Kimball & Ross, 2013; Provost & Fawcett, 2013; Van der Aalst, 2016; Watson, 2017). These are complemented by applied and contemporary works on financial control architectures, dashboard governance, predictive financial planning, procurement analytics, and cost management in dynamic enterprises (Kalu *et al*., 2022; Adesuyi *et al*., 2023; Ogbole *et al*., 2023; Walawalkar *et al*., 2024; Mark *et al*., 2025). Sector-sensitive insights from mining, energy, and resource-related studies are incorporated to preserve contextual relevance, especially regarding safety, environmental exposure, raw material demand, energy reliability, and commodity-linked operational risk (Muma *et al*., 2020; Nii-Okai, 2024; Wobo & Odoemelam, 2024; Mensah *et al*., 2025). The combination of foundational and applied literature supports both conceptual depth and practical sector fit.

The final stage of the methodology is conceptual model construction. Based on the synthesized evidence, the proposed model is developed around a sequential and feedback-based governance logic. The model starts with volatility sensing, where firms monitor external signals such as commodity prices, inflation trends, FX shifts, regulatory developments, and supplier market conditions. It then moves to cost intelligence integration, where operational, procurement, logistics, asset, and financial data are consolidated through dashboards and analytic systems. The third layer is governance design, where cost thresholds, authorization rules, risk triggers, performance indicators, and cross-functional accountability structures are formalized. The fourth layer is response orchestration, where forecasting outputs, scenario models, procurement actions, supplier strategies, and capital allocation decisions are coordinated. The final layer is adaptive control, where actual outcomes are tracked against targets, deviations are analyzed, and governance rules are updated to reflect changing market conditions. In this way, the methodology does not merely summarize prior literature; it systematically translates the evidence into a review-based conceptual model capable of guiding mining and energy firms in sustaining cost discipline, protecting margins, and improving strategic resilience in unstable commodity markets.

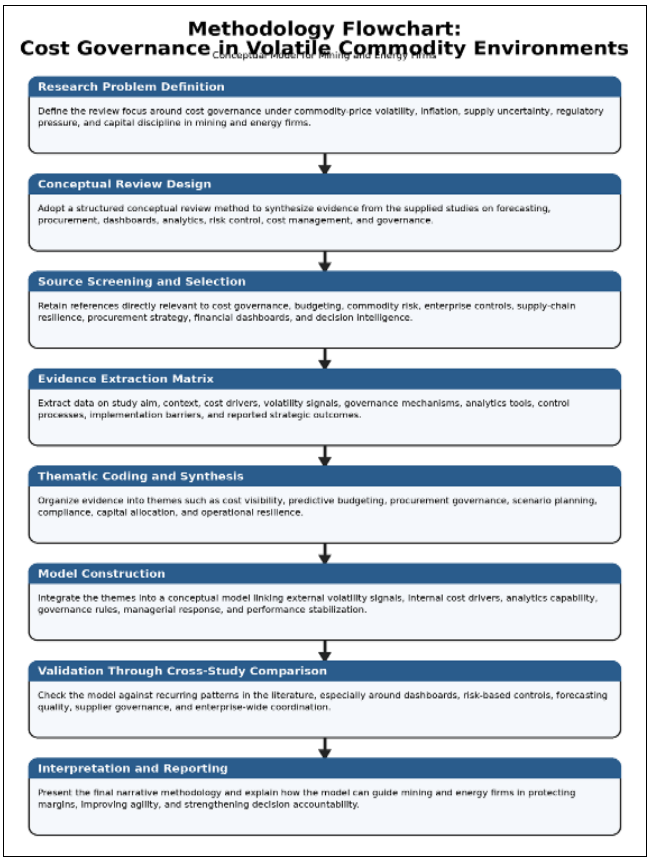

Fig 1: Flowchart of the study methodology

2.2 Understanding Cost Governance in Commodity-Based Firms

Cost governance in commodity-based firms refers to the system of principles, structures, processes, accountabilities, and decision rules through which costs are planned, reviewed, challenged, prioritized, and aligned with broader organizational objectives. It is a broader and more strategic concept than the mere recording or monitoring of expenses. In mining and energy firms, cost governance concerns how the organization decides what to spend, why to spend, when to spend, and under what conditions spending should be maintained, adjusted, deferred, or intensified. It also concerns who has authority to make such decisions, what information is used to support them, how risks are considered, and how competing priorities are balanced (Mikalef, *et al*., 2020, Nii-Okai, 2020). In this sense, cost governance is not just a financial control mechanism. It is an organizational capability that shapes how the firm responds to changing market conditions, protects critical assets, sustains operations, and preserves value across commodity cycles. Its scope extends across capital expenditure, operating expenditure, project spending, maintenance budgets, contractor costs, procurement decisions, production efficiency, and organizational overheads. It also reaches into strategic planning, risk management, performance review, and operational coordination. This makes cost governance especially important in firms whose profitability is exposed

to volatile commodity prices and whose cost structures are often heavy, technically complex, and difficult to adjust quickly (Taiwo & Amoah-Adjei, 2022, Udechukwu, 2022).

The scope of cost governance in commodity-based firms is particularly wide because the cost base in these sectors is shaped by both operational necessity and external uncertainty. Mining and energy firms must manage spending related to extraction, processing, transportation, maintenance, safety, environmental compliance, workforce capability, technology, and infrastructure. Many of these expenditures are not discretionary in the usual sense because they are tied to regulatory requirements, asset integrity, production continuity, and risk mitigation. At the same time, firms must decide how aggressively to invest in expansion, efficiency, exploration, decarbonization, or market access while operating in environments where revenues can change sharply due to fluctuations in oil, gas, coal, metal, or electricity prices (Adeleke, 2025, Mark, *et al*., 2025, Sanni, Iwuanyanwu & Essien, 2025). Cost governance therefore includes not only oversight of existing expenditures but also the judgment required to distinguish between spending that protects long-term value and spending that can be optimized without creating hidden risks. This broader scope explains why cost governance must be treated as a strategic issue rather than a purely accounting matter. Figure 2 shows conceptual framework of environmental accounting costs and financial performance: interplay of resource-based view, stakeholder and legitimacy theories presented by Wobo & Odoemelam, 2024.

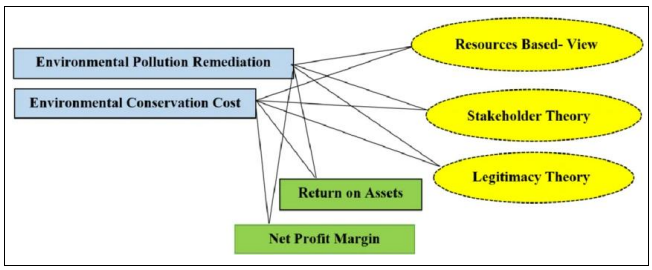

Fig 2: Conceptual Framework of Environmental Accounting Costs and Financial Performance: Interplay of Resource-Based View, Stakeholder and Legitimacy Theories (Wobo & Odoemelam, 2024)

A clear distinction should be made between cost governance, cost control, and cost reduction. These concepts are related, but they are not the same. Cost control usually refers to the set of managerial actions aimed at keeping actual costs within budget or within expected performance boundaries. It is often concerned with monitoring variances, enforcing spending limits, reviewing budget adherence, and correcting excesses (Aniebonam, Aniebonam & Nii-Okai, 2023). Cost control is necessary in any organization, but it tends to be operational and periodic in orientation. Cost reduction, by contrast, refers more specifically to deliberate efforts to lower costs, often through efficiency measures, restructuring, procurement savings, workforce rationalization, process redesign, or the elimination of waste. Cost reduction is often episodic and may become especially prominent during downturns or margin pressure.

Cost governance goes beyond both of these. It provides the overarching framework within which cost control and cost reduction are carried out. It asks deeper questions about the logic, timing, ownership, and consequences of cost-related decisions. A firm may have strong cost control mechanisms yet weak cost governance if it monitors budgets carefully but makes poor strategic trade-offs about what should or should not be funded. Similarly, a firm may achieve short-term cost reduction yet still have weak cost governance if those reductions undermine safety, maintenance, asset reliability, workforce capability, or future competitiveness (Aliliele, *et al*., 2025, Opara, *et al*., 2025). Cost governance therefore includes but is not limited to control and reduction. It focuses on disciplined judgment, structured accountability, and alignment between costs and strategic intent. In volatile commodity environments, this distinction matters greatly because the wrong cost actions can solve immediate financial pressure while creating more serious operational or strategic problems later (Akomolafe, *et al*., 2022, Lawal & Oduleye, 2022, Morah, *et al*., 2022).

The strategic importance of cost governance in mining and energy operations is rooted in the structural features of these industries. These sectors are capital intensive, asset heavy, and highly exposed to price volatility. Their projects often involve long development timelines, substantial sunk costs, and technical interdependencies that make abrupt cost changes difficult and sometimes dangerous (Aliliele, Mbonu & Iwuanyanwu, 2023, Taiwo, Amoah-Adjei & Aramide, 2023). Decisions about maintenance spending, contractor management, asset utilization, production scheduling, environmental compliance, and project continuation all have financial implications, but they also affect safety, productivity, operational continuity, and future revenue potential. In such conditions, cost governance becomes strategically important because it helps firms manage costs in ways that are consistent with both short-term realities and long-term business viability. Figure 3 shows the conceptual framework governance of more sustainable woodfuel value chains presented by Sola, *et al*., 2019.

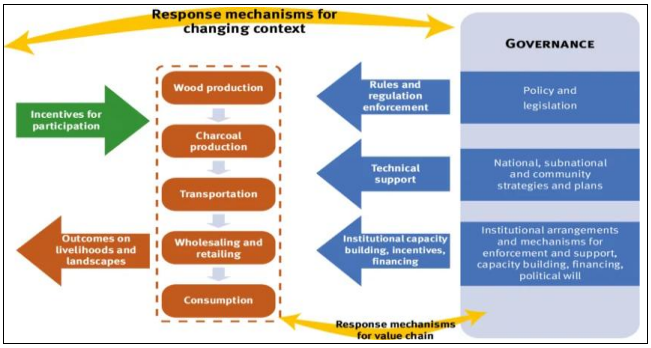

Fig 3: Conceptual framework Governance of more sustainable woodfuel value chains (Sola, *et al*., 2019)

For example, when commodity prices fall, pressure to reduce costs often intensifies. Without effective governance, firms may respond through blunt cuts that appear financially prudent in the short term but weaken operational resilience. Delayed maintenance may reduce current expenditure but increase the probability of equipment failure, downtime, or safety incidents. Reducing technical staff may lower payroll costs but erode problem-solving capacity and production reliability. Cancelling exploration or technology programs may preserve cash today but weaken future growth options (Sharma, Mithas & Kankanhalli, 2014, Van der Aalst, 2016). Strong cost governance provides a decision framework that helps firms weigh these consequences. It encourages disciplined analysis of what costs are essential,

what costs can be optimized, what costs should be staged differently, and what spending supports strategic resilience even during downturns. In this way, cost governance is central to strategic survival and competitive positioning in commodity-based sectors (Agu & Akomolafe, 2020, Uzoho, 2022).

The relationship between governance structures and financial discipline is also fundamental. Financial discipline is not achieved only through good intentions or budget targets. It depends on the structures through which decisions are made, reviewed, escalated, and enforced. Governance structures include committees, approval hierarchies, reporting routines, accountability arrangements, performance metrics, and cross-functional review processes. In mining and energy firms, where cost decisions often involve operational, engineering, procurement, and commercial considerations, financial discipline is stronger when governance structures create clarity about roles, decision rights, and challenge mechanisms (Adeleke & Baidoo, 2022, Babalola, *et al*., 2022, Mbonu, *et al*., 2022). If spending decisions are fragmented, weakly reviewed, or dominated by functional silos, financial discipline tends to deteriorate. Departments may optimize for their own goals while overlooking broader enterprise costs or risks. Projects may proceed without adequate cost challenge. Operational decisions may be made without sufficient understanding of financial implications. Figure 4 shows conceptual framework for sustainable mining operations and environmental management proposed by Muma, *et al*., 2020.

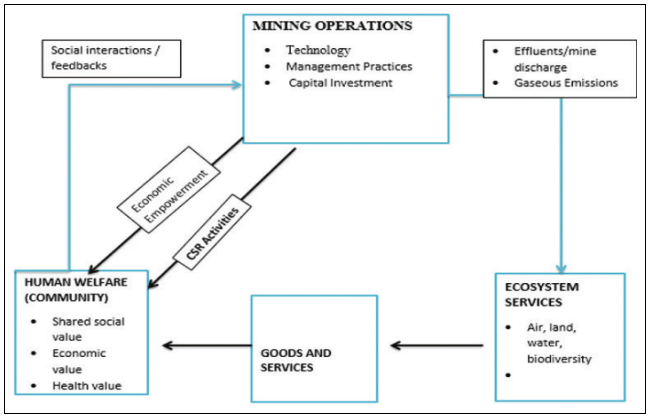

Fig 4: Conceptual framework for sustainable mining operations and environmental management (Muma, *et al*., 2020)

Effective governance structures promote discipline by ensuring that spending decisions are transparent, justified, and reviewed from multiple perspectives. They connect financial oversight with operational understanding. They make it easier to identify cost drift, prevent uncontrolled escalation, and distinguish between justified expenditure and avoidable inefficiency. They also support consistency across commodity cycles. During periods of high prices, governance structures help prevent complacency and uncontrolled cost expansion. During downturns, they help ensure that cost pressure does not lead to hasty decisions that damage future value. In this sense, governance structures are not bureaucratic obstacles (Aniebonam, *et al*., 2025, Nii-Okai, 2025). They are the institutional means through which financial discipline becomes durable and credible.

One of the most important roles of cost governance is balancing short-term survival and long-term value. Commodity-based firms regularly face tensions between immediate financial pressure and the need to preserve strategic capacity. When prices decline, firms must often conserve cash, defend margins, reassure investors, and maintain covenant compliance. These pressures can make short-term survival the dominant priority. However, long-term value in mining and energy depends on preserving assets, maintaining safe and efficient operations, sustaining technical capability, meeting regulatory obligations, and positioning the firm for recovery or growth when markets improve (Côrte-Real, Oliveira & Ruivo, 2017, Provost & Fawcett, 2013). Cost governance helps firms navigate this tension by creating frameworks for prioritization and trade-off management.

This balancing role is particularly important because not all costs have the same strategic meaning. Some costs are value preserving, such as essential maintenance, safety controls, regulatory compliance, or investments in asset reliability. Some costs are growth enabling, such as selective exploration, digital capability, or market development. Some are discretionary and may be adjusted with limited long-term harm. Others may be inefficient or redundant. Without governance, cost decisions during volatile periods can become overly reactive, driven by headline savings targets rather than strategic differentiation (Akidau, *et al*., 2015, Chen, Chiang & Storey, 2012). Strong cost governance forces the organization to ask which expenditures support future cash generation, which protect operational integrity, and which can be modified without damaging long-term performance. It therefore supports survival without allowing survival logic to erode the foundations of future value creation.

Cost governance is relevant to both upstream and downstream activities, though the nature of the issues may differ across the value chain. In upstream mining and energy activities, such as exploration, extraction, drilling, production, and field development, cost governance is critical because operational uncertainty, asset intensity, and technical risk are especially high. Upstream decisions often involve major capital commitments, long timelines, reserve uncertainty, equipment reliability issues, and exposure to input cost inflation (Adeleke & Olajide, 2024, Jessa & Ajidahun, 2024, Sanni, *et al*., 2024). Governance is needed to assess project economics, manage contractor costs, monitor production efficiency, and ensure that cost decisions do not undermine safety or asset performance. In these environments, cost governance must work closely with engineering, geology, operations, and risk teams because financial choices are inseparable from technical realities (Taiwo, 2022).

In downstream activities, such as refining, processing, distribution, storage, trading, and marketing, cost governance remains equally relevant but often operates through different cost drivers and commercial pressures. Downstream businesses may face thinner margins, higher throughput sensitivity, changing demand patterns, logistics complexity, and customer-facing market competition. Cost governance in these areas helps manage procurement efficiency, energy usage, plant utilization, turnaround spending, transportation costs, and product mix decisions (Jagadish, *et al*., 2014, Kelleher & Tierney, 2018). It also supports coordination between commercial and operational

units so that cost discipline does not weaken service reliability or market responsiveness. In integrated firms spanning both upstream and downstream activities, cost governance becomes even more important because spending decisions in one part of the value chain can affect performance elsewhere. A coherent governance approach helps ensure that cost management is not fragmented across business segments but aligned with enterprise-wide strategy and risk appetite (Adeleke & Olugbogi, 2025, Lawal, *et al*., 2025).

Overall, understanding cost governance in commodity-based firms requires recognizing that costs are not merely accounting entries to be tracked or reduced. They are strategic commitments, operational necessities, and signals of organizational priorities. In mining and energy firms, where volatility, capital intensity, and technical complexity are persistent realities, cost governance provides the discipline needed to manage costs wisely rather than mechanically. It distinguishes thoughtful stewardship from blunt cost cutting (Aliliele, Mbonu & Iwuanyanwu, 2023, Sanni & Attah, 2023). It connects governance structures to financial discipline. It helps firms balance immediate pressure with long-term value protection. It supports both upstream and downstream performance by aligning cost decisions with operational realities and strategic objectives. For these reasons, cost governance should be viewed as a central component of resilient management in commodity-dependent sectors, not as a secondary administrative process (Anioke & Atima, 2023, Babatope, *et al*., 2023, Ogunboye, *et al*., 2023, Okonkwo, Mayo & Okeke, 2023).

2.3 Characteristics of Volatile Commodity Environments

Volatile commodity environments are defined by instability in prices, input conditions, market expectations, and operating costs, all of which shape the financial and strategic decisions of mining and energy firms. These environments are not volatile in a narrow or temporary sense. Rather, volatility is a recurring structural condition in sectors whose revenues depend heavily on internationally traded commodities such as crude oil, natural gas, coal, gold, copper, lithium, iron ore, and other extractive resources. For firms operating in these sectors, the external environment is rarely stable enough to support fixed assumptions about costs, demand, or returns over long periods (Adeleke, Ajala & Olugbogi, 2021, Fadayomi, *et al*., 2021). This makes volatility a central managerial reality rather than an occasional disruption. Understanding the characteristics of such environments is essential for explaining why cost governance has become such a critical concern. Commodity-dependent firms must operate in contexts where price signals shift rapidly, non-price pressures increase unpredictably, supply conditions change suddenly, and long-term investments remain exposed to uncertainties that cannot be fully controlled (Atima & Anioke, 2020, Okonkwo, *et al*., 2020).

A defining characteristic of volatile commodity environments is the nature and drivers of commodity price fluctuations. Commodity prices are affected by a complex interaction of global supply and demand forces, investor sentiment, speculative activity, technological change, macroeconomic cycles, inventory levels, weather patterns, and policy decisions. Unlike firms in industries where prices can often be adjusted based on firm-level strategy or market segmentation, mining and energy companies typically act as price takers in broader international markets. This means that the revenue side of their business is shaped by forces beyond their direct control (Aniebonam, *et al*., 2025, Kevin, *et al*., 2025). A rise in global industrial demand can increase prices for metals or energy resources, while economic slowdown in major consuming economies can depress demand and weaken prices. Similarly, changes in production output by major producers, the discovery of alternative energy sources, new extraction technologies, or unexpected supply disruptions can alter market balance quickly. Commodity prices also respond strongly to expectations. Even before actual shortages or surpluses materialize, market anticipation of future events can drive significant price swings. This makes pricing behavior not only reactive but also highly speculative, creating uncertainty for firms trying to plan expenditure, protect margins, and make investment decisions (Aye and Tawose, 2016, Lawal & Oduleye, 2018).

The impact of inflation, exchange rates, and geopolitical disruptions adds another layer of complexity to commodity environments. Inflation affects mining and energy firms not only through general price increases but through direct pressure on labor costs, contractor rates, spare parts, energy inputs, transport charges, and capital equipment prices. Because many commodity operations depend on heavy machinery, specialized services, fuel-intensive logistics, and technically skilled labor, inflation can significantly expand the cost base even when production levels remain constant. Exchange rate movements further complicate this picture (Aliliele, Mbonu & Iwuanyanwu, 2024, Nii-Okai, 2024, Wedraogo & Sanni, 2024). Commodity prices may be denominated in global currencies such as the United States dollar, while operating costs may be incurred in local currencies. A depreciation in the local currency may increase export competitiveness, but it may also raise the cost of imported machinery, technical services, and debt obligations. Conversely, currency appreciation may reduce some import costs while weakening local revenue translation. These currency effects make financial planning more difficult, especially for firms operating across multiple jurisdictions (Akomolafe, Agu & Bello, 2022, Liadi, 2022, Owoade, *et al*., 2022).

Geopolitical disruptions intensify volatility by introducing sudden and sometimes severe changes in trade flows, market access, sanctions exposure, shipping routes, investment confidence, and regulatory risk. Political conflict, diplomatic tensions, trade restrictions, nationalization concerns, border closures, or security threats can all affect the ability of firms to source materials, move products, secure financing, or maintain stable operations. In energy markets especially, geopolitical developments often influence not only actual supply conditions but also market expectations about future availability (Batistič & van der Laken, 2019, Dubey, *et al*., 2019). Mining firms are similarly affected when instability in producing regions changes export flows or raises operational risk. These disruptions create environments in which firms must respond not only to economic changes but also to strategic uncertainty that is difficult to model with precision.

Another important characteristic of volatile commodity environments is supply chain instability and input cost uncertainty. Mining and energy operations rely on complex supply networks involving equipment manufacturers, engineering contractors, transportation providers,

consumables suppliers, technology vendors, and maintenance service partners. In stable conditions, these supply relationships can be managed through predictable schedules, long-term contracts, and established procurement routines. In volatile conditions, however, supply chains become less reliable (Aliliele, *et al*., 2025, Mensah, *et al*., 2025). Delivery delays, shipping bottlenecks, supplier insolvency, labor shortages, transport disruptions, and sudden shortages of critical materials can all interrupt operations or force firms to secure inputs at higher prices. This is particularly problematic in sectors where equipment downtime can severely affect output and where replacement parts may be specialized and not easily substituted. Input cost uncertainty becomes more acute when firms cannot predict whether the materials, services, or logistics they need will be available on time or at expected cost. As a result, budgeting becomes less certain, procurement planning becomes more defensive, and operational efficiency becomes more vulnerable to external shocks (Gandomi & Haider, 2015, Inmon, 2005, Kimball & Ross, 2013).

Regulatory, environmental, and social pressures also shape the cost profile of commodity-based firms in volatile ways. Mining and energy firms operate under increasingly demanding expectations regarding environmental stewardship, emissions reduction, land use, community relations, worker safety, and corporate governance. These expectations arise from governments, regulators, local communities, investors, lenders, and civil society groups. Regulatory changes can increase compliance costs, delay project approvals, alter operating standards, or require additional reporting, monitoring, and mitigation expenditures (Adeleke, Olugbogi & Abimbade, 2024, Sanni & Wedraogo, 2024). Environmental obligations may include emissions controls, remediation spending, water management, biodiversity protections, and investments in cleaner technologies. Social pressures may involve community compensation, local employment commitments, indigenous engagement, security arrangements, and infrastructure contributions in host regions. These are not marginal concerns. They often have significant cost implications and can shape whether projects remain viable or socially acceptable (Adesuyi, *et al*., 2024, Falemi, Akhigbe & Akin-Oluyomi, 2024).

What makes these pressures especially relevant to volatile commodity environments is that they often evolve alongside market fluctuations rather than independently of them. A firm may face declining commodity prices at the same time that compliance requirements are tightening or stakeholder scrutiny is intensifying. In such situations, management cannot simply reduce costs without considering how cuts might affect safety, environmental performance, or community trust. These external pressures therefore make the cost environment more complex. They also highlight why cost governance in mining and energy sectors must be broader than routine cost control, since many costs are strategically and socially necessary even when financial pressures are severe (Akin-Oluyomi & Akhigbe, 2023, Falemi, Akhigbe & Akin-Oluyomi, 2023).

Capital intensity and long project life cycles are additional characteristics that make volatility particularly challenging in mining and energy industries. These sectors require substantial upfront investment in exploration, drilling, processing facilities, transport infrastructure, power systems, environmental controls, and site development. Once these investments are made, they create long-term cost commitments that cannot be adjusted quickly without significant consequences. Many projects take years to move from discovery to production, and once operational, assets may remain in use for decades (Akokodaripon, Okoruwa & Babatope, 2024, Babatope, Akokodaripon & Okoruwa, 2024, Okoruwa, *et al*., 2024). This means that firms make major capital allocation decisions under conditions of uncertain future prices, uncertain policy developments, and uncertain cost trajectories. Unlike sectors with shorter production cycles or lower asset specificity, mining and energy firms cannot easily reverse investment choices or reconfigure their asset base in response to short-term market changes.

The long life cycle of projects also creates timing challenges. A commodity may appear attractive at the point of project approval, but by the time production begins, market conditions may have changed significantly. Similarly, cost estimates made during early project phases may become outdated due to inflation, design changes, supply disruptions, or regulatory adjustments. This long temporal gap between investment decisions and realized outcomes makes cost governance especially important. Firms must manage not only present costs but also future obligations, sunk investments, and the financial resilience of projects across cycles (Adesuyi, Kalu & Walawalkar, 2023, Ogbole, *et al*., 2023, Taiwo, Aramide & Tiamiyu, 2023). Capital intensity therefore amplifies the consequences of volatility because it limits flexibility while increasing the scale of financial exposure.

Operational uncertainty linked to reserves, production, and maintenance further defines the character of volatile commodity environments. In mining, reserve quality, ore grade, geological complexity, and extraction conditions may differ from initial assumptions, affecting productivity and cost per unit. In energy, reservoir behavior, production decline rates, pressure conditions, equipment reliability, and field performance can alter output expectations and operating economics (Bello, *et al*. 2022, Oteri & Edivri, 2022, Taiwo & Amoah-Adjei, 2022). These technical uncertainties mean that firms often face variability in both production volumes and production costs. Even when commodity prices are favorable, operational underperformance can erode margins. Conversely, when prices are weak, unexpected operational costs can create significant financial stress.

Maintenance adds another dimension to this uncertainty. Mining and energy assets operate under harsh physical conditions and require ongoing maintenance to preserve reliability, safety, and efficiency. Maintenance spending is often one of the first areas targeted during cost-cutting periods, yet deferred or inadequate maintenance can create much larger future costs through breakdowns, production loss, accidents, or asset damage. Firms therefore operate in environments where maintenance decisions are tightly linked to both cost volatility and operational risk (Dada, Isiekwu & Oluwo, 2021, Isiekwu, Oluwo & Dada, 2021, Oteri, 2021). Production targets, reserve realities, and equipment conditions interact continuously, making the cost environment dynamic rather than static. Management must therefore balance output goals, asset integrity, and expenditure constraints under conditions where technical performance is not perfectly predictable.

Taken together, these characteristics show that volatile commodity environments are shaped by a combination of market instability, cost uncertainty, structural rigidity, and external pressure. Commodity price fluctuations create unstable revenue conditions. Inflation, exchange rates, and geopolitical disruptions amplify financial unpredictability. Supply chain instability complicates operational planning. Regulatory, environmental, and social pressures expand the range of costs that firms must manage responsibly (Awanye, *et al*., 2023, Babatope, *et al*., 2023, Oluwadele, *et al*., 2023, Tawose, *et al*., 2023). Capital intensity and long life cycles reduce flexibility and magnify the consequences of poor decisions. Operational uncertainty linked to reserves, production, and maintenance makes cost behavior harder to forecast and control. These features explain why mining and energy firms require more than simple budgeting discipline. They require robust cost governance capable of supporting disciplined adaptation in environments where uncertainty is not an exception but a normal condition of business (Okoruwa, *et al*., 2024, Olalere & Uzu-Okoh, 2024, Oluwadele, Tawose and Adetumbi, 2024).

2.4 Major Cost Governance Challenges in Mining and Energy Firms

One of the major cost governance challenges in mining and energy firms is fragmented cost visibility across departments and projects. These firms typically operate through highly complex structures involving exploration units, production teams, engineering functions, procurement units, maintenance departments, finance divisions, logistics operations, environmental management teams, and project delivery offices. Each of these areas generates costs, manages budgets, and makes spending decisions that affect the financial position of the organization. However, the visibility of these costs is often uneven and disconnected (Lawal & Oduleye, 2018, Okonkwo, Ogunwole & Okeke, 2018). Departments may track their own expenditures in separate systems, classify costs differently, or emphasize only the metrics most relevant to their immediate responsibilities. Projects may also operate with different reporting formats, approval thresholds, and forecasting assumptions. As a result, the organization may struggle to obtain a unified view of total cost exposure across operating assets, capital projects, service contracts, and support functions. This fragmentation makes it difficult to determine where cost pressures are emerging, which projects are drifting from budget, how departmental decisions affect one another, and whether overall expenditure aligns with strategic priorities (Akomolafe, *et al*., 2022, Oluwo, Dada & Isiekwu, 2022). In volatile commodity environments, this lack of integrated cost visibility is especially problematic because firms need timely and coordinated insight into spending patterns in order to respond effectively to shifting market conditions.

The challenge of fragmented visibility is often compounded by delayed reporting and weak real-time cost intelligence. In many mining and energy firms, cost information is collected, consolidated, and reviewed through periodic reporting cycles that may be too slow for the pace of market and operational change. Monthly cost reports, quarterly reviews, and project update meetings can provide useful retrospective information, but they may not offer decision-makers the immediate visibility needed to respond to fast-changing commodity prices, supply disruptions, contractor claims, equipment failures, or inflationary pressures. When reporting is delayed, management often acts on outdated information (Akokodaripon, *et al*., 2023, Gupta, *et al*., 2023). This weakens the organization's ability to detect cost escalation early, understand the root causes of overspending, or intervene before financial issues become more severe. Weak real-time intelligence also reduces the quality of operational decisions. A production team may continue to use an inefficient process without realizing its full cost impact. A project manager may not recognize that contractor rates and material costs are eroding the expected economics of a development plan. A procurement unit may not see how supplier instability is affecting total cost of ownership across sites. In capital-intensive industries where even minor operational disruptions can have significant financial consequences, delayed cost insight undermines governance because decision-making becomes reactive rather than anticipatory (Akin-Oluyomi, *et al*., 2025, Babatope, Akokodaripon & Okoruwa, 2025, Bello, *et al*., 2025).

Another serious challenge is the pressure for short-term cost cuts that may harm long-term performance. Mining and energy firms are frequently exposed to sharp downturns in commodity prices, margin compression, investor pressure, and liquidity concerns. Under such conditions, management may be compelled to reduce costs quickly in order to preserve cash, reassure stakeholders, or protect earnings. While cost reduction is often necessary during periods of stress, the problem arises when short-term cuts are pursued without sufficient governance, strategic analysis, or understanding of downstream consequences (Anioke & Atima, 2019, Badmus & Olamide, 2019). In these sectors, some expenditures are not merely optional costs but investments in reliability, safety, technical capability, and future production. Cutting maintenance budgets may improve short-term financial results but increase the likelihood of asset failure, downtime, or safety incidents. Reducing engineering oversight may lower current payroll or contractor expenditure while weakening project quality and technical resilience. Cancelling technology upgrades or delaying exploration may support immediate cash preservation but harm long-term competitiveness and growth potential (Adesuyi, *et al*., 2023, Ogbole, *et al*., 2023). In this context, one of the biggest governance challenges is resisting blunt cost-cutting responses that create deeper operational or strategic problems later. Effective cost governance requires the ability to distinguish between prudent efficiency measures and damaging reductions made under pressure. Yet this is often difficult in organizations facing intense market uncertainty and strong pressure for immediate financial results.

Misalignment between finance, operations, procurement, and engineering further complicates cost governance in mining and energy firms. These functions all shape the cost base of the organization, but they do not always operate with the same priorities, time horizons, or evaluation criteria. Finance may focus on budget discipline, cash preservation, return thresholds, and reporting compliance. Operations may emphasize throughput, continuity, safety, and productivity. Procurement may prioritize supplier terms, savings targets, and contract execution. Engineering may focus on technical integrity, project quality, design performance, and long-term asset functionality (Olude & Badmus, 2015, Kolndadacha, *et al*., 2013). Each of these priorities is legitimate, yet when they are not aligned through a coherent governance

framework, cost decisions become fragmented and sometimes contradictory. A procurement-led decision to choose the lowest-cost supplier may create reliability issues for operations. An engineering recommendation for a technically superior design may be resisted by finance due to cost escalation. Operations may push for urgent spending to avoid downtime, while finance may question the affordability of unplanned expenditure. In these situations, the absence of strong cross-functional alignment weakens cost governance because decisions are shaped by local optimization rather than enterprise-wide judgment (Akin-Oluyomi & Akhigbe, 2023, Oteri & Edivri, 2023). Misalignment also creates conflict, slows decision-making, and increases the likelihood that important trade-offs are either ignored or addressed too late.

Weak accountability for cost decisions at different management levels is another major governance challenge. In many firms, cost accountability is formally assigned through budgets, approvals, and reporting relationships, but in practice the ownership of cost outcomes may remain unclear or diluted. Senior leaders may set cost targets without fully owning the implementation risks. Middle managers may be responsible for expenditure control but lack authority over the drivers of those costs. Project managers may be accountable for budget delivery but depend on functional teams whose decisions affect project economics. Operational supervisors may influence labor, maintenance, or material use without being fully involved in cost planning. This diffusion of responsibility creates governance weaknesses because no single level of management is clearly positioned to connect spending decisions with performance consequences (Adesuyi, *et al*., 2025, Falemi, Akhigbe & Akin-Oluyomi, 2025, Olaogun, *et al*., 2025). In some cases, accountability becomes heavily concentrated in the finance function, which monitors and reports variances but does not directly control the operational behaviors that create them. In other cases, accountability exists only in a formal sense, while real decision-making occurs informally through relationships, urgency, or functional pressure. Such conditions make it difficult to challenge overspending effectively, enforce discipline consistently, or learn from cost performance failures. In volatile commodity environments, where timely and disciplined cost decisions are critical, weak accountability reduces organizational responsiveness and creates space for cost drift, duplication, and poor prioritization (Bello, *et al*. 2023, Lawal & Oduleye, 2023, Mayo, *et al*., 2023, Taiwo & Okosieme, 2023).

A related challenge is the difficulty in distinguishing strategic spending from wasteful expenditure. This is particularly important in mining and energy firms because the line between necessary and excessive spending is often less obvious than it appears. Some expenditures may seem high in the short term but are essential for preserving asset integrity, maintaining regulatory compliance, protecting safety, sustaining community trust, or enabling future growth. Other expenditures may be embedded in longstanding practices, legacy processes, or complex project structures that make inefficiency harder to detect (Adesuyi, Walawalkar & Kalu, 2022, Liadi, 2022). For example, a major maintenance program may be expensive but strategically necessary to prevent a costly shutdown. A digital monitoring investment may appear discretionary in the current budget period but generate long-term reliability and efficiency gains. Community engagement spending may not produce immediate financial return but may be critical to securing the firm's social license to operate. At the same time, firms may carry hidden inefficiencies in contractor usage, duplicated support services, poor inventory practices, overdesigned solutions, or low-value administrative processes (Adesiyan & Alaba, 2025, Badmus & Olamide, 2025, Oluwadele, *et al*., 2025, Yusuff, *et al*., 2025). The challenge for cost governance is that both strategic and wasteful expenditures can exist within the same cost categories, making simple cost-cutting logic insufficient. Without a strong governance process, firms may reduce valuable spending while failing to eliminate persistent inefficiencies.

This difficulty is amplified by the technical complexity of projects and operations in these sectors. Non-financial decision-makers may struggle to articulate why certain expenditures are strategically important, while financial reviewers may not always have the operational context needed to distinguish value-preserving costs from avoidable spending. This can lead to recurring tension between those advocating for expenditure to protect long-term performance and those pushing for immediate financial restraint (Okonkwo, Ogunwole & Okeke, 2018, Olamide & Badmus, 2018). It can also encourage defensive budget behavior, where departments justify every expense as essential in order to avoid cuts, thereby making genuine waste harder to isolate. Effective cost governance must therefore create mechanisms for disciplined challenge without oversimplification. It must allow the organization to ask not only whether spending is high, but whether it supports safety, continuity, efficiency, compliance, resilience, or future value creation in proportionate ways.

These major challenges do not exist in isolation. Fragmented cost visibility makes it harder to identify where spending is strategic or wasteful. Delayed reporting weakens the ability to respond before cost problems intensify. Pressure for short-term cuts increases the risk of sacrificing long-term value. Functional misalignment creates conflicting interpretations of what good cost decisions look like. Weak accountability allows poor spending decisions to persist without correction. Difficulty in distinguishing value from waste makes governance debates more complex and often more political (Akin-Oluyomi & Akhigbe, 2023, Mayo, *et al*., 2023). Together, these factors reveal why cost governance in mining and energy firms cannot be reduced to routine budget monitoring. It must involve integrated visibility, timely intelligence, disciplined cross-functional coordination, clear ownership, and structured judgment about the purpose and consequences of expenditure.

In volatile commodity environments, these governance challenges become even more severe because the margin for error is smaller. A firm may move from strong profitability to financial stress within a short period due to price decline, inflation, or supply disruption. Under such conditions, governance weaknesses that were manageable in favorable markets can quickly become damaging. Cost escalation may go unnoticed until liquidity tightens. Functional disagreement may delay essential spending decisions (Isiekwu, 2024, Okonkwo, *et al*., 2024, Taiwo, 2024, Walawalkar, Kalu & Adesuyi, 2024). Short-term cuts may weaken the organization just as market recovery begins. Poor accountability may allow cost overruns to continue during a period when every spending choice matters more.

For this reason, understanding these challenges is essential to the development of a more robust cost governance model. Mining and energy firms require governance systems that do more than report costs after the fact. They need systems that connect cost visibility, decision quality, accountability, and strategic judgment in ways that can withstand uncertainty and support both financial resilience and operational continuity (Adesuyi, Kalu & Walawalkar, 2021, Badmus & Olamide, 2021, Olamide & Badmus, 2021).

2.5 Core Dimensions of the Proposed Conceptual Model

The proposed conceptual model of cost governance in volatile commodity environments is built on the premise that mining and energy firms require more than routine budgeting or periodic cost reduction efforts to remain resilient. Because these firms operate under conditions of price volatility, high capital intensity, operational uncertainty, and growing stakeholder pressure, cost governance must be structured as an integrated organizational capability. The model therefore rests on several core dimensions that work together to strengthen decision quality, financial discipline, and long-term value protection (Adediran, *et al*., 2025, Okonkwo, *et al*., 2025, Olawore, *et al*., 2025, Oluwadele, *et al*., 2025). These dimensions are strategic cost alignment, real-time cost intelligence, governance accountability, adaptive decision controls, capability development, and the integration of financial, operational, and risk perspectives. Each dimension addresses a critical weakness commonly found in cost management practices in commodity-based sectors, and together they offer a more coherent approach to governing expenditure under uncertainty (Akeju, *et al*., 2021, Dada, Isiekwu & Oluwo, 2021, Morah, *et al*., 2021).

A first and foundational dimension is strategic cost alignment with corporate goals and market conditions. In volatile commodity environments, costs cannot be governed effectively if they are treated only as accounting items to be minimized. They must be interpreted in relation to the organization's broader strategy, operational priorities, and current external conditions. Strategic cost alignment means that spending decisions should support the firm's core objectives, whether those involve production continuity, cash preservation, project delivery, asset reliability, decarbonization, market expansion, or long-term reserve development (Lawal & Oduleye, 2019, Mabo, Swar & Aghili, 2018). In mining and energy firms, some costs are directly linked to the preservation of future value, while others are more discretionary or subject to optimization. Governance becomes stronger when firms distinguish clearly between expenditure that protects strategic capability and expenditure that does not materially support priority outcomes (Agu, Akomolafe & Bello, 2023, Mayo, *et al*., 2023).

This dimension also requires sensitivity to market conditions. Commodity cycles influence what types of cost decisions are appropriate at different moments. During high-price periods, the challenge may be to prevent uncontrolled cost expansion and maintain discipline even when revenue conditions appear favorable. During downturns, the challenge may be to reduce or defer certain expenditures without undermining safety, production reliability, or future competitiveness. Strategic cost alignment therefore demands a dynamic understanding of context. It does not assume that the same cost posture is suitable across all market conditions (Adeosun, *et al*., 2025, Nonso, *et al*., 2025, Okoruwa, *et al*., 2025). Instead, it requires management to continually reassess how costs support corporate objectives in light of changing prices, demand conditions, regulatory expectations, and capital constraints. This makes cost governance more than a budgeting exercise. It becomes a process of aligning expenditure with strategic intent under fluctuating external realities.

A second core dimension is real-time cost intelligence for monitoring and rapid response. In volatile commodity environments, delayed cost information weakens governance because firms need timely insight into emerging financial pressures, cost drift, inflation effects, supply disruptions, and project overruns. Real-time cost intelligence refers to the ability of the organization to generate, interpret, and act upon current cost information rather than relying only on retrospective reports (Anioke & Atima, 2020, Badmus & Olamide, 2020, Ojonugwa, *et al*., 2021). This does not mean that every decision must be made instantly, but it does mean that decision-makers need visibility into expenditure patterns early enough to intervene meaningfully. In mining and energy firms, where costs can escalate quickly due to contractor variation, equipment failure, logistics disruption, or input price changes, rapid cost visibility is essential for effective management (Abolaji, *et al*., 2020, Olamide & Badmus, 2020, Patrick, *et al*., 2020).

This dimension includes more than data availability. It also involves the quality, relevance, and usability of cost information. Real-time intelligence should allow managers to understand not only what costs are changing, but why they are changing and what implications they carry. A sudden increase in maintenance spending, for example, may reflect necessary reliability action, poor asset condition, supply chain inflation, or inefficient planning. Good cost governance depends on the ability to interpret such differences rather than simply noticing the numerical change (Liadi, 2023, Ogunboye, *et al*., 2023, Okonkwo, *et al*., 2023, Olalere & Uzu-Okoh, 2023). Real-time intelligence therefore supports rapid response, but it also supports better judgment. It allows firms to act with greater confidence when conditions shift, and it reduces the risk of reacting too late or reacting in the wrong way. In sectors characterized by uncertainty and large financial exposure, this capacity is central to resilient governance.

A third dimension is governance accountability through roles, responsibilities, and controls. Cost governance becomes weak when no one is clearly responsible for spending choices, when authority is poorly defined, or when decisions are made outside transparent review structures. In mining and energy firms, expenditure decisions are often influenced by multiple actors across finance, operations, procurement, engineering, and project delivery. Without clear governance accountability, cost outcomes may be shaped by urgency, functional bias, or informal influence rather than disciplined decision-making (Badmus, *et al*., 2021, Ogunwole, *et al*., 2021, Okonkwo, *et al*., 2021). This dimension therefore emphasizes the importance of assigning roles and responsibilities clearly, ensuring that decision rights are understood, and building controls that allow significant spending choices to be challenged and justified.

Governance accountability should exist at multiple levels. Senior executives are responsible for setting the overall cost posture, defining thresholds, and ensuring alignment with

corporate strategy. Middle managers are responsible for translating those expectations into departmental and project decisions. Operational leaders and project teams must understand how their spending choices affect broader financial and strategic outcomes. Finance has an important role in providing oversight, challenge, and insight, but accountability cannot rest solely within the finance function (Lawal & Oduleye, 2025, Monye, *et al*. 2025, Taiwo, 2025, Walawalkar, *et al*., 2025). Effective governance requires shared ownership supported by clear controls. Controls in this context are not only restrictive mechanisms. They include approval processes, escalation rules, review forums, cost thresholds, audit trails, and performance expectations that make spending decisions visible and answerable. When accountability is well structured, the organization is better able to maintain discipline across both stable and volatile periods (Adesuyi, *et al*., 2025, Mayo, *et al*., 2025, Olaitan, *et al*., 2025).

A fourth dimension is adaptive decision controls for uncertainty and scenario planning. Traditional cost controls often assume relatively stable conditions, fixed assumptions, and predictable operating environments. Commodity-based sectors do not enjoy such stability. Mining and energy firms face changing prices, uncertain demand, fluctuating input costs, evolving regulatory requirements, and operational risks that make static controls insufficient. Adaptive decision controls are therefore necessary to ensure that the governance system can respond intelligently to uncertainty rather than simply enforcing outdated assumptions. This dimension emphasizes flexibility with discipline (Akokodaripon, *et al*., 2023, Ogbole, *et al*., 2023). It does not mean abandoning control; it means designing controls that can adjust as conditions change.

Scenario planning is a key element of this dimension. Firms must govern costs not only against a single forecast, but across a range of plausible future conditions. This may include high-price, low-price, inflationary, supply-constrained, or disruption scenarios. Adaptive controls help management determine which expenditures should remain protected under all scenarios, which can be delayed under pressure, and which should be accelerated when conditions improve. They also help firms prepare decision rules in advance, reducing the likelihood of panic-driven or purely reactive responses (Adediran, *et al*., 2025, Isiekwu, Oluwo & Dada, 2025, Obi, *et al*., 2025). In practice, this means that cost governance should include contingency frameworks, trigger points, dynamic thresholds, and structured review mechanisms that allow the organization to adapt while maintaining coherence. Adaptive controls are especially important in capital-intensive sectors, where decisions made under uncertainty can have long-lasting consequences for operational integrity and financial performance (Oluwadele, *et al*., 2025, Tawose, Ekeocha & Oluwadele, 2025, Umoh, *et al*., 2025).

A fifth core dimension is capability development in cost analysis, forecasting, and governance practice. Even the strongest governance framework will remain ineffective if the people responsible for using it lack the necessary skills and judgment. Cost governance in volatile commodity environments requires more than technical accounting knowledge. It requires the ability to analyze cost drivers, forecast under uncertainty, interpret operational and market signals, evaluate trade-offs, and participate in governance discussions with confidence and clarity (Akomolafe, *et al*., 2024, Oteri & Edivri, 2024). This means that firms must invest in building capability across multiple functions, not just within finance. Operations managers need to understand the cost consequences of production choices and maintenance decisions. Engineers need to articulate the financial implications of technical recommendations. Procurement professionals need to assess total cost effects rather than purchase price alone. Finance teams need to understand the operational context of the costs they review (Anioke & Atima, 2023, Badmus & Olamide, 2023, Mayo, *et al*., 2023, Taiwo, Tiamiyu & Ayodele, 2023).

Capability development is also essential because governance quality depends on how consistently principles are applied in practice. If managers do not know how to challenge expenditure constructively, use scenario tools, interpret dashboards, or distinguish between strategic and discretionary spending, then governance processes may become mechanical or superficial. Training, coaching, peer learning, and practical exposure to cost review processes all help strengthen governance practice. Over time, this builds a more mature organizational ability to govern costs intelligently rather than simply following procedural requirements. In volatile environments, where judgment matters as much as compliance, capability development is a central rather than secondary element of effective governance (Agbabiaka, *et al*., 2019, Olamide & Badmus, 2019).

The sixth and integrating dimension is the combination of financial, operational, and risk perspectives. One of the most persistent weaknesses in cost management is the tendency to view expenditure only through a financial lens. In mining and energy firms, this is particularly dangerous because costs are deeply connected to operations, safety, engineering integrity, regulatory compliance, and strategic exposure. A purely financial view may identify a cost as excessive without recognizing that it protects reliability, prevents regulatory breach, or supports future production continuity (Isiekwu, 2022, Liadi, 2022, Kalu, Walawalkar & Adesuyi, 2022). Conversely, an operational team may justify a cost as necessary without fully appreciating its effect on cash flow, margin, or investment capacity. The proposed model therefore insists that cost governance must integrate financial, operational, and risk perspectives if it is to produce sound decisions.

Financial integration ensures that expenditure is evaluated in relation to profitability, liquidity, efficiency, and capital discipline. Operational integration ensures that cost decisions are grounded in the realities of production, maintenance, logistics, and technical performance. Risk integration ensures that short-term financial choices are assessed for their implications on safety, compliance, asset reliability, community relations, and long-term resilience. This integrated perspective is what allows cost governance to move beyond simplistic cost cutting (Awanye, *et al*., 2024, Oluwo, Dada & Isiekwu, 2024, Taiwo, Aramide & Tiamiyu, 2024). It creates a more complete basis for evaluating trade-offs and supports decisions that protect value under uncertainty. In cross-functional review settings, this integration can reduce conflict and improve the quality of challenge, because different functions are encouraged to view cost decisions through a shared and balanced framework.

Taken together, these core dimensions form a coherent conceptual model for cost governance in volatile commodity

environments. Strategic alignment ensures that expenditure supports corporate goals and responds appropriately to market conditions. Real-time intelligence provides the visibility needed for early intervention and informed response. Governance accountability clarifies ownership and strengthens discipline. Adaptive decision controls allow the organization to manage uncertainty without losing coherence (Akeju, *et al*., 2018, Lawal & Oduleye, 2019). Capability development ensures that managers and teams can apply governance principles effectively. Integration of financial, operational, and risk perspectives creates the balanced judgment necessary for sound cost decisions in complex, asset-intensive sectors. This model is valuable because it acknowledges that cost governance is not a narrow accounting function but a strategic and organizational capability. For mining and energy firms facing uncertainty, volatility, and long-term financial exposure, such a model provides a stronger basis for disciplined adaptation, performance resilience, and sustainable value creation (Agu, Akomolafe & Bello, 2023, Oduleye & Medon, 2023).

2.6 Implementation of the Cost Governance Model

Implementing a cost governance model in volatile commodity environments requires a structured and organization-wide approach that moves beyond policy statements or isolated cost initiatives. In mining and energy firms, the challenge is not simply to define better cost principles but to translate those principles into operating routines, decision processes, and leadership behaviors that can function under uncertainty. Because these firms operate with high capital intensity, technical complexity, and exposure to commodity price swings, implementation must be deliberate, phased, and aligned with both strategic objectives and day-to-day operational realities (Akhigbe, Falemi & Akin-Oluyomi, 2025, Ogundipe, *et al*., 2025, Uzoho, 2025). A strong cost governance model becomes effective only when it is embedded in how the firm assesses cost performance, makes spending decisions, responds to volatility, and coordinates across functions. For this reason, implementation should begin with a careful understanding of existing governance capability and then progress toward stronger structures, better information, more integrated collaboration, scenario-based planning, and sustained organizational support (Olalere & Uzu-Okoh, 2025, Oluwadele, *et al*., 2025, Tawose, Olayinka & Oluwadele, 2025).

A critical first step is the assessment of current cost governance maturity. Organizations cannot improve what they have not first understood clearly. In many mining and energy firms, cost governance practices already exist in some form through budget reviews, approval hierarchies, procurement controls, project committees, and operational reporting processes. However, these practices may be uneven in quality, fragmented across business units, or insufficiently aligned with the realities of volatile commodity environments (Kazeem, *et al*., 2022, Medon & Oduleye, 2022, Taiwo, 2022). A maturity assessment helps determine how well the current system supports strategic cost alignment, cost transparency, accountability, timely decision-making, and resilience under uncertainty. It should not be limited to checking whether procedures exist. It should also examine how effectively those procedures function in practice.

A useful maturity assessment would review several areas. It should evaluate whether cost decisions are linked clearly to strategic priorities, whether departments and projects have a shared understanding of cost accountability, whether data is timely enough to support rapid intervention, and whether cross-functional review processes are strong enough to manage trade-offs between finance, operations, procurement, engineering, and risk. It should also assess whether managers are using cost information proactively or mainly responding after variances have occurred (Adesuyi, *et al*., 2023, Okoruwa, *et al*., 2023). In addition, firms should examine whether current governance arrangements encourage discipline during both high-price and low-price periods, or whether cost behavior becomes inconsistent across commodity cycles. Interviews, document reviews, dashboard audits, meeting observations, and performance analysis can all support this assessment. The value of this stage lies in identifying not only formal weaknesses but also cultural and behavioral patterns that may undermine effective governance, such as overreliance on finance, siloed decision-making, or tolerance for poor cost visibility (Adesuyi, Walawalkar & Kalu, 2021, Oduleye & Medon, 2021, Patrick, *et al*., 2021).

Once maturity has been assessed, the next implementation requirement is the establishment of governance structures and decision rights. A cost governance model cannot function well if authority is unclear, if different functions apply conflicting standards, or if important spending decisions are made without appropriate review. Mining and energy firms need governance structures that define who is responsible for setting cost priorities, who approves spending under different categories, who challenges assumptions, and who owns the consequences of expenditure decisions (Anioke & Atima, 2020, Badmus & Olamide, 2020, Falemi, Akhigbe & Akin-Oluyomi, 2020). These structures should operate across both operating expenditure and capital expenditure, since both have major implications for financial performance and strategic resilience.

Clear decision rights are especially important in volatile environments because firms often face pressure to act quickly. If authority is ambiguous, urgent decisions may be delayed or pushed through informally without proper analysis. The model should therefore define approval thresholds, escalation routes, and role responsibilities at executive, managerial, project, and site levels. Senior leadership should retain responsibility for setting cost posture, risk tolerance, and major allocation priorities (Akomolafe, *et al*., 2024, Olagunju, Edivri & Oteri, 2024). Business unit leaders should be accountable for translating these priorities into operating decisions. Finance should provide challenge, visibility, and analytical support, but not carry sole ownership of cost discipline. Operations, procurement, engineering, and project teams should have defined responsibilities for identifying cost drivers, justifying expenditure, and managing performance against agreed expectations. Governance structures may include cost review committees, capital allocation forums, expenditure challenge panels, or integrated performance meetings. The key point is that governance should be visible, structured, and consistent enough to support decision quality without becoming so bureaucratic that it slows operational responsiveness (Badmus, *et al*., 2021, Ojonugwa, *et al*., 2021, Okonkwo, *et al*., 2021).

Another important implementation element is the development of cost dashboards and performance metrics. In commodity-based sectors, governance is weakened when cost information is too delayed, too technical, or too fragmented to guide action. Dashboards should therefore be designed to provide timely, decision-relevant insight into cost performance across business units, sites, and projects. They should go beyond basic variance reporting and help decision-makers understand trends, emerging risks, and the drivers behind cost movements (Ezeh, *et al*., 2024, Liadi, 2024, Okonkwo, *et al*., 2024, Olamide & Badmus, 2024). For example, dashboards may track operating cost per unit, project cost drift, contractor spending, maintenance intensity, procurement inflation exposure, working capital effects, cost of downtime, and alignment between approved budgets and actual commitments. Where appropriate, they should also distinguish between controllable and uncontrollable costs, essential and discretionary spending, and short-term savings versus long-term risk exposure.

Performance metrics should support governance rather than distort it. In mining and energy firms, narrow cost targets can sometimes encourage behaviors that look efficient in the short term but create hidden problems later. For that reason, cost metrics should be complemented by indicators related to reliability, safety, regulatory compliance, schedule performance, and asset integrity. A maintenance team, for instance, should not be rewarded only for reducing expenditure if the result is an increase in equipment failure or unplanned shutdowns (Badmus, 2019, Fadayomi, *et al*., 2019, Okonkwo, *et al*., 2019). Similarly, procurement should not be judged only by purchase price reductions if supplier decisions create logistical or quality risks that raise total cost elsewhere. Effective dashboards therefore need to reflect both financial and operational realities. They should be accessible to different functions and capable of supporting both periodic governance reviews and rapid response when conditions change. This makes them central tools for embedding the cost governance model into managerial practice (Akande, *et al*., 2023, Medon & Oduleye, 2023).

Strengthening cross-functional collaboration and review processes is equally essential during implementation. Cost governance in mining and energy firms cannot be effective if finance, operations, procurement, engineering, and other functions continue to evaluate spending through isolated lenses. Many of the most important cost decisions in these sectors involve trade-offs between production continuity, technical integrity, supplier terms, cash discipline, environmental obligations, and long-term asset value (Akhigbe, Falemi & Akin-Oluyomi, 2024, Babalola, *et al*., 2024, Oteri & Edivri, 2024). No single function can govern these decisions well on its own. Implementation should therefore include formal processes for cross-functional review, joint challenge, and integrated decision-making. These may include regular cost performance meetings, capital review boards, contract evaluation forums, shutdown planning reviews, or scenario workshops where multiple functions interpret financial and operational implications together.

Cross-functional collaboration improves implementation because it reduces local optimization and strengthens enterprise-wide judgment. Finance gains better operational context, while operations and engineering gain better visibility into financial constraints and strategic capital priorities. Procurement can contribute market intelligence on supplier cost dynamics, while risk and sustainability teams can highlight compliance and stakeholder implications that influence cost decisions (Okoruwa, *et al*., 2024, Owoola-Adebayo, Umoh & Ofurum, 2024, Umoh, Ofurum & Folasade, 2024). These interactions help the organization distinguish between legitimate expenditure, manageable risk, and avoidable inefficiency. They also improve trust and reduce the adversarial patterns that sometimes emerge when cost governance is seen as a finance-led enforcement exercise. Strong review processes should encourage constructive challenge rather than routine approval. They should make it normal for functions to question assumptions, test alternatives, and evaluate spending implications together.

Embedding scenario analysis and contingency planning is another critical aspect of implementation, especially in volatile commodity environments where market conditions can change rapidly. A cost governance model that works only under one assumed set of prices, supply conditions, and regulatory expectations is unlikely to remain effective for long. Firms need to embed structured scenario analysis into cost planning and review processes so that expenditure decisions can be tested against different possible futures. This may include scenarios based on high and low commodity prices, inflation shocks, supply chain disruption, production shortfalls, regulatory changes, or delayed project delivery (Liadi, 2024, Okonkwo, *et al*., 2024, Opara, *et al*., 2024, Walawalkar, Adesuyi & Kalu, 2024). The objective is not to predict the future exactly but to ensure that the organization has thought through the implications of uncertainty before crisis conditions arise.

Contingency planning complements scenario analysis by defining how the firm will respond if particular conditions materialize. This may involve identifying protected expenditures that should remain funded under all but the most extreme conditions, as well as categories of spending that can be deferred, rephased, or reduced if pressure increases. It may also involve defining decision triggers linked to price thresholds, cash flow stress, or cost inflation indicators. By embedding these tools into governance, firms reduce the likelihood of panic-driven responses when volatility intensifies (Bello, *et al*. 2024 Dada, Isiekwu & Oluwo, 2024, Taiwo & Ayodele, 2024, Taiwo & Oloruntoba, 2024). They also improve consistency, because decisions are guided by pre-agreed principles rather than improvised under stress. In capital-intensive sectors with long project cycles and large operating exposure, this foresight is essential for balancing flexibility with discipline.

Finally, successful implementation depends heavily on leadership support, communication, and change management. A cost governance model will not become embedded simply because new structures and dashboards are introduced. People must understand why the model matters, how it differs from previous practice, and what is expected of them in using it. Leadership support is crucial because it signals that cost governance is a strategic priority rather than a temporary cost-cutting initiative (Lawal & Oduleye, 2021, Olalere & Maduka, 2021). Senior leaders must reinforce the message that the model is intended to improve resilience, decision quality, and long-term value protection, not merely reduce expenditure for short-term reporting purposes. Their visible engagement in governance

forums, cost discussions, and accountability reviews helps legitimize the new approach across the organization.

Communication must be clear and consistent throughout implementation. Employees and managers need to understand how the governance model links to corporate strategy, how decision rights are changing, what new metrics or review expectations will apply, and how the organization intends to balance financial discipline with operational integrity. Communication should avoid framing the initiative in overly punitive or narrow financial terms, since that can trigger defensiveness and resistance. Instead, it should emphasize that good cost governance supports stronger operations, better capital allocation, faster response to volatility, and more sustainable performance (Anioke & Atima, 2018, Badmus & Olamide, 2018). Change management is needed because implementation often challenges existing habits, power dynamics, and assumptions about ownership. Some managers may resist greater transparency or stronger challenge. Some functions may be uncomfortable with more structured accountability or cross-functional scrutiny. These reactions are normal, and they need to be managed through engagement, training, coaching, and reinforcement rather than ignored.

In practice, change management should include stakeholder mapping, readiness assessment, targeted communication, capability building, and visible reinforcement of desired behaviors. Managers may need training in how to use dashboards, conduct cost challenge discussions, or interpret scenario analysis. Teams may need support in learning how to collaborate more effectively across functional boundaries. Recognition mechanisms may be useful to reinforce good governance behavior, such as identifying teams that demonstrate strong cost discipline without compromising safety or reliability. Over time, these change efforts help shift cost governance from a formal framework into a shared organizational practice (Akomolafe, Agu & Bello, 2023, Bello, Akomolafe & Agu, 2023).

Overall, implementing the cost governance model in mining and energy firms requires more than procedural adjustment. It requires a structured transformation in how cost decisions are understood, supported, monitored, and governed. Through maturity assessment, clear structures, effective dashboards, stronger collaboration, scenario-based planning, and committed leadership, firms can move from fragmented cost management toward a more resilient and strategically aligned governance model. In volatile commodity environments, such implementation is not optional. It is a practical necessity for firms seeking to protect performance, preserve value, and navigate uncertainty with greater discipline and confidence (Akomolafe, *et al*., 2025, Ogbole, *et al*., 2025).

2.7 Expected Benefits and Practical Implications

Cost governance in volatile commodity environments offers significant benefits for mining and energy firms because it strengthens the organization's ability to respond to uncertainty without sacrificing long-term value. In sectors where revenues are heavily influenced by external price swings, where capital requirements are substantial, and where operations depend on asset integrity and regulatory discipline, cost governance provides a more reliable foundation for decision-making than routine cost control alone. It helps firms move from reactive cost cutting to more structured, strategic, and accountable management of expenditure (Ayodele, Taiwo & Awele, 2024, Akokodaripon, *et al*., 2024, Oluwadele, *et al*., 2024). The expected benefits are particularly important in environments where commodity downturns, inflationary pressures, supply chain disruption, and regulatory obligations can create sudden and severe pressure on financial performance. A well-developed cost governance model helps organizations maintain discipline under stress, allocate resources more effectively, protect core operations, and reduce the unintended consequences that often follow poorly governed spending decisions.

One major expected benefit is improved cost resilience during commodity downturns. Commodity-based firms are especially vulnerable when market prices decline because much of their cost structure is fixed, technically necessary, or difficult to adjust quickly. During downturns, firms often experience margin compression, reduced cash flow, tighter financing conditions, and increased pressure from investors or lenders to preserve liquidity. In the absence of strong cost governance, the typical response may be hurried cost reduction measures that focus on immediate savings without adequate assessment of operational or strategic consequences (Anioke & Atima, 2024, Badmus & Olamide, 2024, Liadi, 2024, Okonkwo, *et al*., 2024). A cost governance model improves resilience by enabling the organization to respond with greater discipline and prioritization. It allows management to distinguish between costs that must be protected, such as safety-critical maintenance, regulatory compliance, or essential technical capacity, and those that can be reduced, deferred, or redesigned with limited long-term damage. This structured approach reduces the risk of crisis-driven decisions that solve short-term cash pressure while weakening the firm's recovery potential.

Improved cost resilience also means that the organization becomes better prepared before downturns occur. Through stronger governance, firms can build clearer visibility into cost drivers, establish trigger points for expenditure review, and develop contingency responses in advance. This reduces the likelihood of panic-based decisions during periods of market decline. It also helps firms preserve strategic stability. Rather than swinging between aggressive spending in upcycles and indiscriminate cuts in downturns, the organization can manage its cost posture more consistently across the commodity cycle (Badmus, *et al*., 2021, Edivri & Oteri, 2021, Olamide & Badmus, 2021). This continuity is valuable because it supports investor confidence, preserves workforce morale, and strengthens the firm's ability to recover when market conditions improve. In this sense, resilience is not simply about surviving downturns. It is about maintaining the organizational strength needed to respond effectively across both negative and positive market movements.

Another important benefit is better capital allocation and expenditure prioritization. Mining and energy firms regularly face difficult decisions about where to direct limited financial resources. These choices may involve trade-offs among sustaining capital, growth projects, exploration activity, emissions reduction programs, maintenance schedules, technology upgrades, community commitments, and working capital needs. In volatile environments, these decisions become even more difficult because price assumptions, project economics, and funding capacity may shift rapidly (Akhigbe, Falemi & Akin-

Oluyomi, 2023, Olaogun, *et al*., 2023). A cost governance model improves capital allocation by providing a clearer basis for evaluating which expenditures are most aligned with strategic priorities, operational needs, and financial resilience. It encourages firms to assess not only the cost of spending, but also the value, timing, and risk implications of each investment choice.

Expenditure prioritization becomes more disciplined when governance structures require transparent challenge, cross-functional review, and alignment with broader corporate goals. Projects that appear attractive from a technical or local perspective can be examined more critically in relation to capital scarcity, cash preservation, and portfolio value. Conversely, essential expenditures that might be overlooked in a purely short-term financial review can be protected because their strategic importance is clearly understood. This is particularly relevant in capital-intensive sectors, where a single poorly governed decision can tie up large sums of money for years and reduce financial flexibility elsewhere (Gupta, *et al*., 2024, Olalere & Uzu-Okoh, 2024, Oluwadele, *et al*., 2024, Umoh, 2024). Better capital allocation therefore improves not only financial efficiency but also strategic coherence. It helps firms direct resources toward expenditures that sustain competitiveness, protect asset value, and position the organization more effectively for future market conditions.

Cost governance also supports stronger operational efficiency and asset reliability. In mining and energy firms, costs are deeply connected to operational performance. Decisions about maintenance, procurement, production scheduling, workforce deployment, contractor usage, and process improvement all influence efficiency and reliability. Weak governance can lead to spending choices that appear efficient in the short term but introduce hidden inefficiencies over time. For example, underinvestment in maintenance may reduce current expenditure while increasing the likelihood of breakdowns, production losses, or safety incidents (Akomolafe, *et al*., 2025, Okonkwor, *et al*., 2025, Uzoho, 2025). Poorly structured procurement decisions may lower initial purchase cost but create recurring reliability or logistics problems that increase total cost. Strong cost governance reduces these risks by ensuring that expenditure decisions are evaluated with both financial discipline and operational understanding.

When cost governance is functioning well, managers are more likely to identify the relationship between spending and performance outcomes. Maintenance decisions are linked to reliability objectives, procurement choices are assessed on total value rather than price alone, and cost reviews take account of the operational implications of efficiency measures. This strengthens the organization's ability to improve operational efficiency without damaging the systems that support continuity and output quality (Liadi, 2023, Okonkwo, *et al*., 2023, Taiwo, Amoah-Adjei & Aramide, 2023). Asset reliability in particular benefits from better governance because the model helps prevent the erosion of critical spending under financial pressure. In sectors where assets are expensive, technically complex, and essential to production continuity, preserving reliability is not a secondary issue. It is central to value creation. Cost governance helps ensure that efforts to improve cost performance do not undermine the physical systems on which the business depends.

A further expected benefit is reduced risk of hidden costs from poor decisions. Hidden costs are common in mining and energy environments because spending decisions often have indirect, delayed, or cross-functional consequences that may not be visible at the point of approval. A decision to reduce contractor support may appear to save money immediately but later result in project delays, lower maintenance quality, or higher internal overtime. Choosing a cheaper supplier may seem efficient but create transport disruptions, quality failures, or increased inventory requirements (Anioke & Atima, 2023, Liadi, 2023, Olamide & Badmus, 2023, Tawose, Ekeocha & Oluwadele, 2023). Cutting environmental or community-related expenditure may reduce near-term cost but trigger regulatory penalties, project delays, or reputational damage. These types of hidden costs are difficult to manage when governance is weak because decisions are made in isolated silos, without sufficient challenge or integrated evaluation.

A strong cost governance model reduces this risk by broadening the basis on which expenditure decisions are judged. It encourages management to consider total cost implications, longer-term effects, and cross-functional trade-offs rather than focusing only on immediate budget impact. It also increases the likelihood that risk, operations, engineering, and finance perspectives will be brought together before major spending decisions are finalized. This leads to better anticipation of consequences and fewer surprises after implementation. Hidden costs are especially damaging in volatile commodity environments because they can intensify financial stress at the worst possible time (Ekeocha, *et al*. 2021, Lawal & Oduleye, 2021, Uzoho, 2021). By reducing these risks, cost governance improves the overall quality and sustainability of financial decisions.

Enhanced transparency and accountability across functions is another important benefit. In many mining and energy firms, cost management is weakened by fragmented systems, functional silos, and unclear ownership of expenditure outcomes. Finance may monitor numbers, operations may drive spending, procurement may negotiate contracts, and engineering may justify technical requirements, yet no integrated view may exist of who is responsible for the quality of cost decisions or the consequences they create. Cost governance addresses this problem by clarifying roles, strengthening reporting visibility, and creating review processes that make spending decisions more transparent (Monye, *et al*. 2025, Ogbole, *et al*., 2025, Taiwo, 2025, Walawalkar, *et al*., 2025). When departments know that expenditures will be examined in relation to strategic purpose, operational value, and financial impact, decision-making tends to become more disciplined and more defensible.

Transparency improves not only oversight but also collaboration. Cross-functional teams gain a better understanding of how their decisions affect one another, and this can reduce conflict between functions. Finance is less likely to be seen purely as a restrictive control function when its role is integrated into shared governance processes. Operations, procurement, and engineering can make stronger cases for necessary spending when the review process is structured and evidence-based. Accountability also becomes more meaningful because managers can be held responsible not only for staying within budgets, but for the quality of the spending choices they make. Over time,

this strengthens the culture of the organization by reinforcing the idea that cost governance is a shared responsibility rather than a narrow financial exercise.

These benefits carry important practical implications for executives, managers, investors, and regulators. For executives, the model implies that cost governance should be treated as a strategic leadership issue rather than delegated entirely to finance or project control teams. Executives need to set the tone for disciplined expenditure, define governance expectations, and ensure that cost decisions are aligned with the firm's priorities under changing market conditions. They must also avoid sending contradictory signals, such as demanding immediate savings while neglecting the long-term risks of poorly governed cost reduction. The executive role is therefore not only to approve budgets, but to shape the overall cost posture of the enterprise and reinforce the integration of financial, operational, and risk considerations.

For managers, the practical implication is that cost governance becomes part of everyday decision-making rather than an occasional review event. Site leaders, project managers, procurement heads, maintenance supervisors, and engineering managers all need the capability to interpret cost information, justify expenditures clearly, and understand the broader implications of their decisions. Managers must also engage more actively in cross-functional review processes and contribute to the disciplined challenge of spending proposals. This may require additional development in cost analysis, forecasting, and governance practice, especially in organizations where operational managers have historically relied heavily on finance to interpret cost matters.

For investors, stronger cost governance offers reassurance that the firm is better equipped to manage volatility, preserve capital discipline, and avoid destructive cost behaviors across commodity cycles. Investors are increasingly attentive not only to cost levels but to the quality of cost management and the resilience of the business model. A firm that demonstrates strong governance over expenditure is likely to be viewed as better positioned to maintain returns, protect asset value, and allocate capital responsibly in uncertain markets. This can improve confidence in leadership quality and long-term investment attractiveness.

For regulators, cost governance has implications because it influences how firms balance financial pressure with compliance, environmental stewardship, and operational safety. Regulators are often concerned that cost-cutting behavior in commodity sectors may lead to corners being cut in areas that affect public safety, environmental protection, or community welfare. A well-governed cost system provides assurance that expenditure decisions are being made with proper regard for these obligations. It supports a more credible operating posture in industries where license to operate depends not only on profitability but also on responsible management of external impacts.

Overall, the expected benefits and practical implications of cost governance in volatile commodity environments are substantial. Improved resilience during downturns helps firms navigate financial stress without weakening long-term value. Better capital allocation and expenditure prioritization improve resource efficiency and strategic discipline. Stronger operational efficiency and asset reliability support continuity and performance. Reduced hidden costs improve decision quality and protect financial outcomes. Greater transparency and accountability strengthen collaboration and organizational discipline. For executives, managers, investors, and regulators, the model offers a more robust basis for understanding how expenditure can be governed in a way that supports resilience, responsibility, and sustainable value creation. In mining and energy firms, where uncertainty is persistent and the consequences of poor decisions can be severe, effective cost governance is not simply beneficial. It is essential.

2.8 Conclusion

In conclusion, cost governance has emerged as a critical capability for mining and energy firms operating in volatile commodity environments where financial performance is exposed to rapid price swings, inflationary pressures, geopolitical disruptions, supply chain instability, regulatory demands, and operational uncertainty. In such settings, the challenge is not merely to reduce spending or remain within budget, but to govern expenditure in a way that protects resilience, sustains operational continuity, and preserves long-term value. Cost governance is therefore more than a financial control function. It is a strategic and organizational discipline that shapes how firms align spending with corporate priorities, respond to uncertainty, allocate scarce resources, and balance short-term pressures with long-term performance requirements. For commodity-based firms whose cost structures are often heavy, complex, and difficult to adjust quickly, effective cost governance is essential for maintaining discipline without compromising the technical, environmental, and strategic foundations of the business.

The study has shown that mining and energy firms face several major challenges that make cost governance both difficult and necessary. These include fragmented visibility of costs across departments and projects, delayed reporting systems that limit real-time decision-making, pressure for short-term cost reductions that may harm future performance, and persistent misalignment between finance, operations, procurement, and engineering. Additional difficulties arise from weak accountability for spending choices at different levels of management and the recurring problem of distinguishing between strategic expenditure and wasteful spending. These challenges are intensified by the broader characteristics of volatile commodity environments, including unstable revenue conditions, rigid cost commitments, capital intensity, long investment cycles, and operational uncertainty linked to production, reserves, maintenance, and asset reliability. Together, these realities explain why routine cost control is not enough. Firms require a stronger and more integrated governance framework capable of guiding expenditure decisions with greater discipline, speed, and strategic coherence.

Against this background, the proposed conceptual model offers a valuable framework for rethinking how cost governance can be designed and applied in mining and energy firms. Its value lies in its recognition that effective cost governance depends on multiple interrelated dimensions rather than a single control mechanism. By emphasizing strategic cost alignment, real-time cost intelligence, governance accountability, adaptive decision controls, capability development, and the integration of financial, operational, and risk perspectives, the model provides a broader and more realistic understanding of what cost governance should look like in uncertain and capital-

intensive sectors. It moves beyond narrow approaches that focus only on budget adherence or episodic cost cutting and instead presents cost governance as a dynamic capability that helps firms respond to volatility while protecting long-term value. This makes the model especially relevant for firms seeking to improve resilience, strengthen capital discipline, and govern trade-offs more effectively across different phases of the commodity cycle.

A particularly important insight from the study is the significance of integrating governance with operational responsiveness. In mining and energy sectors, cost decisions cannot be separated from the technical and operational realities of the business. Spending choices affect not only financial outcomes but also production continuity, maintenance quality, safety performance, environmental compliance, workforce capability, and project delivery. If governance is too rigid or too financially narrow, it may constrain the firm's ability to respond effectively to operational risk or market change. If it is too loose or fragmented, cost discipline may weaken and value may be lost through drift, inefficiency, or poorly judged trade-offs. The study therefore highlights the need for a balanced model in which governance provides structure, discipline, and accountability, while still allowing firms to respond quickly and intelligently to volatile conditions. This integration is essential because resilient performance in commodity environments depends not only on controlling costs, but on doing so in a way that remains sensitive to operational reality and strategic timing.

The study also contributes to management and strategic finance literature by extending the discussion of cost management beyond conventional notions of control and reduction. It positions cost governance as a broader strategic construct that connects management control, organizational accountability, risk management, and operational decision-making. In doing so, it adds a sector-specific perspective to the literature by focusing on industries where cost behavior is shaped by exceptional capital intensity, technical complexity, and exposure to external shocks. The model contributes to current debates on organizational resilience and strategic adaptation by showing that expenditure decisions in commodity-based firms must be understood as governance issues rather than purely financial adjustments. It also reinforces the idea that high-quality management in uncertain sectors depends not only on analytical tools, but on the institutional and behavioral systems that support sound judgment. This provides a useful foundation for future research on governance maturity, cross-functional decision processes, and the relationship between cost governance and long-term firm performance in resource-dependent industries.

Ultimately, the study concludes that sustainable value creation under uncertainty requires a more disciplined, integrated, and forward-looking approach to cost governance. Mining and energy firms cannot rely on reactive or fragmented methods if they hope to navigate market turbulence while preserving the assets, capabilities, and stakeholder trust on which their future depends. Sustainable value is created not by pursuing cost reduction at all costs, but by governing expenditure in ways that support resilience, protect critical functions, and maintain the flexibility to respond to changing conditions. This requires clarity about which costs preserve value, which create future opportunity, and which can be reduced without undermining the organization's long-term position. In highly volatile commodity environments, such judgment is central to both financial performance and strategic survival. Cost governance, when understood and practiced as an integrated organizational capability, becomes a key mechanism through which firms can adapt responsibly, perform consistently, and sustain value over time despite persistent uncertainty.

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