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The Formation of Carbon Management Accounting Systems: A Systematic Review of Driving Factors, Mechanisms, and Contextual Conditions

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Abstract: This study analyzes the formation of carbon management accounting (CMA) systems through a systematic literature review focusing on driving factors, mechanisms, and contextual conditions. A PRISMA-based SLR yielded 21 final articles from Scopus (2020–2026) selected on the basis of direct conceptual relevance to CMA. Findings reveal that CMA system formation results from the simultaneous interaction of regulatory and internal organizational pressures, carbon information measurement and integration mechanisms, and contextual conditions encompassing industry characteristics, institutional maturity, and carbon financial risk exposure. This study advances theoretical integration within a domain that remains fragmented, offering an explicit multi-dimensional framework with particular implications for firms navigating mandatory sustainability reporting obligations in emerging economy contexts.

Keywords: Carbon Management Accounting, Driving Factors, Mechanisms, Contextual Conditions, SLR.

INTRODUCTION

Climate change has transformed from a peripheral environmental issue into a systemic threat to global economic stability and business continuity. The IPCC (2023) report affirms that without substantial and immediate emission reductions, the economic losses attributable to climate change will surpass the entire cost of transitioning to a low-carbon economy. The international community has responded through the Paris Agreement, aiming to limit the global temperature rise to no more than 1.5 degrees Celsius, thereby compelling each nation to translate this commitment into concrete policies at both national and corporate levels. This global regulatory pressure, combined with intensifying market demands for emissions

transparency, has shifted carbon management from a mere compliance obligation into a core strategic consideration for firms (Aris, et al., 2024; Hazaea et al., 2022).

Indonesia occupies a strategically significant yet challenging position within this transition landscape. As the world's seventh-largest greenhouse gas emitter, Indonesia has reaffirmed its commitment through an Enhanced Nationally Determined Contribution targeting emission reductions of 31.89 percent independently and 43.20 percent with international support by 2030 (ICAP, 2023). This commitment is underpinned by a series of increasingly concrete domestic policies: Presidential Regulation No. 98 of 2021 establishes the legal foundation for carbon economic value, while in September 2023, the Indonesia Carbon Exchange (IDX Carbon) formally commenced operations under the supervision of the Financial Services Authority/ Otoritas Jasa Keuangan (OJK), covering 99 coal-fired power plants representing approximately 37 percent of national generation capacity (ICAP, 2023).

These regulatory developments do not stand in isolation; they constitute part of a broader sustainability architecture that OJK has been progressively constructing. OJK Regulation No. 51/POJK.03/2017 on the Implementation of Sustainable Finance laid the initial foundation, mandating sustainability reporting for issuers and public companies, albeit within a comply-or-explain framework that still affords a degree of flexibility.

OJK Regulation No. 2 of 2023 further mandates ESG disclosure as an integral component of good corporate governance obligations. The most critical milestone in this trajectory is the mandatory full sustainability reporting requirement, effective from 2027, for all Indonesia Stock Exchange-listed companies. This encompasses greenhouse gas emission disclosures (Scope 1, 2, and 3), TCFD-based climate risk assessments, and the establishment of measurable, independently verifiable emission reduction targets (OJK, 2017; OJK, 2023). This shift from comply-or-explain toward full mandatory compliance positions the capacity to build a reliable CMA system not merely as an optional strategic advantage, but as a non-deferrable regulatory prerequisite.

The operational reality of IDX Carbon two years after its launch reveals deeper challenges. Total transaction value has reached only IDR 78 billion with 132 registered participants, far below projected potential (IEEFA, 2025). By comparison, global carbon markets recorded revenues exceeding USD 100 billion in 2024, while the EU Emissions Trading System encompasses more than 11,000 participants with an average carbon price of USD 70 per ton of CO_2 (The World Bank, 2025). The Indonesian government targets transactions of up to Rp 16 trillion at COP30 in Belém, with annual potential estimated at approximately Rp 128 trillion from 13.4 billion tons of CO_2 through 2050 (Jakarta Globe, 2025). This performance gap is not solely attributable to market design shortcomings; it reflects the limited capacity of firms' internal management systems to respond strategically to carbon price signals.

The gap between IDX Carbon's price signals and corporate responses on the ground reflects a more fundamental problem: the absence of a management accounting system capable of translating carbon information into concrete budgeting decisions, performance evaluations, and investment priorities. Swalih, et al. (2024) demonstrate that many organizations implement environmental management accounting practices symbolically without integrating them into meaningful strategic decision-making. Effective CMA encompasses reliable emission quantification, cost-based reduction strategy formulation, and reporting that supports substantive managerial accountability (Abhishek, 2025; Hazaea et al., 2022).

Despite growing academic interest in this topic, the existing literature has yet to comprehensively explain how CMA systems form within organizations. Theoretical fragmentation constitutes the primary impediment: extant studies tend to employ institutional theory, contingency theory, or resource-based view in isolation, leaving no analytical framework capable of holistically explaining the simultaneous interaction among external

pressures, internal capacities, and contextual conditions (Alnaim & Metwally, 2024; Marlowe & Clarke, 2022). This problem is compounded by the tendency of the literature to identify adoption-driving factors rather than examine the concrete mechanisms that link them to actual changes in management accounting practice.

This study addresses these gaps through the Systematic Literature Review (SLR) method. The central research question is: how do CMA systems form within firms, and what driving factors, mechanisms, and contextual conditions shape this process? Specifically, this study examines: (1) the external and internal factors that drive CMA system formation; (2) the mechanisms linking those factors to changes in management accounting practice; and (3) the organizational and environmental contextual conditions that strengthen or impede this process.

The contributions of this study are cumulative. At the conceptual level, this study constructs an integrative analytical framework that explicitly distinguishes among driving factors, mechanisms, and contextual conditions as three analytical dimensions that have never before been systematically synthesized in the literature. At the theoretical level, the integration of institutional theory, contingency theory, and resource-based view within a single coherent explanatory framework fills the fragmentation gap that has long impeded knowledge accumulation. At the contextual level, explicit attention to the relevance of findings for developing countries makes this study one of few that seriously positions Global South energy transitions within the academic discourse of carbon management accounting.

The Oretical Foundation

Carbon Management Accounting (CMA)

Carbon Management Accounting (CMA) is an accounting system that integrates carbon emission information into managerial decision-making processes. CMA has emerged in response to growing demands for transparency and accountability related to climate change (OJK, 2023). Carbon Accounting is an accounting process that aims to measure the amount of carbon dioxide equivalent that will be released into the atmosphere as a result of flexible mechanism projects (Husnatarina, 2024). Abhishek (2025) demonstrates that CMA plays a pivotal role in linking environmental performance with corporate financial performance through the systematic measurement and control of carbon emissions. Sharaf addin (2024) models the Carbon Management Accounting System (CMAS) as a conceptual framework comprising emission measurement components, carbon data interpretation, and reporting integrated with the firm's management control system. CMA implementation enables companies to identify emission sources, manage carbon costs, and improve long-term operational efficiency. In the Indonesian context, Ramadhan et al. (2023) examine the role of accountants as facilitators of net-zero emission programs, focusing on emission measurement, sustainability reporting, and environmental auditing. Ramadhan, Setiawan, & Jimmy, (2025) further identify Strategic Management Accounting as a primary driver of climate action among Indonesian enterprises, particularly in the energy sector, which contributes the largest share of national carbon emissions.

Institutional Theory

Institutional theory, as developed by Dimaggio and Powell (1983), explains that external pressures, including regulations, social norms, and industry practices, shape organizational behavior (Scott et al., 2014). In the context of CMA, coercive pressures (government regulation), normative pressures (professional standards), and mimetic pressures (competitor imitation) drive firms to adopt carbon accounting systems. Alnaim and Metwally (2024) empirically test all three types of institutional pressures as drivers of Environmental Management Accounting (EMA) adoption, moderated by corporate environmental strategy, finding that coercive pressures exert the strongest effect in the context of high-emission

industries. Comite et al. (2025) complement this perspective by demonstrating that actor-networks among regulators, investors, and firms generate collective pressure that intensifies as the global climate agenda escalates. At the corporate level, the role of internal auditors in overseeing ESG practice implementation constitutes an important mechanism that reinforces institutional responses to these pressures (Ramadhan et al., 2023).

Contingency Theory

Contingency theory holds that no single system is universally most effective for all organizations (Fiedler, 1967; Otley, 2016). A system's effectiveness depends on the fit between the system and the organization's internal and external conditions. In the CMA context, factors such as firm size, operational complexity, environmental uncertainty, and industry characteristics shape how organizations design and implement carbon accounting systems. Kazemian et al. (2022) demonstrate that variations in sectoral conditions within Australia's high-emission industries significantly moderate the effectiveness of all three CMA phases (data collection, interpretation, and reporting), affirming the relevance of the contingency approach in CMA system design.

Resource-Based View (RBV)

The Resource-Based View, introduced by (Barney, 1991), emphasizes that a firm's competitive advantage derives from internal resources and capabilities that are valuable, rare, inimitable, and non-substitutable (VRIN). In the CMA context, capabilities such as managerial competence, integrated information systems, and organizational culture play an important role in supporting the formation and implementation of carbon accounting systems. Without adequate internal capability support, external pressures will not produce an effective and substantive CMA system. Burritt et al, (2023), in their twenty-year review of EMA frameworks, demonstrate that organizations that have organically developed CMA capabilities are more likely to integrate them strategically compared to those that merely respond reactively to regulatory pressure. In the Indonesian context, Rifai and Ramadhan (2025) demonstrate that green accounting capabilities significantly influence corporate achievement of Sustainable Development Goals, alongside ESG disclosure and environmental performance.

The three theories outlined above are mutually complementary in explaining the phenomenon of CMA system formation. Institutional theory explains the source of external pressures driving adoption; contingency theory explains why the effectiveness of adoption varies across firms and industries; while the RBV explains why some firms are capable of converting external pressures into competitive advantage through substantive CMA, while others produce only ceremonial adoption. Bui et al. (2022) empirically demonstrate that carbon accounting systems functioning as management control mechanisms significantly moderate the relationship between carbon strategy and emissions performance, confirming the importance of this integrative perspective.

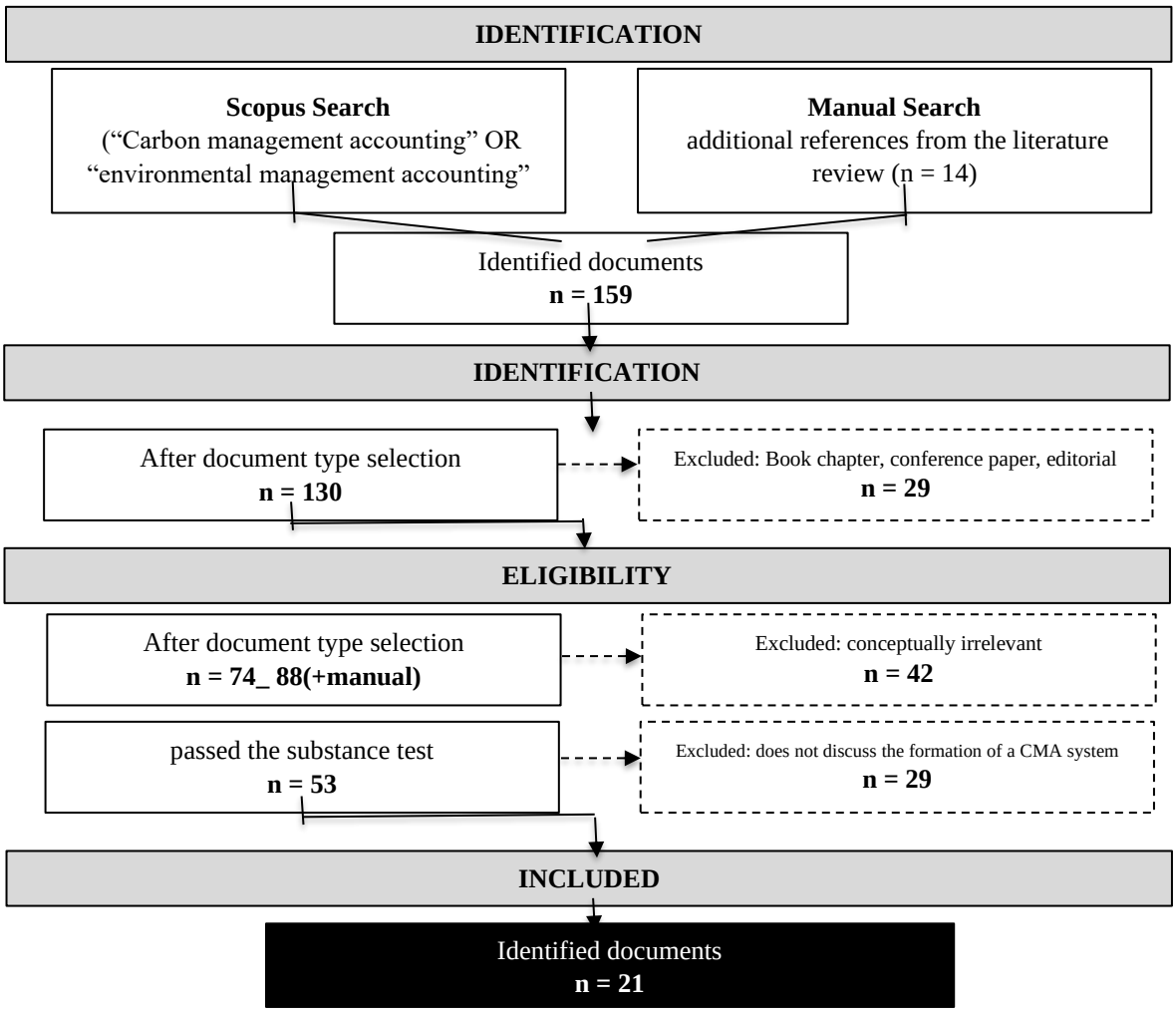
METHODS

This study employs a Systematic Literature Review (SLR) approach, a method that systematically, transparently, and replicably identifies, evaluates, and synthesizes findings from prior research. SLR offers particular relevance for integrating diverse empirical findings from international journals, yielding more robust conclusions than conventional narrative reviews (Booth et al., 2021). This study draws data from scientific articles in the Scopus database covering the period 2020–2026.

PRISMA Framework

This study follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, which encompasses four stages: identification, screening, eligibility, and included. This process enhances the transparency and reliability of research findings (Page et al., 2021). The selection process flow diagram is presented in Figure 1, while Table 1 summarizes all selection stages in detail.

Figure 1. PRISMA Flow Diagram of the Literature Selection Process



Source: Adapted from PRISMA 2020 (Page et al., 2021)

Table 1. PRISMA-Based Literature Selection Process

Stage	Activity	Criteria / Notes	No. of Documents
Identification	Scopus search (title, abstract, keywords) Query: "carbon management accounting" OR "environmental management accounting" AND "strategic" OR "decision making" OR "performance" OR "integration" Year: 2020–2026	All initial document types	159

Stage	Activity	Criteria / Notes	No. of Documents
Screening	Document type and language filtering	Journal articles and reviews only; English or Indonesian; Exclusion: book chapters, conference papers, editorials, retractions	130
Eligibility (1)	Title and abstract screening	Addresses driving factors, mechanisms, implementation conditions, or strategic integration of CMA/EMA. Exclusion: CMA only as background variable or irrelevant industry context	74
Eligibility (2)	Manual search and full-text screening	+14 from manual search → 88 total. Exclusion: full-text not accessible → 53 passed	53
Eligibility (3)	Substantive eligibility evaluation	Conceptual alignment with: driving factors, mechanisms, contextual conditions of CMA. Exclusion: descriptive statistics only, no system formation discussion, performance focus without process	32 excluded
Included	**Final articles for synthesis**	**Direct and comprehensive conceptual relevance to CMA focus**	**21**

Source: PRISMA literature selection results (2026)

Search Strategy

This study searched the Scopus database using the following query: ("carbon management accounting" OR "environmental management accounting") AND ("strategic" OR "decision making" OR "performance" OR "integration"), restricting the publication year to 2020–2026. The search covered titles, abstracts, and keywords. This temporal boundary ensures the relevance of findings to the most recent developments in global and domestic carbon policy, particularly given the accelerating pace of Paris Agreement implementation over the past five years.

Inclusion and Exclusion Criteria

Inclusion Criteria:

1. Scientific journal articles or review articles indexed in Scopus;
2. Written in English or Indonesian;
3. Addresses CMA or EMA in the context of strategy, decision-making, performance, or internal integration;
4. Demonstrates direct conceptual relevance to at least one of the three analytical dimensions: driving factors, mechanisms, or contextual conditions of CMA.

Exclusion Criteria:

1. Book chapters, conference papers, editorials, and retraction notices;
2. Articles addressing carbon accounting techniques exclusively without connection to managerial decision-making;
3. Purely environmental or technical engineering studies without a management accounting dimension;
4. Articles focused on performance outcomes without explaining the CMA system formation process.

Data Analysis

This study analyzed data through a narrative-thematic approach. Each article that passed the selection process was coded according to analytical dimension (driving factors, mechanisms, contextual conditions), research method, geographic context, and primary conceptual contribution. The research team subsequently grouped these codes to identify patterns, gaps, and consistent findings across studies. Two members of the research team independently conducted the coding process, reconciling their results to ensure interpretive consistency.

RESULTS AND DISCUSSION

Selection Results and Article Distribution

Of the 159 documents identified in the initial search, the PRISMA selection process yielded 21 final articles demonstrating direct and comprehensive conceptual relevance to the research focus. Table 2 below presents all 21 selected articles along with their respective analytical dimensions and research methods. Although the literature search covered the 2020–2026 period, all articles meeting the final criteria and passing substantive synthesis originated from the publication period 2021–2026.

Table 2. List of 21 Selected Articles for Synthesis Analysis

No.	Author(s)	Year	Short Title	Analytical Dimension	Method
1	Abhishek N.	2025	CMA: Enhancing Transparency and Accountability	Driving Factor	Empirical (PLS-SEM)
2	Aris N.M. et al.	2024	Bibliometric Analysis of CMA	Framework/SLR	Bibliometric
3	Alnaim M. & Metwally A.B.M.	2024	Institutional Pressures and EMA Adoption	Driving Factor	Empirical (Regression)
4	Mahmoudian F. et al.	2021	Inter/Intra-Org Stakeholder in CMA	Mechanism	Empirical (Qualitative)
5	Sharaf-Addin H.H.H.	2024	CMAS and Corporate Environmental Performance	Mechanism + Framework	Conceptual
6	Bui B. et al.	2022	CAS Moderating Strategy and Carbon Performance	Mechanism	Empirical (CDP Data)
7	Alhumoudi H. et al.	2024	MFCA and LCA Integration in CMA	Mechanism	Conceptual/Review
8	Xia L. et al.	2025	EMA, CEM and ESG Performance	Mechanism	Empirical (Regression)
9	Liew C.Y. & Cao Y.	2025	Carbon Accounting in Green SCM	Framework/SLR	SLR
10	Kasperzak R. et al.	2023	Carbon Emissions Reporting under GHG Protocol	Mechanism	Descriptive Analytical

No.	Author(s)	Year	Short Title	Analytical Dimension	Method
11	Kazemian S. et al.	2022	CMA in Australia's High-Emission Industries	Contextual Condition	Empirical (Qualitative)
12	Barani O. et al.	2025	EMA Drives Performance: Meta-Analysis	Contextual Condition	Meta-Analysis
13	Sitompul M. et al.	2023	Carbon Management Strategy and Financial Performance	Framework/SLR	SLR
14	Houqe M.N. et al.	2024	Business Strategy and Carbon Emissions (US Firms)	Driving Factor	Empirical (Panel Data)
15	Marlowe J. & Clarke A.	2022	Carbon Accounting: SLR and Future Research	Framework/SLR	SLR
16	Hazaea S.A. et al.	2023	Past, Present and Future of Carbon Accounting	Framework/SLR	Comprehensive Review
17	Swalih M.M. et al.	2024	EMA for Strategic Decision-Making	Framework/SLR	SLR
18	Burritt R.L. et al.	2023	EMA Framework – 20 Years Development	Framework/SLR	Framework Review
19	Comite U. et al.	2025	Accounting for Climate Change: Temporal Analysis	Framework/SLR	SLR (ANT)
20	Syam M.A. et al.	2024	Carbon Accounting and Corporate Sustainability Reports	Mechanism	Empirical
21	Wang Q.	2023	Financial Effects of Carbon Risk and Disclosure	Framework/SLR	Literature Review

Source: SLR-PRISMA literature selection results (2026)

Table 2 reveals that the 21 selected articles employ a diverse range of research methods: quantitative empirical (regression, panel data, PLS-SEM), qualitative empirical, meta-analysis, bibliometric, SLR, and conceptual framework review. This methodological diversity strengthens the validity of the synthesis, as findings converging across multiple methodological approaches carry greater credibility. Table 3 presents the distribution by analytical dimension.

Table 3. Distribution of Articles by Analytical Dimension

Category	N	Key References
Driving Factors (External & Internal)	3	Abhishek (2025); Alnaim & Metwally (2024); Houqe et al. (2024)
Mechanisms (Measurement, Integration, Control)	7	Alhumoudi et al. (2024); Bui & Nurul (2022); Kasperzak et al. (2023); Mahmoudian et al. (2021); Sharaf addin (2024); Syam et al. (2024); Xia et al. (2025)

Contextual Conditions	2	Barani et al. (2025); Kazemian et al. (2022)
Conceptual Frameworks & SLR	9	Aris, et al. (2024); Burritt et al. (2023); Comite et al. (2025); Hazaea et al. (2022); Liew & Cao (2025); Marlowe & Clarke (2022); Sitompul et al. (2023); Swalih et al. (2024); Wang (2023)
Total	**21**	—

Source: Thematic analysis results (2026)

Of the 21 selected articles, eight employ empirical methods (quantitative or qualitative), six utilize SLR or literature review approaches, three are based on bibliometric and meta-analytic methods, and four are conceptual in nature. Empirical articles primarily explain the driving factors, mechanisms, and implementation of CMA, while review and conceptual articles strengthen the theoretical synthesis of carbon accounting and EMA developments. Geographically, the majority of studies focus on developed countries such as Australia, the United States, and the European Union, with some studies addressing the Asian context and global analysis. This distribution indicates that CMA literature continues to be dominated by developed-country contexts, thereby reinforcing the urgency of more specific research in the Indonesian context.

Thematic Analysis

1. Driving Factors for CMA Adoption

Among studies addressing driving factors, the literature demonstrates that a combination of external pressures and internal firm capabilities drives CMA formation. From the external perspective, government regulation, carbon trading schemes, and emission reporting obligations constitute the primary drivers compelling firms to develop carbon accounting systems (Abhishek, 2025; Alnaim & Metwally, 2024). Additionally, mimetic pressures from industry competitors and normative pressures through international standards such as GRI and ISO 14064 further reinforce CMA adoption (Aris et al., 2024; Comite et al., 2025). These findings align with Dimaggio and Powell (1983) institutional theory on isomorphism mechanisms.

From the internal perspective, top management commitment and information system capabilities emerge as critical factors supporting the integration of CMA into strategic decision-making (Abhishek, 2025). Firms with a strong sustainability orientation are more likely to develop substantive CMA systems compared to those focused solely on formal compliance. Furthermore, Houqe et al. (2024) demonstrate that business strategy type influences firms' responses to environmental pressures, with prospector-type firms tending to invest more proactively in carbon management systems compared to defender-type firms. In the Indonesian context, Ramadhan et al. (2025) also affirm that Environmental Management Accounting (EMA) supports corporate environmental performance and the implementation of corporate climate action.

Overall, cross-study findings indicate that CMA formation is not driven by a single factor but by the interaction between external pressures and firms' internal resources. From the Resource-Based View perspective (Barney, 1991), internal capabilities constitute the critical determinant of CMA implementation effectiveness.

2. Mechanisms of CMA Formation

A review of studies focused on mechanisms reveals that CMA formation proceeds through three primary, interrelated mechanisms that collectively constitute the actual CMA implementation process within organizations. The first mechanism is emission calculation and measurement, encompassing Scope 1, 2, and 3 emission inventorying in accordance

with GHG Protocol standards. Kasperzak et al. (2023) demonstrate that measurement approaches such as equity share, operational control, and financial control influence both the scope and accuracy of emission data used in managerial decision-making. These findings indicate that the choice of carbon measurement method determines the quality of information generated within the CMA system. Moreover, Liew and Cao (2025) extend this perspective by emphasizing the importance of Scope 3 emission measurement through Green Supply Chain Management, given the growing demand for comprehensive carbon reporting throughout the corporate value chain. Consequently, the quality and consistency of emission data form the primary foundation of CMA effectiveness and determine the reliability of carbon information available to management (Hazaea et al., 2022).

The second mechanism is the integration of carbon information into budgeting, performance evaluation, and pricing systems. Sharaf Addin (2024) explains that effective CMA positions carbon information not merely as a reporting instrument but as a substantive basis for investment decisions, cost control, and corporate performance measurement. Bui et al., (2022) reinforce this finding by demonstrating that carbon accounting systems function as control mechanisms that strengthen the relationship between carbon strategy and corporate emission performance. Additionally, Alhumoudi et al., (2024) demonstrate that integrating Material Flow Cost Accounting (MFCA) and Life Cycle Assessment (LCA) extends carbon cost measurement to the product life cycle, though this approach demands more complex data collection and analytical processing. In the Indonesian context, Ramadhan et al. (2025) further affirm that strategic management accounting plays an important role in supporting corporate climate action through the integration of environmental information into strategic and operational decisions. Syam et al. (2024) likewise demonstrate that the integration of carbon accounting into corporate sustainability reporting systems strengthens corporate transparency and accountability toward stakeholders.

The third mechanism is inter-organizational and intra-organizational stakeholder coordination. Mahmoudian et al., (2021) find that coordination among internal departments and relationships with suppliers, business partners, and external stakeholders directly shapes CMA effectiveness. Such coordination is necessary to ensure that carbon information is used consistently across all corporate business processes. Xia et al. (2025) complement these findings by demonstrating that Carbon Emission Management (CEM) functions as a more comprehensive nexus between EMA and corporate ESG performance, extending beyond emission reduction to encompass broader corporate sustainability value enhancement.

Collectively, these three mechanisms are mutually dependent. Accurate emission measurement forms the foundation for carbon information integration, while effective integration requires adequate stakeholder coordination. CMA formation therefore necessitates the ongoing development of organizational capabilities to ensure that the constructed system is not merely administrative in nature but also supports strategic corporate decision-making.

3. Contextual Conditions Influencing CMA Formation

An analysis of studies focused on contextual conditions reveals that the effectiveness of CMA driving factors and mechanisms is strongly shaped by the organizational and environmental conditions within which firms operate. Three primary contextual conditions that consistently emerge in the literature are industry characteristics and emission intensity, institutional maturity, and carbon financial risk exposure. These three conditions do not operate linearly; rather, they interact and collectively shape a distinct CMA implementation landscape within each sectoral context.

Industry characteristics and emission intensity constitute the most consistently identified contextual condition in the literature. Kazemian et al. (2022) evaluate CMA practices in Australia's high-emission industries and find that sectors with high emission exposure and regulatory pressure tend to develop more systematic CMA systems, although implementation effectiveness still varies due to differences in operational processes, cost structures, and sector-specific reporting requirements. Of the 21 synthesized articles, at least nine explicitly situate high-emission sectors as the primary research context, which can be grouped into four categories: energy and mining (Kazemian et al., 2022; Ramadhan, et al., 2025); energy-intensive manufacturing (Alhumoudi et al., 2024; Xia et al., 2025); utilities and power generation (Bui et al., 2022; Kasperzak et al., 2023); and supply chains and commodity exports (Kasperzak et al., 2023; Liew & Cao, 2025; Marlowe & Clarke, 2022; Sitompul et al., 2023). These four categories are discussed in greater depth below, as they carry direct implications for the readiness of Indonesian firms to build reliable CMA systems.

a. Energy, Mining, and Utilities Sector

Kazemian et al. (2022) examine CMA practices in coal mining, oil and gas, and fossil fuel power generation sectors in Australia. This study demonstrates that CMA implementation proceeds through three primary stages: emission data collection, emission intensity analysis, and disclosure to both regulators and investors. Findings also indicate that operational characteristics vary across industry sub-sectors and directly affect CMA measurement accuracy. Open-cut mines tend to have more straightforward emission measurement compared to underground mines, which face greater measurement complexity.

These findings are directly relevant to Indonesia, as IDX Carbon has covered 99 coal-fired power plants representing approximately 37 percent of national generation capacity since 2023 (ICAP, 2023). Firms in this sector face pressures from the emission trading scheme and the 2027 mandatory sustainability reporting obligation. Kasperzak et al. (2023) demonstrate that the choice of GHG Protocol approach, such as operational control or equity share, can affect the quantity and boundary of emissions reported. Firms therefore need consistent carbon accounting policies to ensure that emission reports possess adequate comparability.

Bui et al. (2022) also find that CMA integrated into management control systems is more effective in supporting emission reductions than CMA deployed solely for formal reporting purposes. This indicates that CMA must be integrated into budgeting and performance evaluation processes in order to substantively support strategic decision-making.

b. Energy-Intensive Manufacturing Sector

In the manufacturing sector, Xia et al. (2025) find that Environmental Management Accounting (EMA) practices, particularly Eco-Efficiency Improvement and Environmental Cost Tracking, enhance corporate ESG performance. Carbon Emission Management (CEM) further strengthens the EMA–ESG performance relationship, indicating that integrating carbon emission management into management accounting systems generates competitive advantage for firms.

Alhumoudi et al. (2024) also demonstrate that the integration of Material Flow Cost Accounting (MFCA) and Life Cycle Assessment (LCA) assists manufacturing firms in identifying the hidden costs of material inefficiencies related to carbon emissions. This approach is considered more accurate than measurement focused solely on direct energy costs, particularly in high-emission industries such as cement.

In the Indonesian context, the 2027 sustainability reporting obligation will require firms in the cement, steel, petrochemical, and pulp-paper sectors to disclose Scope 1 and Scope 2 emissions, and to begin mapping Scope 3 emissions. Firms therefore require CMA systems integrated with internal information systems to enable emission measurement and reporting processes to be conducted more effectively and efficiently.

c. Supply Chain and Commodity Export Sector

Liew and Cao (2025) find that Scope 3 emissions originating from transportation, product use, and supply chains dominate the total carbon footprint of retail, food and beverage, and commodity export firms. However, Scope 3 measurement remains a primary challenge due to its dependence on data from numerous suppliers with varying capability levels. Marlowe and Clarke (2022) further affirm that Scope 3 measurement remains one of the foremost issues in the carbon accounting literature.

In the Indonesian context, export firms in the palm oil, rubber, and forestry sectors face growing pressure to measure Scope 3 emissions in response to the implementation of the EU Deforestation Regulation (EUDR). This compels firms to build CMA systems capable of tracing emissions across the entire supply chain. Sitompul et al. (2023) also demonstrate that integrated carbon management strategies have a positive relationship with corporate long-term financial performance.

d. Carbon Financial Risk in High-Emission-Intensity Firms

The literature demonstrates that carbon risk increasingly shapes corporate financial dimensions, including financial performance, cost of capital, and market valuation. Firms with high emission intensity face the risk of stranded assets, defined as the potential erosion in value of fossil fuel-based assets as energy transition accelerates and decarbonization pressure intensifies (Wang, 2023). Beyond industry characteristics, the business strategy orientation management adopts further shapes corporate responses to carbon regulatory pressure. Prospector-type firms invest more proactively in CMA systems as part of strategic adaptation, while defender-type firms respond more reactively as regulatory pressure rises (Houqe et al., 2024). These findings indicate that CMA formation readiness depends not only on industry emission levels but equally on management's strategic orientation and risk perception.

In the Indonesian context, increasing transparency in carbon disclosure and the 2027 mandatory sustainability reporting obligation are driving firms to integrate CMA with financial risk management. Beyond industry characteristics, institutional maturity and capital market pressures also influence CMA implementation effectiveness. Barani et al. (2025) demonstrate that countries with more mature environmental regulations and larger-sized firms tend to have more effective CMA implementation. Wang (2023) further affirms that institutional investor pressure can accelerate CMA adoption even before regulatory obligations are fully enforced. Overall, contextual conditions such as industry characteristics, institutional maturity, and capital market pressures interact in influencing the effectiveness of CMA implementation within each firm.

4. The 2027 Sustainability Reporting Obligation as a Critical Contextual Condition for CMA Formation in Indonesia

One of the contextual conditions that distinguishes Indonesia from the majority of contexts in the CMA literature is the existence of a mandatory, deadline-bound sustainability reporting obligation. Through its Sustainable Finance Roadmap Phase II (2021–2025), OJK targets full sustainability reporting implementation for all issuers by 2027 (OJK, 2017; OJK, 2023). Unlike the preceding comply-or-explain approach, this

obligation encompasses greenhouse gas emission disclosures, TCFD-based climate risk assessments, and verifiable emission reduction targets. This condition positions the CMA system as a strategic compliance prerequisite rather than merely a voluntary reporting tool.

This obligation is directly linked to the three CMA mechanisms identified in this study. On the measurement dimension, firms need to develop emission inventorying systems based on GHG Protocol or ISO 14064. On the integration dimension, carbon information needs to be incorporated into budgeting and performance evaluation processes rather than used solely for formal reporting. On the coordination dimension, sustainability report preparation requires cross-functional coordination among finance, operations, environmental, and legal units.

However, regulatory pressure may also drive ceremonial CMA adoption. Alnaim and Metwally (2024) demonstrate that coercive pressure without internal capability support can produce CMA systems oriented purely toward formal compliance. Accordingly, the effectiveness of sustainability reporting depends not only on the disclosure of emission data but also on the integration of carbon information into corporate decision-making systems.

Thus, 2027 is not merely an administrative compliance deadline; it is equally a capability-building deadline for CMA. Firms that do not begin constructing substantive CMA systems early risk encountering technical barriers, ESG reputational pressures, and intensifying transparency demands from institutional investors. Meeting this deadline demands that firms treat CMA not as a compliance exercise but as a substantive organizational transformation.

Synthesis: Integrative Analytical Framework

Drawing on the findings from the three analytical dimensions discussed above, this study constructs an integrative analytical framework as presented in Table 4. This framework explains CMA system formation as a staged and mutually dependent process among three primary dimensions. External driving factors (regulation, market pressure, international standards) operate jointly with internal driving factors (management commitment, information system capabilities, organizational culture) to trigger the CMA formation process. However, this process will yield a substantive, rather than merely ceremonial, CMA system only when supported by the appropriate mechanisms: accurate emission measurement, integration of information into strategic decisions, and effective stakeholder coordination. This entire process is then mediated by contextual conditions comprising industry characteristics, institutional maturity, business strategy type, and carbon financial risk exposure.

Table 4. Integrative Analytical Framework for CMA System Formation

A. DRIVING FACTORS	B. MECHANISMS	C. CONTEXTUAL CONDITIONS
Regulatory and carbon policy frameworks (IDX Carbon, Presidential Regulation 98/2021, POJK 51/2017; OJK Sustainability Roadmap 2027) Market and investor pressures International standards (GRI, TCFD) Top management commitment Information systems capability Organizational sustainability culture	Scope 1, 2, 3 emission measurement (GHG Protocol) Integration into budgeting and performance evaluation Carbon-based product pricing Inter/intra-organizational stakeholder coordination Technical instruments: MFCA, LCA, CEM Internal reporting and control	Industry characteristics and emission intensity (energy, manufacturing, supply chain, finance) National EMA institutional maturity Firm size and operational complexity Business strategy type (prospector vs. defender) Carbon financial risk exposure Developing vs. developed country context
▼ Simultaneous Interaction of Three Dimensions ▼		
OUTPUT: SUBSTANTIVE CMA SYSTEM		
Reliable emission measurement • Integration into strategic decisions • Carbon-based control and reporting		

Source: Synthesis from 21 selected articles (2026)

This integrative framework has several practical implications relevant to Indonesian firms currently facing pressures from IDX Carbon and the 2027 mandatory sustainability reporting obligation. First, firms should begin by strengthening emission measurement capabilities as an indispensable technical foundation. Second, investment in ERP systems or emission management technology must be accompanied by business process changes ensuring that carbon information is genuinely used in operational and strategic decisions. Third, the effectiveness of the CMA system should be assessed not on the basis of formal compliance but on the extent to which carbon information alters decision-making behavior across multiple organizational levels.

This framework also identifies areas where Indonesia faces specific limitations that must be addressed: relatively low institutional maturity (Barani et al., 2025), a carbon market still in its early stages of development (IEEFA, 2025), and a limited body of Indonesia-based data that could serve as benchmark material. These conditions reinforce the urgency of further empirical research specifically examining CMA system formation within the Indonesian institutional and regulatory context.

Implications and Research Agenda

The findings of this study carry implications at three levels. At the academic level, these results reinforce the need for a multi-theoretical approach in examining CMA, wherein the integration of institutional theory, contingency theory, and RBV generates a more comprehensive explanation than any single theory alone. Relevant future research agendas include: (1) empirical studies that quantitatively test the relationships among the three dimensions within this framework; (2) cross-industry comparative research in Indonesia to identify the most significant specific contextual conditions; and (3) longitudinal studies that document the evolution of CMA systems in response to changes in domestic carbon policy, particularly following the implementation of the 2027 mandatory sustainability reporting obligation.

At the policy level, these findings imply that the effectiveness of IDX Carbon depends greatly on the capacity of participating firms to operationalize substantive CMA systems. Regulators should consider incentives that promote the development of internal corporate capabilities, beyond mere reporting compliance, alongside the integration of CMA into strategic decision-making as part of a comprehensive carbon market policy design.

At the practical level, these findings provide guidance for corporate management in allocating investments for CMA system development in a staged manner: beginning with measurement (Phase 1), integration into management systems (Phase 2), and optimization through supply chain coordination and capital market reporting (Phase 3). This investment sequence reflects the hierarchy of mechanisms identified in this study and must be executed before the 2027 reporting obligation deadline.

CONCLUSION

This study concludes that the formation of a Carbon Management Accounting (CMA) system is a multi-dimensional process that cannot be explained by any single factor. A synthesis of 21 articles from the Scopus database (2020–2026) identifies three dimensions operating simultaneously and interdependently.

First, the driving factors for CMA formation are dual in nature: external institutional pressures (regulation, industry norms, international standards) and internal organizational capabilities (management commitment, information systems, sustainability culture) must coexist to produce a substantive CMA system. The absence of either will result in symbolic or ceremonial adoption. Empirical evidence from studies employing diverse methods and geographic contexts consistently confirms this finding.

Second, the mechanisms of CMA formation are hierarchical. Accurate emission calculation and measurement (Scope 1, 2, and 3 per GHG Protocol) constitute the foundation enabling the integration of carbon information into strategic decisions (budgeting, pricing, performance evaluation), which is subsequently reinforced through inter-organizational and intra-organizational stakeholder coordination. Failure at the first mechanism limits the effectiveness of the entire system, as demonstrated by the seven studies examining the mechanism dimension.

Third, contextual conditions, encompassing industry characteristics and emission intensity, national institutional maturity, business strategy type, and carbon financial risk exposure, significantly moderate the effectiveness of CMA driving factors and mechanisms. High-emission-intensity industries exhibit substantially different CMA capability profiles, implying that policymakers must design national CMA capability enhancement programs on a sector-specific basis. These findings carry particular relevance for Indonesia, where a substantial gap persists between national carbon regulatory ambitions (IDX Carbon, Presidential Regulation 98/2021, and the 2027 mandatory sustainability reporting obligation) and corporate implementation capacity at the firm level. Regulation alone will be insufficient. Substantive progress requires the systematic development of internal corporate capabilities that translate external regulatory pressure into embedded management practice.

The primary contribution of this study is the construction of an integrative analytical framework linking these three dimensions within a single coherent explanatory model, filling the theoretical fragmentation gap that has long impeded knowledge accumulation in the CMA field. For future research, it is recommended that empirical studies quantitatively testing this framework within the context of Indonesian firms be conducted, particularly in sectors directly affected by IDX Carbon policies.

This study has limitations arising from its restriction to the Scopus database, meaning that articles in other databases (Web of Science, Google Scholar) are not covered. Furthermore, as an SLR, this study does not generate new empirical findings but rather synthesizes existing ones. These limitations may be addressed in future research through a combination of multi-database SLR and primary empirical studies in the Indonesian context.

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