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Environmental Management Accounting Implementation Challenges and Supply Chain Management in Emerging Economies' Manufacturing Sector

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Abstract: Environmental management accounting (EMA) implementation challenges within supply chain management systems (SCMSs) and environmental awareness in emerging economies should be addressed for sustainable development. Therefore, this study explores EMA implementation challenges in the supply chain in manufacturing to propose a framework to guide manufacturing companies to achieve a cleaner production chain. After conducting an extensive literature review on literature related to EMA in developing countries, challenges characterising EMA implementation have been identified. These include incoherent government policies and regulations; unavailability of resources; technological incapability; inadequate training and expertise; allocation of environmental costs; and environmental reporting. Hence, it is suggested that manufacturing companies must understand the financial and environmental benefits of achieving cleaner production through implementing EMA. Managers can make more environmentally friendly decisions based on their supply chain using the developed framework. Regulators may need key regulatory framework reforms and policies to monitor and assess environmental compliance throughout the supply chain. Longitudinal and quantitative data from manufacturing companies in developing countries are suggested to validate the existence of EMA implementation challenges.

Keywords: developing economies; environmental management accounting practices; manufacturing; sustainable supply chain management

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1. Introduction

Environmental management accounting (EMA) implementation challenges in supply chain management systems (SCMSs) and environmental awareness in emerging economies should be addressed for sustainable development. Therefore, this article's two (2) main objectives are to identify EMA implementation challenges in SCMSs and propose a framework to guide manufacturing companies to achieve a cleaner production chain. The motivation to address EMA implementation challenges in SCMSs emanated from the global agenda [1] to end environmental challenges, particularly in the manufacturing sector [2]. Many studies confirmed that the manufacturing and extractive industries contribute significantly to environmental challenges through carbon emissions and water and air pollution [3,4]. Ref. [5] posit that several manufacturing industries contribute significantly to pollution, including petroleum refineries, iron and steel, pulp and paper, metal products, industrial chemicals, and leather products. Therefore, fostering EMA implementation in the manufacturing sector presents opportunities for businesses to contain the negative impact of their operations on the environment [6].

EMA allows organisations to implement various practices such as energy accounting (EA), water management accounting (WMA), material flow accounting, biodiversity accounting, and carbon management accounting (CMA) for improved financial and environmental performance [7]. It has been noted that EMA implementation would result in

improved efficiency leading to lower energy, water, and material cost and usage [8]; maintenance of the natural ecosystem [9]; formulation of environmentally sensitive decisions; improved quality; and competitive advantages [10]. However, the uptake of EMAPs in the manufacturing sector in developing countries has also come under the spotlight. With so many challenges characterising the SCMSs, [11] acknowledged that there is evidence of manufacturing companies' involvement in EMAPs. However, most organisations are encountering challenges such as limited knowledge and training; and difficulties defining, separating, classifying, measuring, and controlling environmental protection costs.

Furthermore, under-reporting of sustainability issues; lack of agreement on performance measures [12,13]; lack of resources, knowledge, and government support [14,15]; failure to allocate environmental cost; and inaccurate environmental costing [16] were also identified. According to [17], developing economies face many barriers to implementing EMAPs, such as a lack of institutional and stakeholder pressures, inadequate technological capabilities, and non-compliance with local government regulations. Therefore, without exploring other approaches to enhance EMA's implementation in the manufacturing sector, achieving sustainable SCMSs might remain a pipe dream.

As the management of the supply chain issues continue to attract the attention of many stakeholders, such as government, society, and companies, as environmental sustainability issues require redress, a slow uptake in EMA adoption is being experienced. Various studies focussing on EMA practices (EMAPs) in developing countries have been done, with much focus on material flow cost accounting (MFCA) [18–20]. Studies that researched EMAPs have also contributed to the discourse [20–22]. Other studies acknowledge that EMA adoption in developing countries is still an issue. However, progress has been made [23–25]. Therefore, this suggests that challenges in terms of EMA implementation still require urgent attention and raises questions about the low adoption of EMA, particularly in developing countries. In an attempt to improve the uptake of EMAPs in SCMSs, the study seeks answers to the following questions:

RQ1: Why are most manufacturing companies failing to implement EMAPs to manage their supply chain?

RQ2: What are the challenges confronting the implementation of EMAPs in supply chain management?

RQ3: How can implementing EMAPs into a framework address the sustainable supply chain challenges?

The researchers established a lack of data, leadership, skills, and frameworks to deal with environmental cost allocation and universally measurable performance indicators as the most significant EMA implementation challenges in SCMSs. The study further suggests that poor implementation of various EMAPs due to the challenges tends to impact materials, water, and energy usage negatively. Therefore, the study proposed a framework regarded as a roadmap to achieve sustainable SMCSs in the manufacturing sector as it offers a twin solution that addresses financial and environmental concerns.

The layout of the article is as follows: In Section 1.1, our approach to using propositions is outlined. This is followed by the background on the need for EMA in SCMS in Section 1.2. Section 3 discusses the materials and methods, including the research methodology. This is followed by the findings and a discussion leading to the conceptual framework followed by the theoretical validation of the framework in Section 4. Finally, the article concludes with conclusions and directions for future work in Section 5.

1.1. The Use of Propositions

The study investigates EMA implementation challenges characterising supply chains in developing countries to propose a conceptual framework that manufacturing companies could use to achieve sustainable supply chain systems. Due to the nature of the research

problem, the study utilises qualitative propositions formulated based on an extensive literature review.

1.2. Background on the Need for EMAPs in the Supply Chain Management System

Environmental accountability has continued to push organisations to divulge information on the impacts of their activities on the environment [4], which has led to EMA's growth [26]. Historically, EMA emerged in the early 1990s and was initiated by the Environmental Protection Agency in the United States of America (USA). This led to the widespread adoption of environmental-related management initiatives [26]. The formalisation of EMA was a result of the efforts of three (3) institutional stakeholders, namely USEPA, which drew an environmental accounting practice; the United Nations Division for Sustainable Development, which issued the first new workbook on EMA in 2001; and the International Federation of Accountants, which issued a guidance note on EMA. Additionally, several individuals contributed to EMA to enhance the understanding of EMA [27,28].

EMA, as a growing discipline, has emerged to assist companies in utilising accounting information to make internal decisions regarding environmentally sensitive decisions [3,29–31]. EMA branched from corporate environmental management accounting, bringing a new dimension by formalising environmental management as a business function [32]. As EMA remains evolving, a universally accepted definition is yet to be agreed upon. However, despite a lack of consensus on the definition of EMA, the need to identify, collect, analyse, and measure the use of energy, water, and materials within their supply chains brought a paradigm shift in accepting the full spectrum of environmental information for companies' decision-making processes.

Despite the lack of a standard definition, the adoption of EMA across the world within supply chains continues to gain attention. EMA has become an essential component in the decision-making process in management accounting, particularly within the complex SCMSs that result from many forces, including globalisation, recognition of dimensions of sustainability, and cost-effective transportation channels [33]. While the link between EMA and sustainable supply chain management continued to receive academic attention in the past decades [34], progress in implementing EMAPs in developing countries, particularly Africa, continues to gain momentum, with many scholars showing interest [17,20,22].

The association between EMA and supply chain management has created a debate in the manufacturing sector, with many studies alluding to the fact that EMAPs improve environmental and financial performance [35,36]. However, several studies have identified barriers to implementing EMAPs in general [2,17]. According to [6], a systematic review of barriers to adopting EMA in small Chinese companies identified a lack of regulatory pressures and fewer expectations from the various stakeholders as barriers. While [37] blamed a lack of company leadership focus and commitment and absence of skills, Ref. [17] pointed to non-compliance with government laws and regulations and inadequate technological capabilities [31]. In other cases, managerial environmental concerns and green absorption capacity are critical factors in innovation performance [38]. Furthermore, it has been established that the attitude of management and the company's culture can hinder the effective implementation of environment-related decisions [39]. Ref. [40] asserts that a lack of managerial incentives for managing environmental costs and failure to account for negative environmental management contributes significantly to the barriers to EMA implementation.

Consequently, content proposition 1 can be formulated as follows:

Proposition Pc1*: The implementation of EMA is mainly determined by many factors, such as:*

- *Government laws and regulations;*
- *Technological capabilities;*
- *Skills and training;*
- *Strategic leadership;*
- *Attitude and culture of management;*
- *Management of environmental cost.*

There has been a surge in problems relating to achieving sustainable supply chain management in developing countries [41,42]. This is against the backdrop of raising environmental awareness in the manufacturing sector to reduce water, energy, and material use to improve environmental performance. The adoption of EMA in developed countries continues to improve unabated, as many companies have since introduced ways of addressing environmental challenges associated with their operations. Though other studies suggested that EMAPs are key to addressing green supply chain management issues in developing countries [34,43], EMA implementation challenges are still rife [44]. Therefore, this raises questions regarding the commitment of companies in developing countries to achieving sustainable SCMSs. It seems to this study's researchers that an analogy to the implementation challenges is that despite efforts by manufacturing companies to promote EMA implementation in developing economies, the adverse environmental consequences due to poor management of the supply chain system remain a significant concern. Therefore, it is imperative to propose a framework to adopt EMAPs in SCMSs in the context of the manufacturing sector in developing economies.

2. Literature Review

2.1. Challenges of Adopting Specific Environmental Management Accounting Practices in Supply Chain Management

Implementing EMAPs in supply chain management is a concern in the manufacturing sector. In pursuance of a better environmental performance agenda, companies fail to adjust because of specific institutional changes that influence standards, regulatory frameworks, and operational strategies [45]. In most cases, various forms of institutional isomorphism enforce organisations to conform to EMAPs, including mimetic, cohesive, and normative pressures [17]. Despite the pressure to adopt EMAPs, manufacturing companies are still facing challenges.

Therefore, this section discusses the challenges facing the manufacturing industry when implementing WMA, biodiversity accounting, CMA, EA, and waste management accounting to address the research objectives.

2.1.1. Water Management Accounting

WMA aims to track inflows and outflows, assets, liabilities, inventories, and reserves for a particular area over time, the outcomes of which are vital for current and future water management decisions [37]. The study and practice of furnishing information to enhance water management by companies are termed water management accounting [46]. Even though water has not received the same magnitude of attention as climate change and biodiversity, there has been an upsurge in corporate practices linked to water management since the early 2000s [47]. The challenges in water include identifying water accounting measures and metrics to assess certain matters, such as water quality and limitations in capacity for making long-term predictions [48]. These challenges are exacerbated by the absence of a history of national standard setting and enforcement, and the absence of international collaboration in developing national standards, which together spawn challenges to developing a global approach to WMA [49].

Ref. [50] argues that collecting and disseminating meaningful water-related information is a complicated undertaking. Another pertinent challenge regarding water management accounting pertains to the water footprint (WF), which is meant to encourage consumers, companies, and governments to pay attention to direct and indirect water use [51]. According to [52], a water footprint can be subdivided into three (3) categories, namely blue WF (the amount of underground and surface water resources consumed in the product supply chain), green WF (water that is stored in the unsaturated soil and consumed by vegetation evapotranspiration), and grey WF (polluted water during production). The green WF is only related to the agricultural sector. However, there are challenges concerning the calculation of grey water due to the complexity and concentration of sewage and the deficiencies of a unified quantitative method [53]. Green water is often ignored in water

resource management and regulations due to its invisibility in the landscape and difficulty in using it for other purposes except for indirect allocation through land use [54].

Recognising the lack of water management in the corporate sector, [48] calls for establishing information systems to back up management decisions in which water is, explicitly or implicitly, implicated. By implication, the existing water management frameworks seem to have inadequate information systems to leverage upon. [55] points out the following reasons for the lack of systems to measure performance across companies: non-standardised data, poor technological integration, geographical and cultural differences, differences in company policy, lack of agreed-upon metrics, or poor understanding of the need for inter-company performance measurement.

The following propositions of content and association stem from the literature above:

Proposition Pc2*: Challenges of water management accounting are multifaceted, and therefore the effectiveness of WMA in achieving sustainable SCMSs can be through considering the following elements:*

- *National standard setting;*
- *Water accounting measures;*
- *Lack of supply chain-related data;*
- *Management of water-related information.*

Consequently:

Proposition Pa1*: There is a shared association between manufacturing companies' water management accounting and supply chain management systems.*

2.1.2. Waste Management Accounting

Several research works have utilised system dynamics modelling in waste management [1,49,50]. The studying and management of complex feedback systems to deal with a substantial scale plus complex systems are termed system dynamics [49,50]. In a different set-up, however, with the same objective of waste management accounting, [51] applied the 3R strategy as an effective tool in waste management. The principle is to utilise the concepts that form the basis of the circular economy: Reduce, Reuse, and Recycle. However, various impediments were encountered and amongst them were the following: Reduce: Waste management is the ultimate goal; however, a lack of design standards and inappropriate urban planning hinders it. Reuse: The goal is to use relevant building material again for its original purpose or to fulfil a different assignment. However, the challenges of a lack of guidance for effective waste collection and sorting, lack of knowledge and standards for reused waste, and underdeveloped markets for reused waste are ubiquitous. Recycle: This entails breaking down used items to make new materials and objects. Application of this strategic practice faces challenges ranging from ineffective management systems, immature recycling technology, underdeveloped markets for recycled waste products, and immature recycling market operations.

Governance practices are also interlinked with aspects of waste management accounting. A case in point is that at least 12 Sustainable Development Goals (SDG) out of 17 goals of the 2030 Agenda for Sustainable Development, adopted by 193 United Nations member states in September 2015, have a direct link with solid waste management [56]. However, the prevalence of measurement challenges or quantification [57], together with problems of calculating and monitoring, leads to the problems of depicting, which refer to sustainability challenges such as food waste production at various steps of the food supply chain. These are frequently difficult to measure, calculate, and monitor, making it very challenging to address these issues with governance instruments [58].

Whichever strategic practice is implemented, there seems to be a substantial inefficient use of valuable resources within the food system resulting in the undermining of food security with clear-cut contributions to environmental pollution and natural resource depletion [59]. Therefore, it is important to note the multifaceted nature of factors that in-

fluence food waste generation to comprehend the challenges in deploying EMAPs in waste management. Among them are product-related, technological, behavioural, legislative, and societal factors—however, the relevance of such factors, which are context-specific, results in predictability challenges [60].

The Food Loss and Waste Accounting and Reporting Standard [61] can be used to determine a reasonable trade-off between resources used for waste quantification and relevance, completeness, consistency, transparency, or accuracy. However, in analysing challenges about food waste accounting, [62] identified the lack of a clear and consensual food waste definition and what [63] termed a harmonised methodology which entailed clarification of definitions and terminology as well as system boundaries and units of measurement. Furthermore, the lack of data and standard methods to assess the effectiveness of different interventions, such as food loss, waste accounting and reporting standards, are obstacles to identifying best preventive practices [64]. Several negative outcomes are associated with the challenges mentioned above, including the incomparability of data across countries and the difficulties in quantifying other waste streams, such as liquid waste. Resultantly, a key proposition emanates and is as follows:

Proposition Pc3*: Whichever strategic practice is implemented to address waste management accounting challenges, without considering the following factors, the achievement of sustainable SCMSs remains an outstanding issue:*

- *Data management;*
- *Waste reporting;*
- *Quantification of waste streams;*
- *Comparability of data;*

Resultantly:

Proposition Pa2*: There is an association between waste management accounting and sustainable SCMSs.*

2.1.3. Carbon Management Accounting

Enhancing the management of carbon emissions and the development of cleaner production can be a daunting task for companies and industries [65]. The intricacies of CMA can be seen in the contradictions in industry dynamics. Increasingly, the convergence of CMA approaches, such as organisation accounting and product carbon accounting, is becoming evident. Companies are battling with the idea of product carbon accounting, which aims to account for the carbon impact of their whole product range [47]. Organisation carbon accounting entails measuring and analysing a company's carbon emissions as a legal entity and setting targets for reducing carbon emissions [44]. Hence, the challenges stem mainly from measuring and analysing carbon emissions. Despite these challenges, carbon management accounting cannot be compromised if the proper response to greenhouse gas (GHG) emissions is to be sustainable.

CMA can also be enhanced by proactively embedding carbon management strategies to instil carbon-conscious thinking into business practice [61]. However, the business nature and regulatory setting could be hindrances, especially when they are not aligned with business strategy [62]. Furthermore, [63] established overall shifts to more corporate carbon disclosure strategies as a way of enhancing CMA.

Proposition Pc4*: In CMA, enhancing the management of carbon emissions and the development of cleaner production is daunting for companies and industries unless the following issues are considered:*

- *Measuring and analysing carbon emissions;*
- *Environmental cost reduction;*
- *Allocation of carbon cost;*

- *Technological capabilities;*
- *Effective carbon management strategies.*

Resultantly:

Proposition Pa3*: There is an association between CMA and SCMSs.*

2.1.4. Biodiversity Accounting

Preservation and maintenance of natural capital are crucial amid raising concerns about the depletion of natural resources and interference with the natural ecosystem [66]. Efforts to promote biodiversity within the SCMS are evidenced by adopting biodiversity accounting which is concerned with accounting for biological plants, including flora and fauna and all inhabitants within the natural ecosystem [9]. Corporate biodiversity accounting and reporting seek to capture vital information concerning biodiversity management by considering the agreed set of credible and valid quantitative and qualitative indicators [67]. Despite many benefits of biodiversity accounting, including improving environmental and financial performance [68], reduction of water and air pollution [69], land appreciation, and reduction of stormwater floods [70], challenges regarding the implementation of biodiversity management accounting still exist. According to [71], assessing biodiversity performance is still a substantial challenge as developed biodiversity indicators in a business context are not widely translatable across heterogeneous contexts, making it extremely difficult for the company to manage biodiversity performance.

Additionally, another challenge relating to biodiversity accounting is directly linked to the under-reporting within the broader management accounting system in addition to sporadic and limited quantitative data and narratives on managing biodiversity [67]. Given the complexity of the ecosystem, particularly with richness, diversity, and abundance, identifying a limited set of biodiversity indicators that explicitly and implicitly communicate various aspects of biodiversity has proved difficult [12,72]. Therefore, it is clear that problems in the implementation of biodiversity accounting are pervasive in the manufacturing sector, and as such, we propose the following content proposition.

Proposition Pc5*: The adoption and implementation of biodiversity accounting in managing SCMSs in the manufacturing sector are characterised by many factors:*

- *Performance indicators;*
- *Reporting of biodiversity performance;*
- *Skills in data sourcing.*

Consequently:

Proposition Pa4*: There is an association between biodiversity accounting and SCMSs in manufacturing companies.*

2.1.5. Energy Accounting

The growing demand for energy driven by high domestic usage and heavy industrialisation worldwide continue to be topical in debates on sustainable development [73]. Therefore, there is a need to reduce energy consumption within the supply chain. Energy accounting has been considered the proper practice to monitor and analyse energy usage within the supply chain for improved energy efficiency [8,74]. Energy efficiency as a function of energy accounting results in endless benefits to the company's supply chain ranging from cost savings, improved profitability, quality and competitiveness, and increased environmental awareness [7,10,75]. Additionally, energy efficiency monitoring, audits, and benchmarks are vital for energy management, as they allow decision-makers to keep track of and identify potential improvement opportunities, and keep track of the effects of decisions regarding energy use [76]. However, despite the associated benefits of

energy efficiency, there are many challenges and barriers to effectively implementing energy accounting within the supply chain. Most companies fail to achieve energy efficiency because of a lack of capital to invest in energy-efficient technology [77], lack of awareness regarding life cycle cost effects [75], limited resources to manage renewable energy sources, low rate of return from renewable energy, lack of knowledge, lack of management support, government policy, and lack of supplier involvement [14]. On the same note, ref. [2] investigated barriers and overcoming strategies to supply chain sustainability innovation and found that lack of technical knowledge and training, the high initial cost of technology, and lack of innovation capacities are associated with fear of diverting from traditional technology. Therefore, based on the challenges discussed, the implementation of energy accounting remains an evolving issue in managing supply chain systems. Based on this, we propose content and association propositions, respectively, as follows:

Proposition Pc6*: Energy accounting allows the effective implementation of energy efficiency strategies for improved probability, competitiveness, and quality within the supply chain; however, the following challenges still exist:*

- *Government policy;*
- *Management support;*
- *Technical knowledge and training;*
- *Available resources;*
- *Supplier involvement.*

Resultantly:

Proposition Pa5*: There is an association between energy accounting and SCMSs in the manufacturing sector.*

2.1.6. Accounting for Material

Material flow cost accounting (MFCA) has gained momentum in recent years as the need to trace, control, and monitor the loss of water, material, and energy remains a global goal [27]. MFCA is beneficial in the supply chain as it results in efficiency and reduces costs and waste. Additionally, MFCA is regarded as a practice to improve financial-economic performance within the supply chain of various companies [78,79]. Ref. [13] acknowledged that MFCA is associated with improving eco-efficiency. However, one of the challenges regarding its implementation lies in the current accounting system, which relies on limited data and insufficient cost allocation. [80] identified various challenges/barriers inhibiting the implementation of MFCA in the supply chain. These barriers include vendor constraints that can create delays; lack of support from the management and financial incentives; and failure to overcome the traditionalist view held by most companies which advocate that improvement in environmental performance is a cost of the company that does not translate to profitability. Additionally, a lack of team cooperation in the company may make it difficult to measure, monitor, and allocate environmental costs [79]. The lack of a performance appraisal framework that recognises the impacts of environmental actions by individuals and departments heavily impacts the efforts to advance MFCA narratives in a company [81]. Inadequate expertise and training are challenges that adversely affect MFCA through inaccurate identification of environmental costs, with some companies failing to allocate to their cost centre properly. Treating environmental costs under general company overheads suggests a narrow focus on manufacturing operations to apply EMA [16]. Other scholars viewed the application of MFCA in the production process as complicated since it is not always followed by the execution for improvement [82]. Therefore, the existential challenge of MFCA application within the supply chain poses challenges that lead to the suggestion of the following propositions.

Proposition Pc7*: Material flow cost accounting (MFCA) enhances the tracing, control, and monitoring of water, material, and energy losses for improved supply chain management. However, the proper implementation may be hindered by the following factors:*

- *Training and expertise;*
- *Allocation of environmental costs;*
- *Performance appraisal management.*

Resultantly:

Proposition Pa6*: There is an association between accounting for material and SCMs.*

2.2. The Role of Environmental Management Accounting in Promoting Sustainable Supply Chain Management Systems

Emphasising the managerial requirements for EMA to support sustainable supply chain management, [65] further captures the strategic importance of EMA to furnish detailed information not only to comply with environmental standards or reduce environmental risks but also to establish sustainable supply chain decisions. On the question of the links between EMA and supply chain management, [83] reiterated that the extent of sophistication provided by EMA support relies on the needs of the manager, the industry, the size of the company, the scope of activities, and whether the decision affects the short or long run. In an attempt to mitigate the risks posed by carbon emissions in the supply chain, large and powerful buying companies within the supply chain will deploy strategies aimed at responding to EMA concerns through advancements in the design, acquisition, production, distribution, use, reuse, and disposal of a company's goods and services [84]. EMA's usefulness in sustainable supply chain management is evident when one considers that without considering business partners' carbon emission performance throughout the supply chain, the measurement and reporting of carbon emissions for products and production becomes incomplete [65]. EMA, therefore, plays a critical role in considering the role played by all partners in the supply chain. Consequentially, complex organisational operations can be simplified. Similarly, ref. [85] noted the pivotal role of EMA in supplying the practices to support sustainable supply chain goals concerning accounting for eco-efficiency.

Through open communication structures, EMA can provide a platform for effective cost reduction in the supply chain systems through logistical enhancements and efficient production designs [44]. The application of both Physical EMA (PEMA), which includes the flow of water and energy, and Monetary EMA (MEMA), which measures the costs of the company's consumption of natural resources and costs for controlling environmental damages, can lead to the identification of cost savings opportunities [35]. According to [48], various practices of EMA are applied in the supply chain and expressed in voluntary international standards, including ISO14051 and ISO145052. ISO14051 involves MFCA in managing upstream and downstream supply chain collaborations, whilst ISO14052 avails more specific guidelines for practising in broader supply chain settings. This leads to a general proposition.

Proposition Pg1*: Adopting EMA is key to promoting sustainable SCMSs in manufacturing companies.*

Proposition Pa7*: There is an association between EMA and SCMs.*

3. Materials and Methods

The methodological orientation of the research hinges on the research onion developed by [86]. Figure 1 depicts the layers of an onion. The research onion provides a systematic approach when deciding on the research design. In the present study, it is deemed that an interpretivism philosophy is appropriate based on the following reasons: Researchers mainly acquire a deeper understanding of the studied phenomenon [87]. Interpretivist

approaches highlight human intentionality as a key determinant of behaviour, in addition to other internal and external causal factors [88]. In line with these reasons, concepts flowing from the literature review were subjected to interpretations. Research approaches such as deductive and inductive are located in the second layer. An inductive approach is suitable for advancing knowledge and generating new theories [89], hence its adoption in this research, with the specific aim of developing a conceptual framework from related literature. Verification of the framework also entails adopting the deductive research approach. A mono-qualitative methodological choice was employed following a literature survey strategy. Using a qualitative design through an extensive literature review is not new, as various studies are based on a comprehensive literature review [87]. Several strategies can be employed, which can be referred to as a general way that assists the researcher in choosing the main data collection methods or sets of methods to answer the research question and meet the research objectives [90]. For the study, the strategy that was followed entailed literature found through Google Scholar to identify research on EMA and supply chain management (SCM) in developing countries.

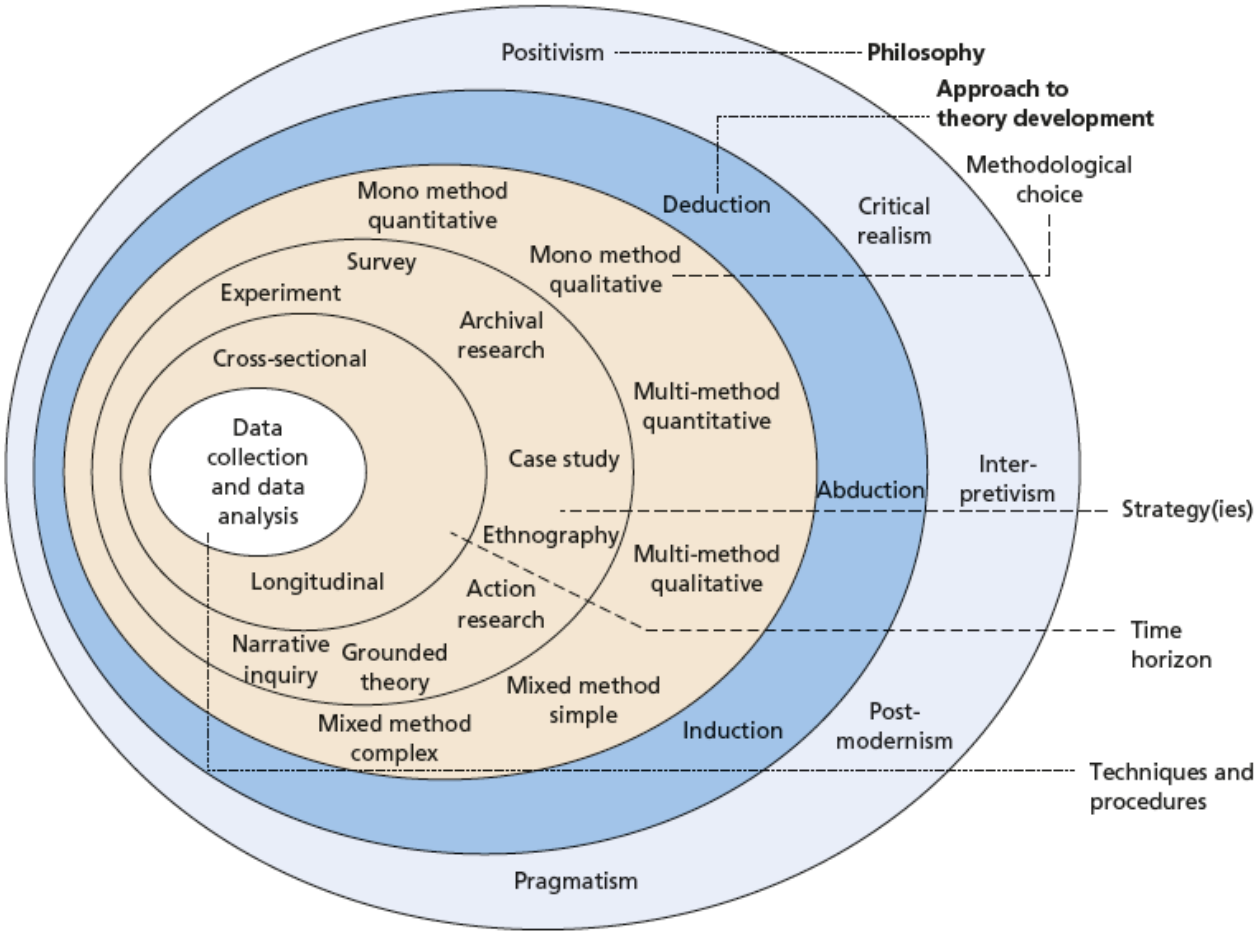

Figure 1. The research onion [86], p. 130 (Source: The research onion diagram is ©2018 Mark Saunders, Philip Lewis, and Adrian Thornhill and is reproduced in this article with their written permission).

To locate the article, keywords such as EMA, EMAPS, supply chain management, supply chain, green supply chain, sustainable supply chain, water accounting, water management accounting, material flow cost accounting, biodiversity accounting, energy accounting, energy management accounting, carbon accounting, carbon management accounting, and waste management accounting. A content analysis of all the identified articles, selected following the keywords, was conducted.

The time horizon of the research is cross-sectional, as the research was done at a specific time. Since the implementation of EMA in developing countries is still an ongoing process, the data for the study had no time frame, as EMA studies in developing countries are limited. The most relevant studies were analysed, and their findings provided the basis for developing propositions. Three (3) propositions from the literature reviewed were utilised in building the conceptual framework and categorised as content, general, and association propositions.

4. Findings

Based on the literature review, qualitative propositions which proposed the association between EMAPs and SCMSs were formulated. The three (3) sets of propositions suggested are content, association, and general propositions. Information in Table 1 shows a summary of propositions. Given that the study aimed to establish the EMA implementation challenges in the SCMSs, the comprehensive literature review provided a foundation for developing the propositions. Therefore, the generated propositions represent the general statements representing the general view of the study findings deduced by the comprehensive literature review.

Table 1. Summary of propositions.

Proposition Nr	Propositions Description
	Content Propositions
Pc1	The implementation of EMA is mainly determined by many factors, such as: • Government laws and regulations; • Technological capabilities; • Skills and training; • Strategic leadership; • Attitude and culture of management; • Management of environmental cost.
Pc2	Challenges of water management accounting are multifaceted, and therefore the effectiveness of WMA in achieving sustainable SCMSs can be through considering the following elements: • National standard setting; • Water accounting measures; • Lack of supply chain-related data; • Management of water-related information.
Pc3	Whichever strategic practice is implemented to address waste management accounting challenges, without considering the following factors, the achievement of sustainable SCMSs remains an outstanding issue: • Data management; • Waste reporting; • Quantification of waste streams; • Comparability of data;
Pc4	In CMA, enhancing the management of carbon emissions and the development of cleaner production is daunting for companies and industries unless the following issues are considered: • Measuring and analysing carbon emissions; • Environmental cost reduction; • Allocation of carbon cost; • Technological capabilities; • Effective carbon management strategies.
Pc5	The adoption and implementation of biodiversity accounting in managing SCMSs in the manufacturing sector are characterised by many factors: • Performance indicators; • Reporting of biodiversity performance; • Skills in data sourcing.

Table 1. *Cont.*

Proposition Nr	Propositions Description
Pc6	Energy accounting allows the effective implementation of energy efficiency strategies for improved probability, competitiveness, and quality within the supply chain; however, the following challenges still exist: • Government policy; • Management support; • Technical knowledge and training; • Available resources; • Supplier involvement.
Pc7	Material flow cost accounting (MFCA) enhances the tracing, control, and monitoring of water, material, and energy losses for improved supply chain management. However, the proper implementation may be hindered by the following factors: • Training and expertise; • Allocation of environmental costs; • Performance appraisal management.
	Association propositions
Pa1	There is a shared association between manufacturing companies' water management accounting and supply chain management systems.
Pa2	There is an association between waste management accounting and sustainable SCMSs.
Pa3	There is an association between CMA and SCMSs.
Pa4	There is an association between biodiversity accounting and SCMSs in manufacturing companies.
Pa5	There is an association between energy accounting and SCMSs in the manufacturing sector.
Pa6	There is an association between accounting for material and SCMs
Pa7	There is an association between EMA and SCMs.
	General Propositions
Pg1	Adopting EMAPs is key to promoting sustainable supply chain management systems in manufacturing companies.

Based on the three kinds of propositions developed through the literature review and summarised in Table 1, the conceptual framework of the research is presented in Figure 2. Content propositions are contained in the blocks in Figure 2, whereas the association propositions link the blocks.

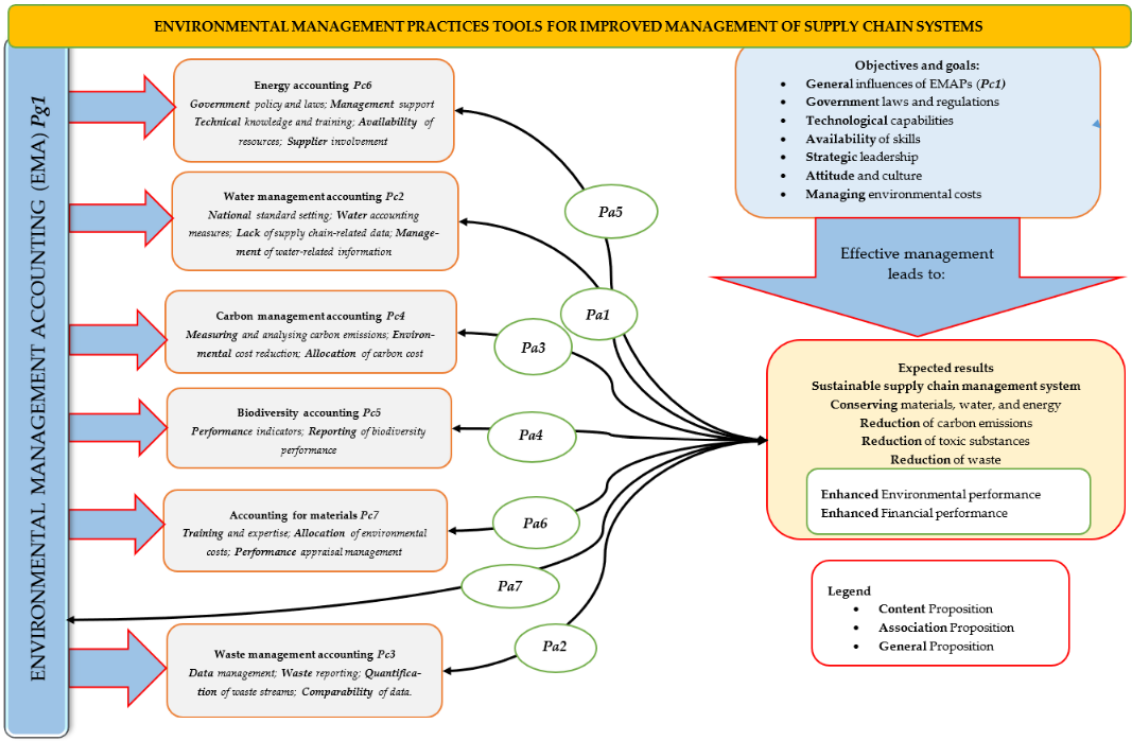

Figure 2. Conceptual framework to address the implementation challenges of EMAPs in supply chain management systems (Researchers' construct).

Validation of the Framework

As depicted in Figure 2, the conceptual framework to address the implementation challenges of EMAPs in SCMSs is mainly informed by three (3) propositions. First, content propositions in the blocks summarise manufacturing companies' challenges when implementing EMAPs within their SCMSs. Second, association propositions are simple statements that propose an association between EMAPs and SCMSs and are depicted through links joining different blocks. Lastly, the general proposition is a statement that assumes that the adoption and implementation of EMA are imperative to achieving sustainable SCMSs.

The implementation of EMAPs in the manufacturing sector is mainly determined by many influences, as shown in the framework. First, government laws and regulations should create an environmentally friendly environment that allows companies to address environmental challenges within the supply chain. Second, the introduction and availability of new technology are imperative when implementing EMAPs in manufacturing, as new machines tend to save materials and energy. Third, the intellectual capacity to initiate, innovate, and apply EMAPs is an important requirement for managing supply chain systems. Fourth, strategic leadership provides direction to the company regarding making environmentally friendly decisions that impact SCMSs. Lastly, managing environmental costs is a significant issue in ensuring the successful implementation of EMAPs in managing supply chain systems in the manufacturing sector. Therefore, the successful adoption and implementation of EMAPs in the manufacturing industry are determined by adequately managing the abovementioned factors, as shown in Figure 2.

The framework further notes that implementing various EMAPs is confronted with multiple challenges. The support of management towards formulating energy efficiency policies in the company is key to energy savings. While technical knowledge and training in the company can ensure the proper implementation of energy accounting (EA), the availability of resources ensures the physical capacity to manage EA strategies for improved SCMSs. Suppliers have great potential to influence EA decisions, as they have the potential to introduce green management strategies starting from the grassroots of the supply chain. Water management accounting (WMA) is another EMAP that ensures water efficiency in the supply chain. Its application in supply chain management is mainly determined by water-related information and data management, lack of supply chain-related data, and water accounting data. Given these shortcomings in WMA, reporting on water use continues to create divergent views, therefore creating challenges in managing supply chain systems.

Reduction of carbon through implementing CMA measures is necessary is sustainable production. The framework suggests that measuring and analysing carbon emissions are still challenges confronted by manufacturing companies in managing supply chain systems. On the other hand, the allocation of carbon costs within the supply chain creates another challenge in reducing environmental costs. While biodiversity accounting presents potential opportunities for companies to maintain and preserve the natural environment, the issues relating to disagreements on biodiversity performance indicators and the reporting format remain a hindrance to effectively accounting for biodiversity. Additionally, accounting for material, popularly known as MFCA, ensures the reduction of waste efficiency in material use. However, the capacitation of employees through providing training that enables them to allocate environmental costs within the supply chain system effectively is one way of overcoming unsustainable production practices. To ensure the employees are implementing MFCA effectively, performance appraisal management can be employed to assist with the contribution of everyone within the supply chain.

Waste accounting, data management, and reporting pose a significant challenge in cleaner production practices. As such, national standards should be set to allow data comparability and quantification within the supply chain. Therefore, addressing specific challenges confronting manufacturing companies in implementing EMAPs is given priority, and cleaner production is mainly to be achieved.

Over and above, through addressing EMAPs implementation challenges in SCMSs, manufacturing companies are most likely to achieve cleaner production in the form of reduced energy, water, and material use. Additionally, improved efficiency in the supply chain leads to a reduction in toxic substances and waste. Hence, the implementation of EMAPs should not be taken for granted. Despite the benefits mentioned above of EMAPs in sustainable SCMSs, companies continue to enjoy the benefits of improved financial and environmental performance. Therefore, EMAPs should be implemented for sustainable development.

5. Conclusions and Future Studies

In this article, we identified and evaluated EMAPs implementation challenges faced by manufacturing companies in particular developing countries. The research aimed to find a solution to EMAPs implementation challenges in SCMSs in manufacturing companies for improved environmental and financial performance.

The article further established that sustainable SCMSs could improve environmental and financial performance through water, energy, and material savings. Additionally, companies can improve efficiency in the supply chain, reducing waste. However, despite the benefits of EMAPs, manufacturing companies in developing countries struggle to overcome various challenges. The synthesis of the extant literature reveals that general factors that influence EMA implementation in the supply chain are multifaceted, including technological capabilities, strategic leadership, government laws and regulation, attitude, and management culture. Therefore, for companies to achieve sustainable SCMSs, it is important to ensure that the adoption and implementation of EMA are effectively managed.

Furthermore, the literature notes that various EMAPs such as EA, CMA, and accounting for material, waste management accounting, and WMA are characterised by many challenges. These are government policy and regulation, available resources, training and expertise, allocation of environmental costs, and environmental reporting. It has been revealed in the literature that by addressing these challenges, manufacturing companies can easily address environmental challenges emanating from the supply chain.

To achieve the research objective, we developed three (3) sets of propositions: content, association, and general. These propositions were formulated based on the literature synthesis and are imperative in proposing the conceptual framework to address the implementation challenges of EMAPs in sustainable SCMSs.

The findings have implications for various groups of stakeholders. For managers in the manufacturing sector, there are implications regarding improving the implementation of EMAPs in the SCMSs, particularly, ensuring leadership is making envisioned environmental decisions that result in better environmental and financial performance. For regulators, key reforms in the regulatory frameworks should be instituted, and policies to monitor and assess environmental compliance throughout the supply chain in developing countries. Finally, regarding other stakeholders such as communities and non-governmental organisations, collaborative reporting and whistleblowing on manufacturing companies that discharged waste in undesignated places ensured their voices were heard, calling for cleaner production.

Despite achieving the objective, the study limitations relate to the selection of a limited number of EMA studies that have been done in Africa. Additionally, by employing a literature survey, the findings are based on secondary qualitative data, which is subjective and may lead to interpretation bias. Therefore, per the proposed conceptual framework in Figure 2, further research could introduce a quantitative method to investigate management's perceptions regarding various challenges encountered in implementing EMAPs in manufacturing companies. Additionally, researchers could focus on longitudinal data companies to empirically validate the relationship between identified EMA implementation challenges, and environmental and financial performance in manufacturing companies.

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