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The synergy of activity-based costing (ABC) and the theory of constraints (TOC) in environmental cost management

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ABSTRACT

This study aims to examine the integration of Activity-Based Costing (ABC) and the Theory of Constraints (TOC) as a conceptual framework for developing environmentally conscious and efficient environmental cost management. A systematic literature review was conducted on twenty relevant scientific publications to identify key patterns, findings, and integration opportunities between the two approaches. The results indicate that ABC enhances the accuracy of environmental cost information by tracing activity-based sources of energy waste, emissions, and waste generation, while TOC focuses on identifying and managing systemic constraints that limit efficiency and sustainability in production processes. The integration of ABC and TOC provides a comprehensive environmental cost management framework that goes beyond economic efficiency and strengthens organizational awareness of ecological limits. Conceptually, this synergy contributes to the advancement of environmental accounting as a knowledge-based system that links economic value with ecological responsibility and offers future development potential through digital technologies such as big data analytics, the Internet of Things (IoT), and artificial intelligence–based environmental management.

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1. INTRODUCTION

The transformation of contemporary business paradigms reflects a significant shift from an exclusive focus on economic value creation toward sustainability-oriented value creation. In this evolving context, companies are no longer perceived solely as profit-driven entities, but as organizational actors with social and environmental responsibilities. Economic activities are inherently embedded within natural systems, and the exploitation of resources without ethical consideration generates not only financial costs but also ecological and social consequences. Accordingly, modern accounting is increasingly expected to function as an information system capable of capturing the interaction between economic activities and environmental sustainability to support informed managerial decision-making (Burritt & Schaltegger, 2014; Deegan, 2017; Gray, 2010; Supriyono & Arfianti, 2020).

The paradigm shift from cost minimization to eco-efficiency fundamentally redefines the role of modern managerial accounting. Rather than serving merely as a mechanism for monitoring operational expenses, managerial accounting increasingly assumes a strategic role in guiding organizations toward sustainable value creation. Eco-efficiency emphasizes the optimization of resource use and the reduction of environmental impacts per unit of value generated, which requires

accounting systems to integrate physical environmental data with monetary cost information. Consequently, managerial accounting becomes an enabler of sustainability-oriented decision-making, where economic performance is evaluated alongside environmental outcomes, and efficiency is interpreted as the alignment of operational processes with long-term ecological and social objectives (Burritt & Schaltegger, 2014; Deegan, 2017; Gray, 2010; Schaltegger & Burritt, 2010).

Although Environmental Management Accounting has evolved to address sustainability demands, the literature reveals conceptual limitations that call for an integrative Activity-Based Costing–Theory of Constraints framework. Existing EMA studies largely rely on ABC to improve environmental cost identification and allocation but often overlook systemic interdependencies and capacity constraints, while TOC-focused research emphasizes system-wide optimization with limited attention to detailed environmental cost generation at the activity level. This separation creates a theoretical gap in which environmental costs are visible yet lack strategic prioritization, and constraints are identified without adequate cost-based justification. Integrating ABC and TOC therefore provides a more coherent framework by linking detailed environmental cost information with a systemic understanding of operational and ecological constraints, enabling prioritized and sustainability-oriented managerial decision-making (Cooper & Kaplan, 1991; Goldratt, 1990; Madanhire & Mbohwa, 2016; Supriyono & Arfianti, 2020; Tsai et al., 2012).

Environmental Management Accounting (EMA) strengthens this perspective by expanding the role of accounting beyond conventional monetary measurement. EMA incorporates environmental costs as integral components of organizational performance, reflecting resource consumption, waste generation, and emissions associated with production processes. Through EMA, organizations are encouraged to understand not only the magnitude of environmental costs incurred, but also their sources and implications for sustainable operations (Burritt et al., 2002; Ferreira et al., 2010; Ningsih & Putri, 2022; Schaltegger & Burritt, 2010).

Within this framework, Activity-Based Costing (ABC) provides a more refined approach to identifying and managing environmental costs. Traditional costing systems often rely on generalized allocation methods that obscure the relationship between organizational activities and their environmental impacts. In contrast, ABC traces costs to specific activities and cost drivers, thereby revealing how human actions, resource consumption, and ecological burdens are interconnected. By mapping activities and identifying cost drivers, ABC enables organizations to detect inefficiencies such as excessive energy use, waste generation, and unsustainable consumption patterns (Arfan & Ratmono, 2019; Dewi & Santoso, 2020; Rahayu & Puspitasari, 2021; Wahyuni & Rahmawati, 2021).

However, accurate identification of environmental costs alone is insufficient without an understanding of system-wide limitations. The Theory of Constraints (TOC) offers a complementary perspective by viewing organizations as integrated systems whose performance is restricted by specific constraints. These constraints are not regarded as weaknesses, but as critical factors that determine overall system capacity. TOC emphasizes that meaningful improvement begins with identifying and managing key constraints rather than indiscriminately expanding resources (Goldratt, 1990; Rini & Haryanto, 2022).

In the context of environmental management, constraints may take the form of energy-intensive processes, waste-generating activities, or operational policies that hinder sustainability efforts. TOC highlights the limited capacity of natural systems to absorb waste and regenerate resources, thereby encouraging organizations to recognize environmental limits as essential considerations in operational decision-making. By prioritizing critical environmental constraints, organizations can improve performance while maintaining ecological balance (Hasanah & Kusuma, 2023; Supriyono & Arfianti, 2020).

The integration of Activity-Based Costing and the Theory of Constraints offers a comprehensive framework for environmental cost management. While ABC provides detailed, activity-level information on where environmental costs occur, TOC explains why such costs persist by identifying systemic bottlenecks that constrain sustainable performance. This integration enables

organizations to align accurate cost information with strategic priorities for improvement (Cooper & Kaplan, 1991; Goldratt, 1990; Madanhire & Mbohwa, 2016; Tsai et al., 2012).

From a sustainability perspective, the synergy between ABC and TOC supports managerial decision-making that balances economic efficiency with environmental responsibility. Cost data generated through ABC serve as an analytical foundation, while TOC principles guide the prioritization of actions toward critical environmental constraints. Consequently, managerial decisions become more proactive and value-oriented, promoting economic sustainability as an outcome of effective environmental management rather than as an isolated objective.

Accordingly, this study aims to conceptually examine the synergy between Activity-Based Costing and the Theory of Constraints in environmental cost management by synthesizing relevant literature and developing an integrated theoretical framework. This framework is expected to provide a foundation for future empirical research and to contribute to the accounting literature by aligning cost efficiency with environmental sustainability.

2. RESEARCH METHOD

This study adopts a Systematic Literature Review (SLR) approach as the primary analytical framework. The SLR method is employed to systematically identify, evaluate, and synthesize findings from previous studies in order to obtain a comprehensive understanding of the synergy between Activity-Based Costing (ABC) and the Theory of Constraints (TOC) in environmental cost management. Through this approach, the study not only compiles conceptual insights but also identifies dominant patterns and theoretical developments within the field of environmental and managerial accounting.

The literature collection process was conducted through systematic searches of major academic databases, including Google Scholar, Scopus, ScienceDirect, and the Garuda Portal, using keywords such as Activity-Based Costing, Theory of Constraints, environmental cost management, eco-efficiency, and green accounting. The review covered relevant publications in Indonesian and English, with inclusion criteria emphasizing relevance to ABC and/or TOC applications in environmental cost management, methodological rigor, and contributions to sustainability-oriented managerial accounting. The analysis was carried out in three stages: descriptive analysis to identify study characteristics, thematic analysis to classify key findings, and synthesis analysis to construct an integrated conceptual framework positioning the ABC–TOC synergy as a sustainability-oriented model for environmental cost management.

The selection of the publication period from 2000 to 2024 enables a longitudinal analysis of the conceptual evolution of Activity-Based Costing, the Theory of Constraints, and environmental management accounting. This time frame captures the transition of ABC and TOC from tools primarily focused on cost accuracy and operational efficiency toward frameworks increasingly embedded in sustainability-oriented and eco-efficiency perspectives. Early studies emphasize internal process optimization and throughput improvement, while more recent literature reflects a growing concern with environmental accountability, resource limitations, and systemic sustainability. By integrating both foundational and contemporary studies, this review identifies theoretical continuities, conceptual shifts, and emerging patterns in the literature, thereby strengthening the analytical depth and robustness of the proposed ABC–TOC framework for environmental cost management in response to contemporary sustainability challenges.

3. RESULTS AND DISCUSSIONS

Research Results

This study synthesizes findings from twenty peer-reviewed publications selected through a Systematic Literature Review to examine the synergy between Activity-Based Costing (ABC) and the Theory of Constraints (TOC) in environmental cost management. The results are organized into three main thematic findings: (1) the role of ABC in identifying environmental costs, (2) the contribution of TOC in managing environmental constraints, and (3) the integrative impact of ABC–TOC on sustainable cost management.

Identification and Transparency of Environmental Costs through ABC

The reviewed literature consistently shows that Activity-Based Costing (ABC) improves the accuracy and transparency of environmental cost identification by directly tracing costs such as energy consumption, waste treatment, and carbon emissions to the activities that generate them. Prior studies (Arfan & Ratmono, 2019; Dewi & Santoso, 2020; Wahyuni & Rahmawati, 2021) indicate that traditional costing systems often obscure environmental costs through indirect allocations, whereas ABC reveals hidden cost drivers associated with environmentally intensive activities. By linking costs to specific operational processes, ABC enhances managerial awareness of resource-inefficient activities and provides a more reliable basis for cost control and environmental decision-making, with empirical evidence further demonstrating that ABC-based carbon cost measurement can lead to measurable emission reductions (Siregar et al., 2022).

Role of TOC in Managing Environmental Constraints

The findings indicate that the Theory of Constraints (TOC) plays a significant role in identifying and managing systemic environmental bottlenecks, as environmental inefficiencies often stem from a limited number of critical constraints such as high-energy processes, waste-intensive production stages, or ineffective environmental management policies (Hasanah & Kusuma, 2023; Rini & Haryanto, 2022). The literature shows that TOC enables organizations to prioritize environmental improvement efforts by concentrating on bottleneck activities that have the greatest impact on overall system performance, rather than dispersing resources across multiple processes. Empirical evidence from energy-intensive and manufacturing sectors demonstrates that addressing these key constraints can simultaneously reduce energy consumption, emissions, and waste generation while maintaining operational efficiency.

Integrative Effects of ABC–TOC on Environmental Cost Management

A key finding of this review is the complementary role of Activity-Based Costing (ABC) and the Theory of Constraints (TOC) in environmental cost management, where ABC provides detailed activity-level environmental cost information and TOC offers a systemic basis for prioritizing improvement initiatives (Hasanah & Kusuma, 2023; Rahayu & Puspitasari, 2021). The integrated application of both approaches enables organizations to identify environmentally intensive activities and determine which should be addressed first based on system constraints, thereby enhancing cost efficiency and environmental performance. Moreover, recent studies indicate that integrating ABC–TOC with digital technologies such as IoT, energy management systems, and big data analytics strengthens real-time monitoring and control of environmental costs, further improving eco-efficiency (Sukendro, 2024; Suresh et al., 2022). Overall, the ABC–TOC synergy provides a structured and effective framework that supports strategic decision-making and advances sustainable and environmentally responsible operations.

Discussion

a. The Role of Activity-Based Costing (ABC) in Environmental Cost Efficiency. In contemporary accounting discourse, Activity-Based Costing (ABC) has developed beyond a conventional cost calculation tool into an analytical framework that explains the relationship between organizational activities and their environmental impacts. Each production activity embodies specific patterns of resource consumption and generates environmental externalities that are often concealed within aggregated financial data. ABC addresses this limitation by revealing causal linkages between activities, resource utilization, and environmental costs, thereby providing a more accurate representation of how economic value creation is accompanied by ecological consequences (Arfan & Ratmono, 2019; Dewi & Santoso, 2020; Supriyono & Arfianti, 2020).

The implementation of ABC enables organizations to identify energy-intensive and environmentally burdensome activities by tracing costs through clearly defined cost drivers. These

cost drivers function as empirical indicators of resource consumption behavior, allowing managers to interpret environmental costs as outcomes of operational practices rather than abstract accounting figures. As a result, efficiency is redefined not merely as cost minimization, but as an organization's ability to understand where resource inefficiencies occur and why they persist within the production process (Dewi & Santoso, 2020; Rahayu & Puspitasari, 2021; Wahyuni & Rahmawati, 2021).

Furthermore, ABC provides a robust foundation for the measurement and management of carbon-related costs within environmental accounting. By linking emissions directly to the activities that generate them, carbon costs become traceable, measurable, and actionable. This approach strengthens ecological accountability by enabling organizations to evaluate the environmental implications of production decisions and to integrate carbon considerations into managerial planning and control systems (Hasanah & Kusuma, 2023; Rini & Haryanto, 2022; Siregar et al., 2022).

Another critical contribution of ABC lies in its ability to allocate waste-related costs based on causal activities rather than proportional distribution. This shift transforms waste management from a corrective, end-of-process approach into a preventive and process-oriented strategy. Empirical studies indicate that such activity-based waste cost identification encourages process redesign, enhances managerial environmental awareness, and supports decision-making that aligns economic efficiency with ecological responsibility (Hasanah & Kusuma, 2023; Ningsih & Putri, 2022; Rahayu & Puspitasari, 2021; Supriyono & Arfianti, 2020).

b. The Role of the Theory of Constraints (TOC) in Environmental Constraint Management, among contemporary management paradigms, the Theory of Constraints (TOC) occupies a distinctive position as both a performance improvement method and a systemic way of thinking. TOC conceptualizes organizations as living systems whose sustainability is determined by their ability to recognize and manage inherent limitations. Every production process and value stream operates within natural boundaries that cannot be ignored. In an environmental context, these boundaries extend beyond machine capacity or labor availability to include the carrying capacity of the environment itself, which fundamentally constrains organizational operations (Goldratt, 1990; Rahayu & Puspitasari, 2021; Rini & Haryanto, 2022).

TOC focuses on identifying bottlenecks that restrict system flow and determine overall performance. This perspective challenges conventional notions of efficiency, emphasizing that performance improvement does not result from accelerating all processes simultaneously, but from strategically managing the most critical constraints. When applied to environmental management, TOC introduces the understanding that sustainability depends on an organization's capacity to identify ecological constraints that define the limits of its production system. Such constraints may include excessive energy consumption, emission-intensive processes, or waste-generating activities that exert disproportionate environmental pressure (Hasanah & Kusuma, 2023; Prabowo & Kartikasari, 2023; Rini & Haryanto, 2022).

Empirical evidence demonstrates that the Theory of Constraints (TOC) is effective in identifying sources of energy inefficiency, excessive emissions, and material waste across industries, with applications in energy-intensive firms showing significant reductions in electricity consumption and liquid waste through the alignment of production processes with optimal system capacity (Hasanah & Kusuma, 2023). The literature further indicates that constraints are often systemic rather than purely technical, embedded in organizational policies, decision-making structures, and operational cultures that are misaligned with sustainability objectives (Prabowo & Kartikasari, 2023; Rahayu & Puspitasari, 2021). Aligned with eco-efficiency principles, each identified constraint represents both an opportunity to improve financial performance and reduce environmental impact, as prioritizing high–ecological-burden activities enables simultaneous economic and environmental efficiency gains. Moreover, recent studies highlight the strong compatibility of TOC with Environmental Management Accounting (EMA) and data-driven approaches, including Big Data Analytics, which facilitate the detection of less visible constraints such as energy dependency, supply chain imbalances, and inefficient resource consumption patterns (Hasanah & Kusuma, 2023;

Sukendro, 2024; Suresh et al., 2022), positioning TOC as a reflective mechanism that enhances systemic awareness and supports sustainability-oriented decision-making.

c. The Synergy of Activity-Based Costing (ABC) and the Theory of Constraints (TOC) in Environmental Cost Management, the integration of Activity-Based Costing (ABC) and the Theory of Constraints (TOC) represents a paradigm shift from a mechanistic accounting perspective toward an adaptive and sustainability-oriented management system. ABC operates internally by deconstructing activity structures and revealing hidden environmental costs arising from energy consumption, material use, and waste generation. In contrast, TOC adopts a systemic perspective by identifying critical constraints that limit efficiency, environmental performance, and long-term sustainability across the production system (Rahayu & Puspitasari, 2021; Supriyono & Arfianti, 2020).

The synergy between ABC and TOC emerges through a complementary relationship between analytical precision and strategic direction. ABC provides detailed and accurate information regarding where and how environmental costs are generated, while TOC determines which constraints should be prioritized to achieve the greatest improvement impact. This integration reshapes the interpretation of cost from a figure that must merely be minimized into a reflection of organizational interaction with environmental carrying capacity. As a result, cost management becomes both an analytical and ethical process that aligns operational efficiency with ecological responsibility (Hasanah & Kusuma, 2023; Wahyuni & Rahmawati, 2021).

Recent empirical and conceptual studies indicate that the ABC–TOC synergy has been effectively applied across various sectors to balance economic efficiency with environmental sustainability. By combining activity-based environmental cost tracing with constraint-focused performance improvement, organizations are able to reduce waste, optimize energy usage, and redesign processes in a more sustainable manner. This integrative approach also enhances managerial awareness by linking environmental cost information with system-wide improvement priorities, thereby supporting more informed and strategic decision-making (Prabowo & Kartikasari, 2023; Rahayu & Puspitasari, 2021; Rini & Haryanto, 2022).

Based on a review of relevant literature, the ABC–TOC integration contributes to the development of a more adaptive and sustainability-oriented environmental cost management system. The synthesis of these approaches demonstrates that environmental efficiency cannot be achieved through cost accuracy or constraint management alone, but through their coordinated application. By aligning detailed cost information with systemic improvement strategies, organizations can achieve economic performance while respecting ecological limits, positioning sustainability as an inherent outcome of effective environmental cost management rather than a secondary objective (Hasanah & Kusuma, 2023; Siregar et al., 2022; Sukendro, 2024).

Table 1. Synthesis of Prior Studies on Environmental Cost Management and the ABC–TOC Synergy

No.	Authors & Year	Title of Study	Method & Object	Key Findings	Relevance to ABC–TOC Synergy
1	Rahayu Suryaningrum & Ratnawati (2024)	The Effect of Environmental Performance, Environmental Costs, Public Ownership, Green Accounting, and Capital Structure on Corporate Financial Performance	Quantitative; Indonesian manufacturing firms (2019–2020)	Environmental performance and green accounting positively affect ROE; environmental costs reduce profitability	ABC improves accurate allocation of environmental costs; TOC addresses high-cost constraints to enhance performance
2	Melin (2014)	Implementation of Environmental Accounting as a Supporting Factor for Environmental Cost Disclosure	Case study; PT Perkebunan Nusantara XIII (Persero)	Environmental costs are not fully recorded; disclosure remains partial and lacks transparency	ABC identifies hidden environmental costs; TOC resolves bottlenecks in waste management

No.	Authors & Year	Title of Study	Method & Object	Key Findings	Relevance to ABC–TOC Synergy
3	Farizi (2018)	Analysis of Environmental Management and Environmental Cost Control at PT Jasa Marga (Persero) Tbk	Qualitative; case study	Environmental management is adequate, but structured environmental cost reporting is absent	ABC classifies environmental costs systematically; TOC optimizes waste management processes
4	Suandi & Ruchjana (2018)	The Effect of Environmental Performance and Environmental Costs on ROA	Quantitative; consumer goods companies listed on IDX	Environmental performance improves ROA; environmental costs reduce profitability	ABC controls high-cost activities; TOC focuses on production efficiency constraints
5	Salsabila (2022)	Relationship between Environmental Performance, Environmental Costs, CSR, and ROA	Quantitative; food and beverage subsector	CSR and environmental performance positively affect ROA; environmental costs are partially insignificant	ABC–TOC aligns environmental costs with sustainable profitability
6	Anugrawati et al. (2020)	The Effect of Firm Size, Environmental Costs, and Environmental Performance on Profitability	Quantitative; mining companies listed on IDX	Firm size negatively affects profitability; environmental variables are jointly significant	ABC identifies high-cost activities; TOC removes production process constraints
7	Adack (2024)	The Impact of Economic Activities on Environmental Pollution	Literature review; local economic activities	Industrial and consumption activities cause air, water, and soil pollution	TOC identifies pollution-related bottlenecks; ABC measures environmental externality costs
8	Sukendro (2024)	Transformation of Energy Management in Modern Office Buildings through Smart Technologies	Literature review; BEMS, IoT, AI systems	Smart technologies reduce energy consumption and improve efficiency	ABC measures energy cost efficiency; TOC directs innovation toward energy constraints
9	Digitemie & Ekemezie (2024)	Building Energy Management Systems (BEMS) for Energy Efficiency	Literature review; building energy systems	IoT and digitalization enhance real-time energy efficiency	ABC maps energy costs; TOC addresses efficiency constraints
10	Suresh, Ramachandran, & Sivaji (2022)	Recent Trends in Big Data Analytics	Literature review; big data applications	Big data supports efficient decision-making in energy and environmental sectors	ABC–TOC leverage big data to analyze cost bottlenecks and environmental impacts
11	Supriyono & Arfianti (2020)	The Role of EMA in Environmental Performance of Manufacturing Firms in Indonesia	Quantitative; Indonesian manufacturing firms	EMA positively affects environmental cost effectiveness	ABC functions as an EMA tool; TOC guides continuous improvement
12	Arfan & Ratmono (2019)	Application of ABC in Environmental Cost Measurement	Case study; Indonesian manufacturing firms	ABC improves transparency and accuracy of environmental cost allocation	Empirical evidence of ABC in ecological cost management
13	Dewi & Santoso (2020)	Environmental Costs from an ABC Perspective in the Food Industry	Quantitative	Waste-intensive activities are the main source of inefficiency	ABC identifies waste-related cost drivers; TOC restructures production processes
14	Rini & Haryanto (2022)	Implementation of TOC in Textile Industry Waste Management	Qualitative	TOC reduces emissions and optimizes energy use	Supports TOC as an environmental constraint management tool
15	Wahyuni &	Analysis of ABC	Quantitative	ABC traces waste and	ABC maps high-impact

No.	Authors & Year	Title of Study	Method & Object	Key Findings	Relevance to ABC–TOC Synergy
	Rahmawati (2021)	Application for Environmental Impact Control		emission costs based on activities	activities; TOC prioritizes mitigation
16	Rahayu & Puspitasari (2021)	Integration of ABC and TOC in Strategic Decision-Making	Mixed-method	ABC–TOC synergy improves cost efficiency and decision quality	Direct relevance to the integrated ABC–TOC model
17	Hasanah & Kusuma (2023)	Optimization of Environmental Performance through TOC and EMA Approaches	Quantitative	TOC reduces energy consumption and waste	Supports TOC-based eco-efficiency
18	Ningsih & Putri (2022)	The Role of EMA in Enhancing Sustainability Performance	Descriptive	EMA strengthens corporate environmental awareness	ABC–TOC function as EMA implementation instruments
19	Prabowo & Kartikasari (2023)	TOC Approach in Sustainable Manufacturing	Quantitative	Environmental constraints significantly affect production system efficiency	TOC structures sustainable industrial management
20	Siregar et al. (2022)	ABC Implementation for Carbon Reduction	Empirical; chemical industry	Activity-based carbon costing reduces emissions by up to 18%	ABC–TOC support activity- and constraint-based emission reduction strategies

Scholarly literature indicates that Activity-Based Costing (ABC) and the Theory of Constraints (TOC) function as complementary frameworks for addressing the complexity of environmental cost management, rather than merely as technical tools. ABC enhances transparency and accountability by identifying hidden environmental cost drivers through the linkage of activities, resource consumption, and ecological impacts, while TOC emphasizes systemic constraints by identifying critical bottlenecks that limit efficiency and sustainability. Their synergy integrates analytical precision with strategic prioritization, enabling organizations to understand both what requires improvement and how to implement effective corrective actions (Hasanah & Kusuma, 2023; Rahayu & Puspitasari, 2021; Siregar et al., 2022; Supriyono & Arfianti, 2020). Recent studies further highlight that the integration of digital technologies—such as IoT, Artificial Intelligence, Building Energy Management Systems, and Big Data Analytics—extends the ABC–TOC framework into a real-time, ethically grounded, and reflective decision-making system that aligns economic efficiency with ecological responsibility, thereby providing a robust conceptual and practical foundation for future research on sustainable cost management and green accounting innovation (Hasanah & Kusuma, 2023; Ningsih & Putri, 2022; Rini & Haryanto, 2022).

4. CONCLUSION

This study concludes that the synergy between Activity-Based Costing (ABC) and the Theory of Constraints (TOC) provides a comprehensive framework for environmental cost management that extends beyond conventional cost reduction strategies. ABC enables organizations to identify hidden environmental costs—such as energy use, emissions, and waste—through activity-based causal analysis, while TOC focuses on identifying systemic constraints that limit operational efficiency and environmental sustainability. The integration of these approaches creates a balance between analytical precision and strategic focus, allowing organizations to prioritize improvement efforts in areas where economic efficiency aligns with ecological responsibility.

The main conceptual contribution of the ABC–TOC integration lies in reframing sustainability-based environmental cost management as a system-oriented managerial accounting approach that links detailed activity-level cost visibility with strategic constraint prioritization.

Environmental costs are positioned not merely as financial burdens, but as indicators of operational inefficiencies and ecological limits embedded within organizational systems. Strategically, this framework enables organizations to align economic performance with environmental carrying capacity by focusing improvement efforts on critical activities and constraints that simultaneously affect cost efficiency and ecological impact, thereby supporting proactive, responsible, and long-term sustainable value creation.

For future research, empirical studies are recommended to examine the practical implementation and performance outcomes of the ABC–TOC integration across various industrial sectors. Further exploration may also incorporate digital technologies, such as big data analytics, the Internet of Things (IoT), and artificial intelligence, to enhance real-time monitoring of environmental costs and system constraints. Additionally, future studies could include behavioral and institutional factors to better understand how managerial awareness, organizational culture, and regulatory environments influence the effectiveness of integrated environmental cost management systems.

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