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The carbon footprint as a key indicator for environmental management controllers: towards environmental performance: A literature review

Bouchouit Kaoutar, PhD Student
Azzouz Elhamma, Professor-Researcher
National School of Business and Management,
Ibn Tofail University, Kenitra, Morocco

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Abstract

Environmental considerations are increasingly critical for corporate sustainability and success. While businesses integrate environmental management into their strategies, the practical implementation of environmental management control systems, or "eco-control," remains underexplored. This paper examines the conditions necessary for effectively integrating carbon footprint requirements and regulatory codes into eco-control systems. We articulate the importance of environmental performance objectives in addition to traditional performance objectives as core values of control management. Additionally, we highlight the pivotal role of environmental management controllers in aligning environmental sustainability with traditional business objectives. By measuring greenhouse gas emissions and developing strategies that are both economically viable and environmentally sound, controllers embed environmental objectives into core business processes. Despite challenges like capturing indirect emissions and the lack of standardized reporting methods, they have the potential to make sustainability a strategic component of corporate management. Future research should focus on enhancing their role by developing better tools and standardized methodologies for measuring environmental performance.

Keywords: Environmental Management Control, Environmental Performance, Carbon Footprint, Management Control Tools, Sustainability

Introduction

The Introduction states the research question, why the research is important, and briefly reviews relevan Environmental considerations have become essential for companies seeking sustainability and long-term success due to climate change, resource depletion, and pollution. Growing environmental awareness and regulatory pressures have led businesses to integrate environmental management into their operational strategies. Researchers have extensively explored these issues with a focus on the impact of environmental control on organizational performance (Henri & Journeault, 2006; Melnyk et al., 2003; Figge et al., 2002; Lothe et al., 1999) and on environmental reporting and disclosure (Wagner, 2005; AlTuwaijri et al., 2004; Antheaume, 2004).

Henri & Journeault (2006) introduced the term "eco-control" to describe environmental management control that incorporates traditional management accounting components. In this regard, companies are expected to manage human, financial, material, and natural resources more rationally to gain a competitive advantage (CMA Canada, 1999a, 1999b). Unlike traditional management control, eco-control has a societal component, that is, holding companies accountable for the environmental and sustainable development impacts of their activities (Pasquero, 2005; Capron & Quairel-Lanoizelée, 2004; Igalens, 2004). In fact, eco-control serves as a tool for macroeconomic regulation (Langevin, 1999), thus extending management control beyond internal boundaries to introduce performance indicators that address societal needs regarding environmental sustainability.

However, eco-control remains something of a "black box"—its implementation conditions are seldom examined, despite being crucial to its effectiveness. Most research has focused on its impact on financial and environmental performance without delving into its internal workings. Given its relatively recent introduction and limited adoption, studies often emphasize the design of eco-control systems and their effects yet overlook the practical conditions required for its successful implementation.

In this paper we aim to explore the conditions necessary for forming an effective environmental management control system. By "opening the black box" of management control (Latour, 1989), we seek to uncover the actors and entities—both human and non-human—involved in eco-control that can recruit other stakeholders to form a robust network (Callon, 1986; Latour, 2005). For eco-control to operate effectively as an environmental regulation mechanism, it must gain support from both local and global stakeholders, through the use of accounting innovations like activity-based

costing (Briers & Chua, 2001) and balanced scorecards (Hansen & Mouritsen, 2005). This exploration highlights the social processes upon which the effectiveness of eco-control ultimately depends.

The Evolution of management control into eco-control: theoretical approaches and transformational challenges

Management control and its historical evolution

Use Management control has evolved as a scientific discipline over time by adapting to the changing contexts of business operations. It has become essential in large organizations, where success depends on anticipating actions, setting objectives, and measuring performance. Significant shifts occurred in the early 20th century with the advent of Scientific Management by Taylor (1905) and productivity innovations like Gantt's (1906) work on overhead costs and General Motors' structural decisions in 1923. At this stage, management control was primarily limited to basic financial oversight.

As organizations' size has expanded significantly and became more complex, the need for task division and operational oversight emerged, giving rise to management control. In the 1930s, cost analysis and the use of forecasted and actual budgets became essential for identifying discrepancies, enabling companies to organize their budgets and improve competitiveness by reducing costs. Management control relied heavily on analytical accounting and budgetary control, and businesses began experimenting with dashboards during this period (Pezet, 2009).

In an increasingly environmentally conscious world, businesses are now faced with new challenges in management. Traditionally, management control has focused on profit maximization and cost management. However, as environmental concerns become more pressing, companies are transitioning toward a more holistic approach—environmental management control (EMC) . This shift is becoming essential for organizations aiming to achieve long-term sustainability and environmental responsibility.

Significant changes were made to managerial control in the 1970s. New technology, disruptions, and globalization led to a reassessment of the discipline. It grew beyond monitoring performance to include influencing organizational decision-making and individual conduct. By the early 1980s, Anthony (1988) and Bouquin (1989), among others, viewed management control as a bridge between operational and strategic control. Notable developments included Kaplan & Norton's (1992) balanced scorecard and Simons' (1995) research on organizational control.

Many definitions still center on allocating resources to achieve strategic objectives established by leadership, even with these developments. Management control is "the process by which managers ensure that

resources are obtained and used efficiently and effectively to achieve the organization's objectives", according to Robert Anthony's (1965) groundbreaking definition. It is thus "a tool for coordinating, judging, and planning", according to Chandler (1967).

Evolving perspectives on management control: from operational to strategic integration

The concept of management control

Originally focused on operational tasks like planning, monitoring, and sanctioning within corporate management, management control expanded over time to include strategic elements. Reflecting this shift, Anthony (1980) updated his earlier definition, describing management control as "the process that allows managers to influence other members of the organization to implement its strategies." From that point onward, most authors emphasized the strong connection between operational control and strategy.

For instance, Ardouin, Michel, & Schmidt (1985) described management control as "the set of actions, procedures, and documents aimed at helping operational managers manage their activities to achieve their objectives." Similarly, Kerviller & Kerviller (1994) highlighted that it is "the set of measures implemented by the company to help operational managers manage their activities to reach their targeted goals."

Simons (1995) defined management control as "the set of formal processes and procedures, built upon information, that managers use to manage the organization's activities." Alazard (2004) further described it as "a process comprising a set of calculation, analysis, and decision-making tools (both quantitative and qualitative), aiming to guide the organization's products, activities, and processes toward its objectives ."

Bouquin (2010) added that management control consists of "the processes and systems that ensure leaders have confidence that strategic choices and actions are, have been, and will be coherent." Coucoureux (2010) emphasized the role of leadership, noting that "those who implement management control have objectives they want to communicate. They must have a clear vision of the company's future and its environment, both short- and long-term, along with persistent determination. In other words, management control serves strategy."

The emergence of eco-control: integrating environmental objectives into management control

With the rise of environmental concerns, management control has expanded to include environmental objectives, leading to the concept of eco-control (see figure below). Eco-control refers to the integration of

environmental management into traditional management control systems, aiming to guide organizations toward sustainable practices (Schaltegger & Burritt, 2000). Its relevance lies in helping companies not only comply with environmental regulations but also improve their environmental performance as part of their strategic goals.

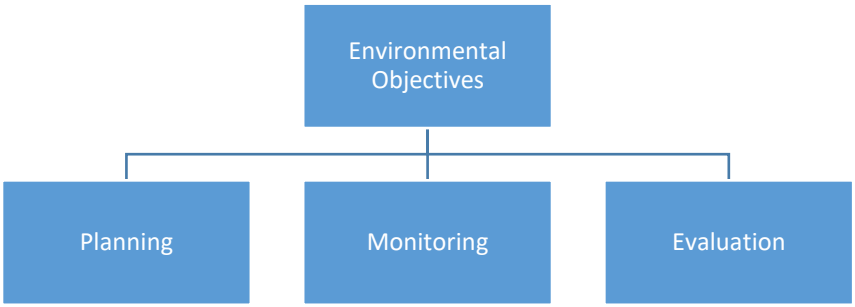

Figure 1. Eco control Integration model

The eco-control is driven mainly by the growing environmental concerns, increased stakeholder pressure, and a heightened sense of corporate responsibility. Organizations face demands from customers, investors, and regulators to minimize their environmental footprint (Burritt, Schaltegger, & Zvezdov, 2011). Thus, this shift compels management controllers to incorporate environmental metrics into their performance evaluations, balancing financial outcomes with sustainability objectives.

Early adaptations of eco-control are evident in companies implementing environmental management systems and sustainability reporting. The adoption of the ISO 14001 standard provided a framework for organizations to systematically manage their environmental responsibilities (International Organization for Standardization, 2015). For instance, Interface Inc., a global manufacturer of modular flooring, integrated eco-control into its operations by setting goals to reduce waste and carbon emissions, demonstrating that environmental sustainability can align with business success (Anderson, 1998).

Environmental management control: a conceptual framework

Definition and scope of environmental management control (EMC)

The concept of Environmental Management Control (EMC) appeared in the 1990s in response to the increasing necessity for organizations to incorporate environmental considerations into their management practices. Hofbeck (1993) is credited with introducing the term, highlighting its primary dimensions as environmental management accounting, environmental management information systems, and environmental

management tools. Although Hofbeck did not provide a precise definition, her work laid the foundation for understanding EMC's scope.

Since the 2000s, with the emergence of new technologies and the arrival of Industry 4.0, management control has encountered a range of new challenges. The recognition of ecological considerations, intangible assets, and human capital as sources of organizational performance has driven the evolution of management control to incorporate more variables, especially environmental aspects (Renaud, 2015). This shift has led to the emergence of concepts like EMC, which integrates environmental objectives into traditional management control systems to steer organizations toward sustainable environmental performance (Henri & Journeault, 2010).

Several authors have proposed definitions and approaches to EMC. Capron and Quairel (1998) define it as "any process established to ensure that an organization is steered in alignment with its strategy and environmental objectives." Similarly, Pondeville (2003) describes EMC as a "process implemented to guarantee the management of the enterprise in full coherence with its strategy and environmental goals." Antheaume (2013) views EMC as a mechanism aimed at aligning individual behaviors within the organization with its environmental objectives, ensuring the rational and efficient use of natural resources.

Renaud (2015) defines Environmental Management Control (EMC) as a process enabling managers to influence others within the organization to implement or support green strategies. This process utilizes tools from environmental accounting, environmental management accounting, and eco-control, relying on environmental information systems and eco-tools to monitor and steer the organization's environmental performance. However, Schaltegger & Burritt (2000) define EMC as "a process that supports the management of the company's environmental activities by providing useful information for planning, decision-making, and monitoring environmental performance. This system encompasses environmental costs and potential benefits associated with the integration of sustainable practices."

Henri Savall (1995) considers EMC as "a management system that enables the measurement, analysis, and correction of the company's environmental performance in relation to its economic and social performance. It serves as a strategic management lever to integrate ecological responsibility into the overall management of the company."

Based on the aforementioned definitions of EMC, it's thus an extension of traditional management control into the environmental dimension. EMC emerged to integrate environmental concerns into organizational management, evolving with technological advancements like Industry 4.0. It ensures alignment with environmental objectives, influencing decision-making, and monitoring performance. Thus, EMC serves as a

strategic tool to balance environmental, economic, and social performance to promote sustainability within organizations and consequently the broader society.

Key components of EMC: tools, processes, and systems

The key components of EMC encompass a variety of tools, processes, and systems designed to measure and manage environmental performance. Tools such as environmental performance indicators, eco-efficiency metrics, and life cycle assessments provide quantitative data to inform decisions (Epstein & Roy, 2001). Processes involve integrating environmental objectives into budgeting, reporting, and performance appraisal systems (Ferreira, Moulang, & Hendro, 2010). Systems like Environmental Management Systems (EMS), exemplified by ISO 14001 standards, offer structured frameworks for managing environmental responsibilities (International Organization for Standardization [ISO], 2015).

These components enable organizations to monitor costs related to energy consumption, natural resources, and pollution prevention or treatment. Taking into account the environmental impacts of their activities, and implementing tools to reduce them, organizations can align their operations with both environmental and strategic objectives (Burritt, Schaltegger, & Zvezdov, 2011). EMC tools stem from environmental accounting, environmental management accounting, and eco-control, based on environmental information systems and eco-tools.

Conceptual models and theoretical foundations of EMC

The theoretical foundations of EMC draw from management control theories and environmental management practices. Contingency theory suggests that EMC systems should be tailored to an organization's specific context and environmental challenges (Otley, 2016). Stakeholder theory emphasizes the importance of responding to the environmental expectations of various stakeholders, including customers, regulators, and the community (Freeman, 1984).

Conceptual models like the Sustainability Balanced Scorecard integrate environmental and social dimensions into traditional performance measurement frameworks (Figge et al., 2002). Environmental Management Accounting (EMA) focuses on identifying and allocating environmental costs for better decision-making (Burritt & Schaltegger, 2000). These models provide a foundation for developing EMC practices that align environmental sustainability with organizational strategy and control mechanisms.

This evolution illustrates how EMC has grown from a niche concept to a critical component of modern management control. It requires management controllers to adopt a broader perspective that balances

organizational performance with environmental sustainability, integrating ecological responsibility into the overall management of the company (Savall, 1995).

Role of controllers in environmental management: a brief review of the literature

Research on the role of management controllers has grown since the 1990s (Bollecker, 2007), yet their particular contributions to the environmental field are still not well understood. The literature on EMC has primarily focused on tools (Marquet-Pondeville, 2003; Janicot, 2007; Caron et al., 2007; Henri & Journeault, 2010; Schaltegger, 2011; Antheaume, 2013), often describing EMC as a process without direct involvement from management controllers. Marquet-Pondeville (2003) notes that "environmental management control often escapes the management control function and is rather articulated at the level of the environmental department."

This absence is attributed to controllers' historical confinement to accounting and financial domains (Capron & Quairel, 1998; Wilmshurst & Frost, 2001; Quairel, 2006; Rivière-Giordano, 2007; Berland, 2007; Caron & Fortin, 2010). Bouquin (2010) observes that "controllers have been bypassed by other functions pursuing the same objectives but closer to operators." Consequently, environmental specialists have assumed tasks traditionally assigned to controllers, such as advisory and auditing activities (see figure 2 below) (Moquet, 2008). Environmental control experts ensure the implementation of green strategies across the organization and help leaders identify strategic environmental opportunities (Renaud, 2013a).

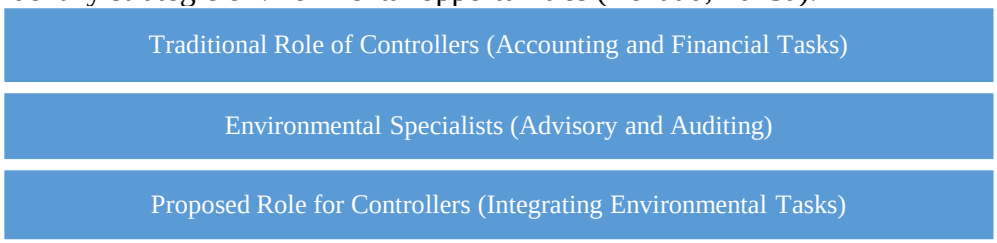

Figure 2. The new tasks of management controller

Despite limited empirical evidence, some authors contend that finance professionals should take on a more active role in environmental responsibility. Quairel (2004) argues that their involvement could improve the credibility of environmental reports and build greater investor confidence (Rivière-Giordano, 2007). Additionally, Sobczak (2011) suggests that management controllers could become essential to managers and sustainability officers by creating tools that address environmental issues and ensuring transparent communication with stakeholders.

One key responsibility for controllers in this context is monitoring the company's greenhouse gas emissions. They conduct carbon footprint assessments using methodologies like that of ADEME (the French Agency for the Environment and Energy Management), measuring emissions in tons of CO_2 equivalent by activity category—such as transportation, travel, packaging, energy consumption, and waste management.

A theoretical perspective of Environmental Performance

Under increasing pressure from stakeholders, companies can no longer focus solely on meeting the expectations of their shareholders. They are now expected to assume broader societal responsibility by considering the interests of all stakeholders (Freeman et al., 2004). As a result, organizational performance is no longer limited to economic criteria but also includes intangible aspects, such as environmental performance (Yeo, 2003).

According to stakeholder and neo-institutional theories, companies are increasingly required to be accountable for their environmental performance. This accountability manifests through the adoption of environmental management controls, which are either responses to explicit stakeholder expectations (Freeman, 1984) or reactions to institutional pressures—whether coercive, normative, or mimetic (Di Maggio & Powell, 1983; Oliver, 1991). However, while companies may not have a choice about compliance, they can still choose how to implement it. The management of environmental performance involves a balance between formal representations and external stakeholders' subjective interpretations of those representations.

The concept of environmental performance

Few authors have explicitly defined the concept of environmental performance. It is often equated with the environmental impacts caused by a company's activities (King & Lenox, 2001; Cole et al., 2008) or the company's ability to manage resources sustainably and efficiently (Janicot, 2007).

The ISO 14000 standard describes environmental performance as the measurable outcomes of an environmental management system, reflecting an organization's control over its environmental aspects in alignment with its environmental policy and objectives (ISO, 1996). Meanwhile, the ISO 14031 standard (2013) assesses environmental performance by evaluating the impact of an organization, industry, or policy on the environment.

According to Schaltegger, Burritt & Petersen (2003), "Environmental performance represents a company's ability to reduce its environmental impacts and efficiently manage natural resources using specific

environmental indicators." However, Boiral, (2007) states that "Environmental performance is not limited to regulatory compliance but involves the proactive integration of ecological concerns into the company's strategy, allowing the company to meet stakeholder expectations and improve competitiveness." Sarkis (1999) defines environmental performance as "an integrated approach that assesses an organization's efforts to minimize its negative environmental impacts through sustainable processes and technologies."

Turki (2014) offers a different perspective, suggesting that environmental performance stems from the eco-friendly initiatives a company implements in response to evolving environmental pressures. According to this view, Turki's (2009) model for evaluating environmental performance includes three key components: strategic, operational, and relational, as shown in the figure below.

Measurement of environmental performance

Laforest et al. (2015) highlight the significance of measuring environmental performance through specific indicators that evaluate the environmental impact of a product or process, covering the entire lifecycle from raw material extraction to disposal . Various authors have attempted to measure a company's environmental performance using different frameworks. For example, Trumpp et al. (2015), Henri and Journeault (2008), Xie & Hayase (2007), and Xue et al. (2017) emphasize two primary dimensions: managerial and operational. In contrast, Thomson Reuters (2015), through its ASSET4-ESG database, identifies three dimensions: reducing environmental emissions, product innovation, and minimizing resource consumption.

Turki's model (2014) incorporates three dimensions: strategic, operational, and relational. Meanwhile, Henri and Giasson (2006) present a model with four dimensions: product and process improvement, stakeholder relations, regulatory compliance, financial and environmental impacts, as well as corporate image .

Apitsa (2019) underscores the rise of new technologies and practices designed to enhance environmental performance, including the use of renewable energy, circular economy approaches, CO2 emissions reduction, and the integration of eco-design in product development. Da Silva (2013) emphasizes the need for coherent environmental policies and regulatory incentives to encourage companies to adopt sustainable practices. Additionally, Becheker & Bekour (2021) highlight the essential role of awareness, education, and stakeholder engagement in the ongoing improvement of environmental performance .

Key Metrics and indicators for environmental performance

Measuring environmental performance involves specific metrics that reflect an organization's impact on the environment. Common indicators include greenhouse gas emissions, energy and water consumption, waste generation, and pollution levels (Epstein & Roy, 2001). These metrics help organizations quantify their environmental footprint and identify areas for improvement. The Global Reporting Initiative (GRI) provides widely recognized guidelines for sustainability reporting, offering standardized indicators that many organizations adopt (GRI, 2016).

Tools for measuring environmental impact in organizations

Organizations rely on various tools to assess and manage their environmental impact. Life Cycle Assessment (LCA) examines the environmental aspects of a product or service throughout its entire life cycle, from raw material extraction to disposal (Guinée et al., 2011). EMS as outlined earlier offer a structured approach to managing environmental responsibilities. Carbon footprint calculators estimate total greenhouse gas emissions associated with organizational activities (Wiedmann & Minx, 2008). Additionally, material flow analysis and ecological footprinting are tools that help in understanding resource use and ecological impacts (Bastianoni et al., 2013).

Limitations and challenges in current measurement approaches

Despite these tools and metrics, measuring environmental performance presents challenges. Data quality and availability can be inconsistent, leading to unreliable assessments (Searcy, 2012). The lack of standardization across industries complicates benchmarking and comparison of environmental performance (Morioka & de Carvalho, 2016). Moreover, current measurement approaches often overlook indirect environmental impacts, such as those occurring in the supply chain (Lenzen et al., 2013). There is also the challenge of integrating environmental metrics with financial performance indicators to provide a holistic view of organizational performance (Burritt & Schaltegger, 2010). These limitations underscore the need for improved measurement methods that are more comprehensive and universally applicable.

Optimizing environmental performance through the use of carbon footprint

The Carbon footprint as a tool for environmental management

The carbon footprint has evolved into a key strategic tool for environmental management controllers, crucial for overseeing a company's environmental performance. According to Moquet (2008), calculating the

carbon footprint is often one of the first responsibilities assigned to environmental management controllers. They use this tool to measure the company's greenhouse gas (GHG) emissions, a vital step in managing environmental impact. Controllers then monitor and analyze these results to recommend corrective measures, positioning them at the center of emissions tracking and strategy development aimed at reducing the company's carbon footprint.

Renaud (2013) supports this view, noting that by identifying emission sources, controllers actively contribute to developing strategies to reduce emissions and improve environmental performance. Their role extends beyond measurement to encompass the identification of improvement opportunities in environmental management.

Capron and Quairel (1998) highlight that establishing a carbon footprint is one of the initial steps in a rigorous environmental management control process. The environmental management controller not only sets up the tool to measure emissions but also ensures ongoing monitoring to meet environmental commitments.

Sobczak (2011) adds that the carbon footprint serves as a strategic guidance tool. It not only measures GHG emissions but also directs corrective actions to enhance overall performance, including economic and social aspects.

Steps in developing and implementing carbon footprint assessments

The process of developing the carbon footprint tool can be broken down into three main stages: establishing an action plan, evolving toward reporting, and refining the original strategy.

In the early 2000s, engineer Jean-Marc Jancovici identified a lack of proper tools for businesses to pinpoint activities contributing to GHG emissions, especially indirect emissions often overlooked but constituting the majority of a company's emissions (Jancovici, 2000). To address this gap, Jancovici developed a calculation tool in partnership with ADEME (French Agency for Environment and Energy Management). The goal was to create a user-friendly tool where companies could input activity data and convert it into CO_2 emissions using a database of emission factors (Poivet, 2014).

The creation of this emission factor database was essential, enabling the conversion of activity data into tons of CO_2 equivalent using specific calculations. For instance, determining CO_2 emissions from electricity consumption requires understanding the country's energy mix and the emissions associated with each energy production method (Jancovici, 2000). Unlike the complex life cycle assessment tools available at the time, this tool was designed to be user-friendly, providing straightforward and practical evaluations to support environmental initiatives (Riot, 2013).

Initial feedback showed growing interest from businesses in this "eco-balance" approach, which provided quick estimates to inform decision-making on emission reduction actions (Jancovici, 2000). The tool evolved into a diagnostic instrument for companies to understand their climate challenges and guide necessary actions.

Strategic use of carbon footprint data for performance improvement

The carbon footprint is not just a measurement tool but a strategic asset for guiding companies toward reducing their environmental impact. Environmental management controllers can rank the actions that provide the greatest reductions in emissions by identifying the main sources of emissions. According to Renaud (2013), this method ensures that efforts to reduce emissions also contribute to operational efficiency and cost savings by bringing environmental objectives into line with corporate strategy.

Continuous monitoring and analysis enable companies to track progress toward environmental goals and adjust strategies as needed. The carbon footprint thus serves as a feedback mechanism, informing management decisions and fostering a culture of sustainability within the organization.

Limitations of the carbon footprint

While the carbon footprint is a valuable tool, it has limitations. Jancovici points out that the tool may not fully account for the complexity of production systems and supply chains, potentially missing some indirect emissions, particularly those associated with the use of products (Jancovici, 2000). Renaud (2013) mentions that capturing Scope 3 emissions—indirect emissions upstream and downstream—is challenging but essential, as they can represent a significant portion of total emissions.

Capron and Quairel (1998) point out that lack of standardization in calculation methods can make comparisons between companies or sectors difficult. Sobczak (2011) warns that focusing solely on GHG emissions may lead to a simplistic approach, neglecting other significant environmental impacts like resource use or biodiversity effects. Garrone and Melac (2015) highlight that relying only on quantitative indicators can limit the effectiveness of emission reduction strategies, as companies might miss more integrated and sustainable solutions.

What role for management controllers in corporate environmental objectives?

Environmental management controllers (EMCs) use the carbon footprint as a transformational lever and as a metric in their work at the nexus of corporate strategy and environmental oversight. They play a crucial role in converting carbon data into workable business plans, not just in terms

of observation. In order to minimize energy consumption and maximize resource allocation, controllers link emissions to operational inefficiencies (Renaud, 2013). Controllers identify the areas with the biggest environmental impact and prioritize reduction efforts that are in line with cost savings and operational improvements, keeping the focus on measurable results (Burritt & Schaltegger, 2010).

With the use of these technologies, EMC specialists monitor pollution, waste production, and water usage, producing data that guides both short-term and long-term decisions. Integrating environmental performance into corporate operations without compromising conventional financial goals requires a data-centric approach. Thus, EMC goes beyond carbon reduction to address more general environmental issues, including environmental management systems and life cycle assessments into routine business operations (Epstein & Roy, 2001).

The ability of EMC to manage stakeholder and regulatory constraints and institutionalize sustainable practices through frameworks like the ISO 14001 standard is also critical to corporate success (ISO, 2015). The difficulty, though, is in striking a balance between these demands and internal company goals. EMC must guarantee that compliance with environmental requirements supports, rather than detracts from, competitive standing. This frequently entails tackling both ecological and economic imperatives at the same time by implementing environmental improvements that also spur innovation in supply chain management or product design (Schaltegger & Burritt, 2000).

EMC is therefore essential to coordinating sustainability and business continuity. They accomplish it not by imposing external norms but by internalizing environmental metrics into basic decision-making processes. Their capacity to produce exact, quantifiable results guarantees that operational goals and environmental goals stay in line, reducing conflict between sustainability and profitability.

Integrating carbon footprint requirements and regulatory codes into environmental management control systems

Understanding and Incorporating Regulatory Requirements

Regulatory bodies such as the European Union Emissions Trading System (EU ETS) mandate the reporting of greenhouse gas (GHG) emissions and establish specific reduction targets (European Commission, 2021). Control managers need to stay informed about these regulations to ensure compliance.

Developing explicit environmental policies that reference compliance with pertinent regulations is crucial. These policies should articulate the organization's commitment to reducing emissions and fulfilling legal

obligations (ISO, 2015). In fact, integrating regulatory requirements into Key Performance Indicators (KPIs) enables organizations to monitor and manage their environmental impact effectively (for instance, see table below)

Table 1. emissions monitoring and compliance

Category	Description
Total GHG Emissions	Tracking total emissions to ensure they remain within legal limits (GHG Protocol, 2015).
Emission Intensity Metrics	Measuring emissions per unit of production or revenue (Schaltegger & Wagner, 2006).
Compliance Rates	Monitoring adherence to emission caps or reduction commitments (Bebbington & Larrinaga, 2014).

Source : author

These KPIs should be regularly reviewed and incorporated into management reports. Adopting standardized carbon accounting frameworks, such as the Greenhouse Gas Protocol, allows for accurate measurement and reporting of emissions (GHG Protocol, 2015). This involves accounting for three types pf scope emissions (see table below).

Table 2. Scopes of emissions

Scope	Description
Scope 1 Emissions	Direct emissions from owned or controlled sources.
Scope 2 Emissions	Indirect emissions from the generation of purchased energy.
Scope 3 Emissions	Other indirect emissions occurring in the value chain.

Source : author

Integrating Environmental Objectives into Management Control Systems

Embedding environmental objectives within management control systems aligns sustainability goals with organizational operations (Epstein & Buhovac, 2014). Incorporating carbon reduction targets into strategic planning ensures that sustainability becomes a core organizational objective (Figge et al., 2002), while budgeting for investments in energy-efficient technologies and renewable energy sources supports emission reduction efforts (Porter & Kramer, 2006). Operational controls such as monitoring energy consumption and waste generation improve efficiency (Hart, 1995), and updating standard operating procedures (SOPs) to include environmental considerations ensures daily operations meet sustainability goals (Angell & Klassen, 1999). Integrating environmental KPIs into performance evaluations (Kaplan & Norton, 1996) and linking employee incentives to environmental targets further embeds sustainability into the organizational structure (Govindarajan & Gupta, 1985).

Strategies for Ensuring Compliance and Continuous Improvement

Ensuring compliance and fostering continuous improvement rely on the integration of technology, employee engagement, and supply chain

management. Environmental Management Information Systems (EMIS) enable real-time monitoring of emissions and resource use, supporting compliance and informed decision-making (Melville & Whisnant, 2014), while predictive analytics allow organizations to forecast future emissions and make proactive adjustments (Henri & Journeault, 2010). Regular internal audits and external certifications, such as ISO 14001, ensure adherence to environmental standards (Simnett et al., 2009; Darnall et al., 2008), and transparent reporting through frameworks like the Global Reporting Initiative (GRI) enhances stakeholder communication (Kolk, 2008). Employee training fosters a culture of compliance (Daily & Huang, 2001), and engagement initiatives encourage active participation in sustainability efforts (Ramus, 2001). Evaluating suppliers based on environmental performance and adopting sustainable procurement policies ensure alignment across the supply chain (Seuring & Müller, 2008; Carter & Rogers, 2008). Continuous improvement is achieved by reviewing environmental KPIs and staying updated with regulatory changes (Searcy, 2012; Delmas & Toffel, 2008).

Conclusion

In this paper we have emphasizes the crucial role that environmental management controllers can play in addressing environmental issues within companies while balancing traditional business objectives. Controllers help businesses cut their environmental footprint without sacrificing operational effectiveness or profitability. As a quantifiable measure of environmental performance, the carbon footprint enables controllers to evaluate greenhouse gas emissions and create plans that are both economically sound for the company and environmentally friendly.

Moreover, environmental management controllers are positioned to bridge the gap between environmental sustainability and business performance. They can identify opportunities for reducing emissions that also result in cost savings, such as energy efficiency improvements or resource optimization. In doing so, they help companies maintain competitiveness in an increasingly eco-conscious marketplace while fulfilling regulatory requirements and stakeholder expectations. Their role extends beyond the technicalities of environmental measurement; they contribute to strategic decision-making that integrates environmental objectives into the core operations of the business.

Integrating carbon footprint requirements and regulatory codes into environmental management control systems allows controllers to ensure that companies not only comply with legal obligations but also proactively enhance their environmental performance. This involves establishing environmental policies aligned with regulatory standards, developing

specific environmental KPIs, and adopting standardized carbon accounting practices to accurately measure emissions across all scopes. Embedding environmental objectives into strategic planning, operational controls, and performance measurement systems facilitates a comprehensive approach that aligns sustainability with core business processes. Additionally, leveraging technology such as Environmental Management Information Systems and engaging in continuous improvement through audits and employee engagement strengthens the company's ability to meet environmental targets while maintaining operational efficiency and profitability.

At the same time, environmental management controllers must navigate the complexity of capturing indirect emissions, particularly those within supply chains (Scope 3 emissions), and address the challenges posed by the lack of standardized methods for environmental reporting across industries. Despite these challenges, they have the potential to make environmental management a core component of corporate strategy, ensuring that businesses meet their environmental responsibilities without losing sight of profitability, growth, and overall operational efficiency.

Future research should further explore the expanding role of environmental management controllers, particularly how they can more effectively manage the dual objectives of environmental sustainability and traditional business success. Developing better tools and standardized methodologies for measuring environmental performance will empower controllers to play a more strategic role in shaping the future of corporate sustainability practices. In this evolving landscape, environmental management controllers are key to ensuring that sustainability becomes an integrated, strategic part of business management, rather than a separate or secondary concern.

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