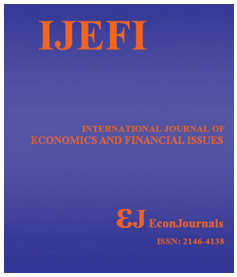

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Carbon Accounting: Its Implications on Accounting Practices and Corporate Sustainability Reports

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ABSTRACT

Carbon accounting is a new accounting paradigm for ecological-based economic transactions. It is also known as carbon cost management. The issues regarding carbon cost management will have implications for other strategic issues related to management accounting. The concept and application of Carbon accounting will also have broad implications for the professions and strategic issues of carbon management accounting. This study focuses on the implication of carbon accounting on accounting practices and corporate sustainability reports. The literature reviews and qualitative analyses were conducted to grab the philosophy, practice, and implication of implementation of carbon accounting – carbon cost management. Based on the study, carbon accounting implementation implied accounting practices and corporate sustainability reports. In term of calculating carbon emissions or greenhouse gasses, there were four methods as set by inter-governmental panel for climate change (IPCC) and European renewable energy. In term of corporate sustainability report, there were three theories considered: Instrumental theories, social and political theories, and normative theories. It is difficult to account for emission allowances and revealed that there is a potential guidance role for auditors during the absence of an international accounting standard. With the emission allowance assets, there is diversity in the accounting treatment of liabilities and a considerable level of non-disclosure. In practice, this means that the only liability recognition in the financial statements is for shortfalls in allowances.

Keywords: Carbon Accounting, Accounting Practices, Corporate Sustainability Reports
JEL Classifications: M410, M480

1. INTRODUCTION

Carbon accounting is a new accounting paradigm for ecological-based economic transactions, it is also known as carbon cost management. The concept and application of Carbon accounting will also have broad implications for the professions and strategic issues of carbon management accounting, especially for developing countries that have implemented the concept of carbon trading in the Carbonomics era (Ratnatunga, 2008; Wahyuni and Ratnatunga, 2014). Carbonomics is a term used to describe the economic implications of carbon emissions and climate change. It refers to the study and analysis of the costs and benefits of reducing greenhouse gas emissions and transitioning to a low-carbon economy. The concept of carbonomics recognizes that carbon emissions have externalities, meaning that the costs of carbon emissions are not fully borne by those who emit them, but are instead passed on to society as a whole. This can result in market failures where the true costs of carbon emissions are not reflected in market prices.

The idea of the Carbonomics era will be able to become a driving force for environmental protection and world rescue from the problem of increasing global warming. The implications of the application of Carbonomics concepts will also result in the development of social culture, professions, economics models, and even to the supply and demand model. Carbonomics aims to

address this market failure by incorporating the costs of carbon emissions into economic decision-making. This can be done through mechanisms such as carbon pricing or carbon taxes, which seek to internalize the costs of carbon emissions and provide incentives for individuals and businesses to reduce their carbon footprint. In addition to reducing the negative impacts of climate change, carbonomics can also create opportunities for economic growth and innovation in areas such as renewable energy, energy efficiency, and carbon capture and storage technologies.

Issues regarding carbon cost management will have implications for other strategic issues related to management accounting. Once the carbon cost of a product is known, various strategic issues in the field of management accounting will be developed. In this case, including carbon dioxide (CO_2) emissions efficiency in raw material use, labor costs, factory overhead costs, environmental overhead costs, as well as issues related to carbon cost management, corporate governance, and carbon accounting standards (Ratnatunga and Balachandran, 2009; Ratnatunga, 2007; Ratnatunga et al., 2011). The environmental awareness, interests and motivations of 150 visitors to the Mt. Coot-tha Botanic Gardens. However, it has been reported that despite business owners/managers having strong "green" attitudes, the level of implementation of environmentally friendly practices is low (Djaddang et al., 2017).

Implementing a carbon price within a company can aid in the internalization of greenhouse gas emission costs by assigning a monetary worth to each ton released. The document outlines the rationale for incorporating an internal carbon price, various methods employed by companies to establish such pricing, and important insights gained from experience, including the manifold business advantages, the significance of integrating the price into the firm's business strategy, and the benefits and difficulties of distinct pricing strategies (Ahluwalia, 2017; Schaltegger et al., 2022). There is no significant influence between environmental awareness and (state-owned enterprise-SOE) earnings quality. Because there is a tendency for the average construction industry not in details in presenting environmental awareness from the accountancy aspect and financial report, environmental litigation, pollution prevention and other aspects, just shows that the company has done social activity related to the environment and the volunteer disclosure (Djaddang et al., 2017).

The process of alignment in economic ecology-based attitudes and behavior does not necessarily apply in an area of social accounting or gives a broad spectrum effect on other fields. The alignment requires readiness of knowledge, technology, legal justification, and especially conventional awareness in business practices. Therefore, in the early stages of the development of the carbon accounting era in developing countries, especially in Indonesia, a set of management accounting engineering is needed as a stimulant for the application of the carbon accounting model (Caffrey and Chinn, 2015; Carbon Credit Capital, 2016; Csutora and Harangozo, 2017; Egbunike and Emudainohwo, 2017; Global Environment Facility-GEF, 2015; Gulluscio et al., 2020; He et al., 2021; Janzen and Bjorkquist, 2019; Rashid et al., 2020).

One recommendation from the Kyoto protocol is the carbon emission threshold and carbon trading system. Companies need new thinking and technology to implement the idea of carbon trading under the Kyoto protocol. The key issue in carbon trading is the amount of carbon that can be rationalized and the carbon trading market model that can affect business strategy, financial performance, and corporate value. To be able to lead to the idea of carbon trading, a good understanding of business and financial accounting elements is needed, such as capital, carbon credit demand and supply, business value of risk management, capital allocation, and even if possible, financial reporting standards specifically related with carbon transactions. In addition, issues regarding taxes related to carbon emissions taxes and the implications of transferring carbon trading prices need to be considered.

This study aims to explore the extent to which the carbon emission integration model in management accounting (implementation of carbon accounting) has an impact on accounting practices and corporate sustainability reports.

2. MATERIALS AND METHODS

2.1. Carbon Accounting: New Accounting Paradigm

Accounting is one of the essential disciplines of both for-profit and non-profit organizations. Accounting is the measurement, elaboration, or provision of certainty about information that will help stakeholders consisting of managers, investors, tax authorities, and other decision-makers to make the allocation of resources for companies, organizations, and government agencies. Broadly speaking, accounting is also known as "business language." In its development, the accounting paradigm experienced a development, one of which was carbon accounting. The carbon accounting paradigm encourages the birth of the Kyoto protocol, which one of its contents is setting the emission standards of an entity. If the mechanism contained in the Kyoto Protocol is implemented properly, it will create a clear carbon trading system, absorption of emissions, and carbon emission limits.

Carbon accounting is the process of measuring and tracking the amount of carbon emissions that are produced by individuals, organizations, and countries over a given period. It involves quantifying greenhouse gas (GHG) emissions and assigning them to specific sources or activities, such as transportation, energy use, and production processes. Carbon accounting is an important tool for understanding the environmental impact of human activities and for guiding efforts to reduce greenhouse gas emissions. By accurately tracking emissions and identifying the sources of carbon pollution, businesses, governments, and individuals can take action to reduce their carbon footprint and mitigate the effects of climate change (Bird et al., 2010; Bowen and Wittneben, 2011; Caffrey and Chinn, 2015; Carbon Credit Capital, 2016; Ciccotosto, 2013; Csutora and Harangozo, 2017; Egbunike and Emudainohwo, 2017; Hashim et al., 2017; He et al., 2021; Ja'far and Kartikasari, 2009; Janzen and Bjorkquist, 2019; KPMG, 2008; Liqiong, 2016; Meng et al., 2018; Miner and Gaudreault, 2013; Qu et al., 2019; Schmidt, 2009; Siregar, 2011; Standard, 2019; Stechemesser and Guenther, 2012).

There are various carbon accounting frameworks and methodologies, including the greenhouse gas protocol, the ISO 14064 standard, and the Carbon trust standard. These frameworks provide guidelines for measuring, reporting, and verifying greenhouse gas emissions and help organizations establish carbon reduction targets and strategies (Burritt et al., 2010; Caffrey and Chinn, 2015; Carbon Credit Capital, 2016; Global Environment Facility-GEF, 2015; Legosz, 2019; Linthorst et al., 2015; PCAF Netherlands, 2019; Siregar, 2011; Wang, 2017). Carbon accounting is increasingly important as governments and companies worldwide set ambitious targets to reduce greenhouse gas emissions and transition to a low-carbon economy. It is also an important component of carbon offsetting, which involves investing in projects that reduce or offset carbon emissions to compensate for emissions that cannot be eliminated.

Regarding this, the Kyoto protocol limits investment in low carbon dioxide (CO_2) emissions. Related to the development of these ideas, it will have an impact on various professions, one of them being the accounting profession. The carbon accounting era will develop if it is supported by an adequate accounting system and engineering. This is an important meaning in the carbon accounting paradigm in the development of accounting engineering to overcome the impact of global warming (ecological consideration) (He et al., 2021; Ratnatunga et al., 2011).

Carbon accounting is a relatively new concept in the field of accounting that involves tracking and reporting the amount of greenhouse gas emissions produced by a company. It is considered a new paradigm because it goes beyond the traditional focus of accounting on financial transactions to include the environmental impact of a company's operations. Carbon accounting involves calculating a company's carbon footprint by assessing the emissions generated from various sources, such as energy use, transportation, and waste disposal. The results of this analysis can be used to identify areas where a company can reduce its carbon emissions and improve its environmental performance. Carbon accounting represents a shift in the accounting profession towards a more holistic approach that considers not only financial performance but also the social and environmental impacts of business operations.

2.2. Carbon Cost Management

Carbon cost management is one part of carbon management accounting (CMA). Based on (Burritt et al., 2002) proposed a comprehensive framework for CMA that breaks down management information into physical and monetary dimensions, and the time frame of the decision-making process. This environmental-related accounting framework is applied to accounting for corporate carbon-related information. The carbon accounting framework serves as a fundamental guide to the information that are most relevant to corporate decision makers (stakeholders) and to how these properties are related to the practices and workflows related to collecting and managing carbon information and reporting. This framework also provides the foundation for comparing the scope, range, and potential variability of carbon accounting structures and processes in practice. (Burritt et al., 2010; 2011).

Ratnatunga and Balachandran (2009) proposed that carbon management accounting was a branch of environmental management accounting, whose main research was carbon dioxide (CO_2). Carbon management accounting played a decisive role in tackling climate change Ratnatunga et al., (2011) put forward a concept named Carbon footprint, which contained business policy, human resource management, market strategy, product strategy, pricing strategy, international strategy, promotion strategy, supply chain strategy and performance evaluation. Through interviewing companies that participated in the Carbon disclosure plan, (Kolk et al., 2008) proposed that carbon management accounting contained three layers, namely the technology layer (carbon emissions), value layer (monetary measurement), and cognitive layer (low carbon consciousness).

Ratnatunga et al., (2011) raised two carbon cost management tools. The first one was to separate the cost related to carbon trading from materials cost, overhead cost., and then summed them up to get the environmental cost. The second one was the carbon cost accounting method based on the product life cycle. It was suggested that carbon emission cost, carbon trading cost, and strategy management cost should also be considered in the carbon cost management system. Based on the study of environmental management accounting (Burritt et al., 2010; 2011), defined the content of monetary carbon accounting and physical carbon accounting under the past-oriented goal and future-oriented goal. In the monetary carbon accounting, we paid more attention to the reduction of investment.

Furthermore, Schaltegger and Csutora (2012) suggested that carbon management accounting should not only meet the social exaptation and market changes, but also contain the carbon-related issues in accounting scope, such as strategy and policy formulation. They advocated that companies use the international three-dimensional accounting method to determine the emission scope. (Scope 1: Direct emission; Scope 2: Indirect emission of purchased energy; Scope 3: Indirect emission of purchased product and service, including transport service, out-sourcing service etc.).

The emission right marketization and the absence of regulatory body make carbon management stay in an uncertain environment. Through qualitative research on two energy companies in Australia (an energy delivery company and an energy production company), Wahyuni and Ratnatunga, (2014) concluded that despite the two companies belonging to the same industry, they would build different carbon strategies and carbon management models in term of carbon disclosure, policies and reports in their accounting procedures. The carbon quota transaction or marketization should be considered as an important factor included in the carbon management accounting system. Carbon management accounting contains three processes: Target control, process control, and result control. Cost management is the quantitative reflection of these processes. It is necessary to make sure that the accounting scope of total carbon management cost, detail the cost management factors, ultimately order to accurately calculate the carbon management cost and grasp the carbon transaction opportunity in time are treated properly.

Carbon management accounting is a subset of carbon accounting that focuses on identifying and managing the costs associated with greenhouse gas emissions. It involves the measurement, analysis, and reporting of carbon emissions and the associated costs across a company's operations. Carbon management accounting aims to help companies better understand the financial implications of their carbon emissions and to identify opportunities to reduce those emissions and associated costs. It can help companies to assess the financial impact of different carbon reduction strategies and to make informed decisions about which strategies to pursue. Carbon management accounting can help companies to better manage their carbon emissions, reduce their environmental impact, and achieve their sustainability goals while also improving their financial performance. It is becoming increasingly important as companies seek to demonstrate their commitment to sustainability and respond to regulatory requirements related to carbon emissions.

2.3. Accounting Practice for Carbon Accounting

There is currently no authoritative accounting standard within international financial reporting standards (IFRS) dealing explicitly for transactions involving carbon units (KPMG, 2008). Given that there is no specific accounting standard on this topic, entities are currently required to draw from existing standards order to form their policies for carbon-related transactions. There is therefore clearly a need to monitor accounting developments in this space. This paper reviews existing methods for carbon accounting (concerning full carbon accounting) for forest-based bioenergy development:

1. The intergovernmental panel on climate change (IPCC) methodology is designed to calculate the emissions and removals from land use and land use change for a national inventory. The IPCC methodology does not aim to estimate the benefits of a project or an activity. The IPCC methodology does not discuss additionality, baselines, or leakage of carbon emission calculation. The IPCC methodology includes the use of climate models, which are computer simulations of the Earth's climate system. These models are used to project future climate scenarios based on different assumptions about greenhouse gas emissions and other factors. The IPCC methodology is a rigorous and transparent process that is designed to provide policymakers with the most up-to-date and accurate information on climate change, its causes, and its impacts. The IPCC reports are widely recognized as authoritative sources of information on climate change and are used by governments, businesses, and organizations around the world to inform policy and decision-making.
2. The EU renewable energy directive is designed in recognition the control of European energy consumption and the increased use of energy from renewable sources, together with energy savings and increased energy efficiency. The EU methodology constitutes important parts of the package of measures needed to reduce greenhouse gas emissions and comply with the Kyoto protocol to the United Nations framework convention on climate change and with community and international greenhouse gas emission reduction commitments beyond 2012. The directive requires EU member states to implement national renewable energy action plans and to provide financial and regulatory support for renewable energy projects. It also establishes sustainability criteria for biofuels and bioliquids to ensure that these sources of energy are produced in an environmentally sustainable manner.
3. The EU renewable energy directive is seen as a key policy tool for reducing greenhouse gas emissions and achieving the EU's climate and energy goals. It has helped to stimulate investment in renewable energy projects across the EU and to create new jobs in the renewable energy sector. In 2020, the EU announced a new target of reaching a 55% reduction in greenhouse gas emissions by 2030 compared to 1990 levels. This new target will require even more ambitious policies and measures to promote the use of renewable energy and to accelerate the transition to a low-carbon economy.
4. The clean development mechanism (CDM) is a market-based mechanism established by the United Nations Framework Convention on Climate Change (UNFCCC) to encourage developing countries to adopt cleaner technologies and reduce greenhouse gas emissions. The CDM only includes afforestation and reforestation (A/R) in the Kyoto Protocol. For these activities, the methodologies of CDM apply the IPCC methodology, with the additional conservative simplification of ignoring pools that can be demonstrated to have carbon stocks that are increasing faster. Hopefully, it was decreasing more slowly with the project than without the project. Under the CDM, developed countries can invest in emission reduction projects in developing countries and receive certified emission reduction (CER) credits for the emissions reductions achieved by these projects. These credits can then be used by developed countries to meet their emissions reduction targets under the Kyoto protocol.
5. The CDM is designed to promote sustainable development in developing countries by encouraging investment in clean energy projects, such as wind and solar power, and in energy efficiency measures, such as improving industrial processes or building insulation. The CDM can also support projects that reduce emissions from deforestation and forest degradation.
6. The voluntary carbon standard (VCS) is an organization outside the UNFCCC that is designing methodologies for use for non-compliant, voluntary emission reductions. The VCS builds on CDM methodologies for A/R, and the first non-A/R methodologies were submitted for public comment in 2010. The VCS has become one of the most widely recognized and respected voluntary carbon standards in the world, with over 2,200 certified projects in more than 80 countries. The VCS has also helped to promote sustainable development in developing countries by supporting projects that generate social and environmental co-benefits, such as improved access to clean energy, job creation, and biodiversity conservation. The VCS has played an important role in promoting private sector engagement in climate change mitigation and in supporting the development of a robust and transparent voluntary carbon market.

2.4. Corporate Sustainability

The increasing strategic importance of environmental, social, and ethical issues well as related performance measures has spurred interest in corporate sustainability performance measurement and management systems. These sustainability-oriented management

tools are based on the balanced scorecard (BSC) as originally proposed by (Kaplan, 2012; Kaplan and Norton, 1992; 1996), a multidimensional performance measurement and management framework originally organized hierarchically with four performance perspectives (finance, customers, internal processes and learning and growth) aimed at balancing financial and non-financial, short-term and long-term, as well as qualitative and quantitative success measures. The sustainability of a balanced scorecard (SBSC) goes a step further by explicitly integrating strategically relevant environmental, social, and ethical goals (Hansen and Schaltegger, 2016; Journeault, 2017).

The shortcomings of insufficiently comprehensive approaches to the measurement and management of corporate success have led to increased economic risks and problems for companies, the economy and society. About concepts of corporate social responsibility (CSR) and corporate sustainability, scholars and practitioners are interested in the integrated measurement of economic, social, and environmental performance by corporate sustainability performance measurement systems (Becchetti et al., 2022; Boffo and Patalano, 2020; Dathe et al., 2022; Hill, 2020; Morrison, 2021; Pollman, 2022; Zhang et al., 2020).

The integration of sustainability into the BSC is considered by or expected from organizations for various reasons. This becomes evident when analyzing the explicit or implicit theoretical foundations of the examined publications. Making use of previously existing classifications of theories in the domain of corporate sustainability and related fields, Hansen and Schaltegger (2016) identified three broad theoretical perspectives linked to the SBSC implementation:

1. Instrumental theories

Publications with this perspective discuss sustainability performance as a contribution to the achievement of conventional corporate objectives (e.g. profitability or market share) and thus the improvement of organizational performance. In this case, the SBSC is understood as a rational advancement in performance measurement and management.

2. Social and political theories

This perspective assumes the existence of interest group conflicts and power struggles among interest groups in society and thus considers a corporation's continued existence as dependent on how successful it is in gaining the approval of its stakeholders (Gray et al., 1995). In this perspective, management techniques such as the SBSC are not interesting for their potential to improve organizational efficiency but for their ability to help the organization adapt to external social expectations and so secure legitimacy.

3. Normative theories

This perspective involves a connection with more fundamental and better-accepted philosophical concepts (Donaldson and Preston, 1995), which makes it a moral duty to integrate sustainability issues and stakeholders into performance management systems. Publications with this perspective are not based on empirical evidence but instead on analytical argumentation.

3. METHODOLOGY

Qualitative research – A literature review was set to explore the ideas, methods, and techniques, of carbon accounting implementation. There are several methodologies for carbon accounting, including the life cycle assessment methodology, the greenhouse protocol from the World Resources Institute (WRI) (Finnegan, 2013), and the Intergovernmental Panel for Climate Change (IPCC, 2006). This research focuses on the implication of carbon accounting on accounting practices and corporate sustainability reports. There is a vast amount of literature on carbon accounting methodology, which encompasses a range of topics related to the measurement, reporting, and verification of greenhouse gas (GHG) emissions.

Standards and frameworks: There are numerous standards and frameworks available for carbon accounting, including the Greenhouse Gas Protocol, ISO 14064, and the Carbon Trust Standard. Studies have highlighted the importance of selecting an appropriate standard or framework that aligns with organizational goals and provides credible and consistent results. The literature on carbon accounting methodology emphasizes the importance of rigorous and transparent processes for measuring, reporting, and verifying GHG emissions. Advances in technology and new approaches to measurement and estimation are expected to continue to improve the accuracy and efficiency of carbon accounting in the future.

4. RESULTS

4.1. Carbon Accounting: The Building Block

The carbon accounting or carbon management accounting in terms of carbon-related information is chosen as the focus of attention of this study. The scholar gave attention and information needed in support of improved carbon management has received increasing attention over the last two decades reinforced by the introduction of emissions trading systems, the cleaner development mechanism and joint implementation measures (Burritt et al., 2010; 2011; He et al., 2021; Ratnatunga, 2008; Ratnatunga and Balachandran, 2009; Schaltegger et al., 2022; Wahyuni and Ratnatunga, 2014; Wang, 2017). Carbon emissions are subject to standardized quantitative measurement and are one of the common environmental aspects appearing in corporate external reports (WRI, 2013).

Since the withdrawal of IFRIC 3 in 2005, there have been no firm rules about how to account for emission allowances. There is no regulatory body that sets carbon-related accounting standards. This uncertain situation has allowed a range of accounting models to flourish, Lovell et al. Accounting for Carbon (ACCA, 2010). Accounting can be seen as a way of making things appear uncontroversial and non-political, but the technical debates about accounting rules and standards sometimes involve intense power struggles.

The increasing awareness of the scholars or practitioners to consider the financial bottom-line significance of emission allowance accounting – and the current level of disparity in corporate reporting – might usefully serve to persuade a

wider audience of academics (and policymakers) that financial accounting is a worthwhile and rich area of study. Recognizing that carbon markets have been created by governments and other institutions, and that these creations can be altered, opens up the possibilities for changing how they work, including their financial accounting. It is necessarily a partial overview of the history of accounting standard setting for emissions trading. It is hoped that a flavour is conveyed of the technical complexity and ambiguity of the treatment of emissions allowances in financial accounting, and of the fact that to date standard setting in this area has been a messy and uncertain process.

4.2. Carbon Accounting: Its Implication on Accounting Practices

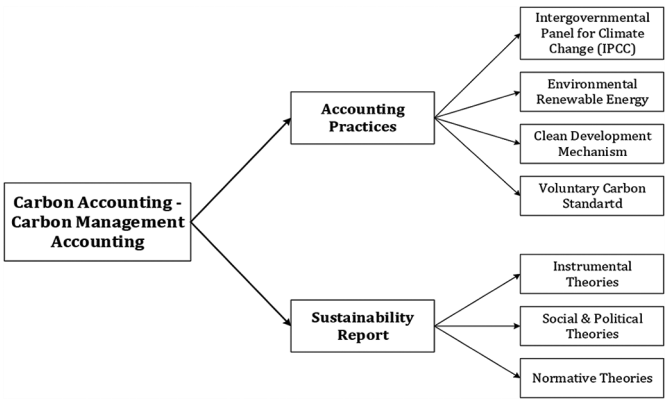
From the literature reviews, it is identified that there were 4 methodologies for estimating the carbon stock changes from land use change. Three of the methodologies are taken from the 2006 IPCC Guidelines, which adopts a tiered approach: the lowest tier (Tier 1) uses default parameters for the estimation and a simplified methodology; the middle tier (Tier 2) uses in general the same methodology but with national or regional data to make the estimate; and the highest tier (Tier 3) makes use of complicated carbon flow models that are parameterized with regionally specific information. In addition, there are slight variations in this general approach depending on the type of land use change. The 4th methodology is taken from the EU renewable energy directive, which adopts its methodology but is based on the approaches in the 2006 IPCC Guidelines (specifically Tier 1) (IPCC, 2006).

The implication of carbon accounting on calculating carbon footprint or greenhouse gasses that impact accounting practices is shown in Figure 1:

Based on the research conducted by ACCA found that large emitters within the EU ETS are using a diversity of accounting practices to account for emission allowances. In particular, this has the following aspects.

- Most of the companies surveyed are not following 'IFRIC 3', the original international accounting guidance issued in 2004 (and subsequently withdrawn in 2005).
- A large proportion of the companies (42%, or 11 of the 26) recognize emission allowances as intangible assets.
- Of the surveyed companies, 31% (eight companies) initially recognize allowances at nil value on the rationale that they are issued at no charge. Only 15% of the sample (four companies) are following the IFRIC 3 draft guidance to recognize emission allowances initially at fair value, with the difference between fair value and cost of allowances classified as a governmental grant (deferred income) on the balance sheet.
- Most of the companies do not disclose any information on amortization/depreciation of assets (69%, or 18 companies), or on revaluation, of emission allowances (50%, or 13 companies).
- Likewise, the majority of the companies (77%, or 20 companies) do not disclose any information on Certified Emission Reductions ('CERs' which can be used interchangeably with EUAs).
- Companies' accounting practices for revealing their overall position on emission allowances (as net assets or liabilities) vary hugely, with no discernible pattern in accounting treatment.

Figure 1: The Implication of Carbon Accounting on the environment



Carbon accounting refers to the process of measuring, tracking, and reporting greenhouse gas (GHG) emissions and removals from human activities, such as energy consumption, transportation, manufacturing, and waste disposal. Carbon accounting provides organizations with a framework for assessing their carbon footprint and identifying opportunities for reducing emissions and increasing efficiency. Carbon accounting is becoming increasingly important as more and more organizations recognize the need to reduce their carbon footprint to mitigate the impacts of climate change. Governments are also implementing policies and regulations that require organizations to report their carbon emissions and take action to reduce them. Accounting practices, on the other hand, refer to the processes and procedures used by organizations to record and report their financial transactions. Accounting practices are important for ensuring accurate financial reporting and compliance with legal and regulatory requirements. Carbon accounting and accounting practices are related in that both involve tracking and reporting data. However, carbon accounting is a specific type of accounting that focuses on GHG emissions, while accounting practices are broader in scope and cover all financial transactions.

In recent years, there has been a growing trend towards integrating carbon accounting into accounting practices. This has led to the development of new frameworks, such as the greenhouse gas protocol and the carbon disclosure project, which guide how to integrate carbon accounting into traditional accounting practices. By integrating carbon accounting into accounting practices, organizations can gain a better understanding of the financial implications of their carbon emissions and identify opportunities for cost savings through emissions reductions. This can also help organizations to demonstrate their commitment to sustainability and corporate social responsibility, which can be important for attracting customers, investors, and employees.

The impact of carbon accounting on accounting practices has been significant. Here are some ways in which carbon accounting has influenced accounting practices:

1. Integration of sustainability into financial reporting: Carbon accounting has also led to the integration of environmental

information with financial reporting. Companies are now required to report their carbon emissions in their annual financial statements, alongside other financial information. Carbon accounting has led to the integration of sustainability issues into financial reporting, requiring businesses to report their carbon emissions and disclose information on how they are managing and reducing their environmental impact.

2. Development of new accounting standards: The introduction of carbon accounting has led to the development of new accounting standards, such as the greenhouse gas protocol, which provides guidelines for measuring and reporting GHG emissions. Carbon accounting has also contributed to the development of new accounting standards. For example, the international accounting standards board (IASB) has developed a new standard on carbon accounting, which guides how organizations should measure and report their greenhouse gas emissions.
3. Increased demand for sustainability reporting: Carbon accounting has led to an increased demand for sustainability reporting, with investors, customers, and other stakeholders seeking information on a company's environmental impact and sustainability practices.
4. Need for specialized expertise: Carbon accounting requires specialized knowledge and expertise, which has led to the development of a new field of accounting professionals who specialize in sustainability and environmental accounting. The growing importance of carbon accounting has also led to increased demand for sustainability expertise within the accounting profession. Accountants now need to have a deep understanding of environmental issues and sustainability in order to provide effective carbon accounting services.
5. Changes in business decision-making: Carbon accounting has led to changes in business decision-making, with companies recognizing the financial and reputational risks associated with environmental impact and taking steps to reduce their carbon footprint.

Carbon accounting has important implications for accounting practices because it requires organizations to account for carbon emissions as a financial liability. This means that companies must report their carbon emissions as a cost on their financial statements and include them in their overall financial analysis. This information can be used by investors, stakeholders, and regulators to assess an organization's sustainability performance and to make informed decisions about investing in or doing business with the company.

Carbon accounting also requires organizations to assess and manage their carbon emissions throughout their supply chain. This means that companies must work with their suppliers to identify and reduce emissions associated with the production and transportation of their goods and services. This requires a deeper level of collaboration and transparency among organizations to accurately account for and reduce their carbon footprint.

Furthermore, carbon accounting can also impact the tax obligations of an organization. Some countries have implemented carbon taxes or emissions trading schemes, which require companies to pay a tax or purchase carbon credits to offset their emissions. These additional costs must also be accounted for in financial reporting and tax calculations.

In recent years, there has been increasing recognition of the importance of diversity in carbon accounting practices. This is reflected in international standards and guidelines, such as the greenhouse gas protocol and the science based targets initiative, which encourage organizations to consider social and environmental impacts in their carbon accounting practices. For example, carbon accounting practices may consider the social and environmental impacts of emissions on low-income communities, indigenous populations, or ecosystems that are particularly vulnerable to climate change. This can involve developing specific metrics and methodologies for measuring and reporting these impacts, as well as engaging with stakeholders from diverse backgrounds to understand their perspectives and priorities. Carbon accounting has had a significant impact on accounting practices, leading to changes in financial reporting, the development of new accounting standards, and the emergence of a new field of accounting professionals. As businesses increasingly recognize the importance of sustainability, the role of carbon accounting in accounting practices is likely to continue to grow.

4.3. Carbon Accounting: Its Implication on Sustainability Report

Companies using internal carbon pricing programs are also seeking to demonstrate leadership on sustainability, an issue that matters to their employees, consumers, and communities. By translating climate impacts into a business language, carbon pricing makes sustainability more visible for the company (Ahluwalia, 2017; Csutora and Harangozo, 2017; Gulluscio et al., 2020; Hashim et al., 2017; He et al., 2021; Janzen and Bjorkquist, 2019). The environmental and social issues were important factors of economic success, and often refer to as the "pays-to-be-green literature."

The initial guidance for basic decisions necessary when managers want to make environmental and social objectives as an integral part of their way of doing business and, more specifically, integrate them into the company's performance management and measurement framework. First, managers need to understand their organization's value system, which describes the general relationship between profit-making and sustainability. The value system indicates the "right" fit of the SBSC hierarchy and leads to hierarchical, semi-hierarchical, or non-hierarchical SBSC designs. We have indicated that it is more likely that public limited companies engage in hierarchical designs, while family businesses, public-private owned companies, cooperatives, and hybrid organizations may also tend to have semi-hierarchical or even network-like architectures. Second, based on the degree of proactivity of their corporate sustainability strategy, managers should engage in a process of strategy formulation in which they decide on the specific relevance to their corporate strategy. This would lead to the add-on, integration or extended designs of SBSC performance perspectives and related architectures (Hansen and Schaltegger, 2016; Janzen and Bjorkquist, 2019; Journeault, 2017; Rashid et al., 2020; Schaltegger et al., 2022).

Carbon accounting is a process of measuring and reporting greenhouse gas emissions (GHG) and removals of an organization or an individual. It involves collecting data on the amount of carbon dioxide and other GHG emissions that an organization produces, as well as tracking the carbon that is removed or sequestered from the atmosphere. Carbon accounting can help organizations identify areas where they can reduce their carbon footprint and improve their sustainability performance. Otherwise, sustainability reports are documents that organizations publish to provide information on their environmental, social, and economic performance. Carbon accounting has a significant impact on sustainability reports, as it is a key component of environmental performance reporting. In particular, carbon accounting can help organizations to:

Measure and report their carbon footprint: Carbon accounting provides organizations with a standardized method for measuring and reporting their carbon footprint. This data can be used to track progress over time, set targets for emissions reduction, and compare performance with other organizations.

Identify areas for emissions reduction: Carbon accounting can help organizations to identify the sources of their emissions and prioritize areas for emissions reduction. This can include reducing energy use, using renewable energy sources, improving transportation efficiency, and implementing more sustainable practices in their supply chain.

Improve stakeholder engagement: Sustainability reports are an important tool for engaging stakeholders, including investors, customers, employees, and communities. Carbon accounting can help organizations demonstrate their commitment to reducing their environmental impact and engaging stakeholders in their sustainability efforts.

Enhance transparency and accountability: Carbon accounting provides organizations with a transparent and accountable method for measuring and reporting their carbon emissions. This can help to build trust with stakeholders and demonstrate the organization's commitment to sustainability.

Carbon accounting allows organizations to identify their largest sources of emissions, set reduction targets, and track progress toward achieving those targets. By including carbon accounting data in sustainability reports, organizations can demonstrate their commitment to sustainability and their efforts to reduce their environmental impact. It also allows stakeholders, such as investors, customers, and regulators, to assess an organization's environmental performance and hold them accountable for their actions.

In recent years, there has been an increased focus on carbon accounting and its role in sustainability reporting. Many organizations are now required to report on their carbon footprint and GHG emissions as part of their sustainability reporting obligations. This has led to a greater emphasis on the accuracy and transparency of carbon accounting data, as well as the need for standardized reporting frameworks and methodologies. Carbon accounting has a significant impact on sustainability reports, providing organizations with a standardized method for measuring and reporting their carbon emissions, identifying areas for emissions reduction, engaging stakeholders, and enhancing transparency and accountability. Carbon accounting plays a crucial role in sustainability reporting by providing the data and information necessary to accurately report on an organization's environmental performance and demonstrate its commitment to sustainability.

5. CONCLUSION AND IMPLICATIONS

Carbon accounting refers to the measurement and reporting of greenhouse gas (GHG) emissions associated with an organization's activities, products, and services. The purpose of carbon accounting is to assess the carbon footprint of an organization and to identify areas where emissions can be reduced or avoided. The accounting methods for carbon need to be improved. There are so many areas of improvement in the carbon accounting methods and formulas. The improvement can be accessed through interviewing managers and employees in the company. The absence of a regulatory body to set carbon accounting standards makes unclear or ambiguous carbon accounting practices.

The implication of carbon accounting on accounting practices is significant. Carbon accounting requires organizations to collect data on their energy consumption, travel, and other activities that generate greenhouse gas emissions. This data must be carefully tracked and verified, which requires specialized accounting skills and expertise. This means that accounting professionals must be trained in carbon accounting methodologies and must have access to appropriate software tools to perform accurate calculations and generate reports. In addition, carbon accounting has implications for financial reporting. As environmental sustainability becomes an increasingly important issue, investors and stakeholders are demanding more transparency and accountability from organizations regarding their carbon emissions. This means that carbon accounting data must be incorporated into financial statements and sustainability reports. Accounting professionals must work closely with sustainability teams to ensure that this data is accurate and properly disclosed.

Carbon accounting has significant implications for accounting practices and sustainability reporting. It requires specialized skills and expertise, and it demands a greater level of transparency and accountability from organizations regarding their environmental impact. By incorporating carbon accounting into their accounting practices and sustainability reporting, organizations can demonstrate their commitment to environmental sustainability and meet the expectations of investors and stakeholders.

Discussions about the definition and classification of emission allowances are indeed progressing in the European commission, and are under review by the IASB and FASB as part of their emissions trading schemes project. The resolution of this matter is likely to influence the accounting treatments adopted. It is difficult to account for emission allowances, and revealed that there is a potential guidance role for auditors in the absence of an international accounting standard. Carbon accounting requires

organizations to report on their environmental impact, which is not traditionally part of financial reporting. Therefore, carbon accounting requires accounting practices to integrate sustainability into their financial reports.

As with emission allowance assets, there is diversity in the accounting treatment of liabilities and a considerable level of non-disclosure. Most of the sample companies (58%) value the obligation based on the cost of allowances already granted/purchased, which is usually close to zero, with the shortfall of allowances for the year measured at the market value. In practice, this means that the only liability recognition in the financial statements is for shortfalls in allowances. Carbon accounting is an essential tool for organizations to measure and report on their environmental impact. Its implications on accounting practices and sustainability reports include integrating sustainability into financial reporting, improving transparency and accountability, identifying cost savings, complying with regulations, and improving decision-making.

There is a diversity of accounting treatment of emission allowances in the EU ETS and this situation has arisen because of a lack of accounting guidance from standard setters in the period 2005-2010. This diversity in accounting practice means that company accounts of large EU ETS emitters cannot, in most cases, be directly compared, even though emission allowances are likely to be material to at least some of the companies. The accounting standard setters should issue clear guidance on emission allowance accounting as soon as is practical (noting that the timetable has already slipped further from an exposure draft that was due in 2009 to one now due in late 2018). As time goes on, the importance of resolving this area will grow as EU ETS emission allowances will be auctioned in EU ETS Phase 3 (which commences in 2013). A level playing field for accounting treatment and disclosure is required to allow fair and transparent comparison of EU ETS financial statements.

Future research on carbon accounting and its implications on accounting practices and corporate sustainability reports could focus on several areas:

1. Integration of carbon accounting into financial reporting: One potential avenue for future research is the integration of carbon accounting into financial reporting. This could involve exploring how carbon accounting data can be incorporated into financial statements, or how carbon accounting can inform decision-making around investment and financing.
2. Impact of carbon accounting on corporate sustainability reporting: Another area of research could examine the impact of carbon accounting on corporate sustainability reporting. This could involve investigating how carbon accounting influences the content and structure of sustainability reports, or how it affects stakeholder perceptions of corporate sustainability.
3. Role of carbon accounting in corporate sustainability strategy: Future research could also explore the role of carbon accounting in corporate sustainability strategy. This could involve examining how companies use carbon accounting to set emissions reduction targets or to inform the development of sustainability initiatives.
4. Link between carbon accounting and environmental performance: Another area of research could focus on the link between carbon accounting and environmental performance. This could involve investigating the extent to which carbon accounting accurately reflects environmental impact, or how carbon accounting data can be used to drive improvements in environmental performance.

Comparison of different carbon accounting methodologies: Future research could compare and evaluate different carbon accounting methodologies and frameworks, to identify best practices and areas for improvement. Exploring the strengths and weaknesses of different approaches to carbon accounting, or assessing the accuracy and reliability of different carbon accounting tools and techniques.

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