



**Università degli Studi di Padova**  
**DEPARTMENT OF ECONOMICS AND MANAGEMENT**  
**“M.FANNO”**

**MASTER PROGRAM IN**  
**ENTREPRENEURSHIP AND INNOVAION**

**“CLIMATE CRISIS AND ORGANIZATIONS: THE ROLE OF**  
**ACCOUNTING AND MANAGEMENT CONTROL”**

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Firma dello studente

A handwritten signature in black ink, appearing to read "Dono", is written above a horizontal line. The signature is stylized and cursive.

## Aknowledgement

I would like to express my deepest gratitude to Professor E. Passeti, whose priceless guidance, reviews, have been crucial in the development of this thesis. His flexibility, prompt feedback, and unwavering support in helping me meet deadlines have significantly shaped my academic and professional growth.

I am eternally grateful to my parents, whose moral support has given me the strength to keep moving forward. A heartfelt thank you to my brothers and sisters—Eman, Reda, Yahia, Sara, and Saif—for their constant encouragement and support.

To my wife, my greatest companion on this journey, your steadfast support and assistance have been my anchor throughout this process.

I also want to express my sincere thanks to my friends—Samy, Samaha, Ebeid, Khaled, Mostafa Bahbah Metwally, Amin, Emam, Adel and Amir—for the beautiful memories we've shared and their continued encouragement.

Lastly, I deeply appreciate the representatives of the companies involved in this research, who generously offered their time and insights during the interviews, making this work possible.

Thank you all for your contributions to my journey. I am profoundly grateful and wish you all continued success.

Done

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# **Chapter 1: Introduction**

## **1.1 Background of the Study**

### Historical Background about Climate Change Mitigation and Businesses

The link between climate change mitigation and businesses in the past few decades has seemed to change constantly. First, analyzing the movement toward industrialization on the example of the 19th and the 20th centuries enterprises were concentrated on economic objectives disregarding ecological aspects. Industrial processes such as in factories, power plants, and other industries emitted relatively high levels of greenhouse gases without much concern with the repercussions it has on the environment. Before the end of the twentieth century, there was conclusive proof that human activities were in a way causing global warming. The appearance of the Intergovernmental Panel on Climate Change (IPCC) reports beginning with the publication of their first document in 1990 became the beginning of awareness of the need for actions against climate change (IPCC, 1990).

To address these issues, the United Nations Framework Convention on Climate Change commonly known as UNFCCC was signed in 1992 and the Kyoto Protocol signed in 1997 elaborated legal emission reduction targets for the developed countries. Companies especially the power generation and manufacturing industries started experiencing pressure to lower their emissions. In their initial stages, market actions in climate change were mainly motivated by policy controls; however, businesses began to discover potential opportunities for market creation in clean technologies, renewable resources and environmentally sensitive business processes.

In the twenty first century, business organizations have embraced an active role in combating abuse of climate. Today large organizations have set sustainability targets not only to meet the legal requirements, but also to meet the emerging customer needs. The ratification of the Paris Agreement in 2015 has also pushed more organizations to adopt climate change strategies and most organizations have taken climate change serious by declaring themselves as net-zero organizations while setting science-based targets (SBT) of global temperature rise to below 2 degrees Celsius. It focuses on how climate change mitigation has mortgage with businesses and how these companies can adapt to the changing political and market environment on fulfilling the sustainability agenda.

## **Sectors Company GHG Emissions**

Emissions in the global economy can be contributed by different sector in varying proportion. The energy sector is still the leading sector in the emission of greenhouse gases contributing to over 70% of the emissions. The use of fossil fuels for generation of electricity, for home heating, and mainly to power automobiles is the main cause of CO<sub>2</sub> emission. The manufacturing industry is also and especially heavy industries including steel, cement and chemical industries contributes approximately 20% of global emissions because of its activity, which is power intensive.

Agriculture is estimated to be producing an approximate of 10% to 12% of the global GHG emissions whereby about 65% of the emissions comprise of methane (CH<sub>4</sub>) from livestock, and other 35% embody nitrous oxide (N<sub>2</sub>O) from the management of agricultural soils. The transportation sector, including road, air, and sea, contributes to about 13. Six % of the total global emissions, the road transportation subsector emissions are the highest because most of the vehicles use gasoline and diesel.

Companies have a significant role in defining our approach to climate change and reduction of GHG emissions. The determination of the major sources of carbon emissions, the assessment of progress in global reduction in carbon emissions, or the formulation of appropriate policies towards the promotion of a low carbon economy all require accurate and consistent carbon inventories.

In the last twenty years, environmental concerns have increased their level of importance internationally mainly caused by disastrous events such as Bhopal gas tragedy in 1984 and the Exxon Valdez oil tanker disaster in 1989. Such events, which received worldwide media coverage, boosted awareness of important issues including warming of the global temperatures, non-renewable resources, and loss of natural habitats.

This has resulted in increased ‘watching’ of businesses and many demands for change from organizations such as Friends of the Earth, Greenpeace, United Nations, the European Union, the UK government, the British Bankers Association, insurance firms and pension funds. It has now been realized that our present lifestyle is unsustainable and dangerous to both man and earth, leading to international treaties that seek to prevent future harm on environments which include; Montreal Protocol, Rio Declaration, Kyoto Protocol among others.

Organizations have woken up to the realization that they are part of the problem and hence the need to find solutions to this problem. It has become a central factor that has to be considered while doing

business alongside other such as product development, promotion, and capital management. Some negative consequences of environmental negligence include; fines raised environmental taxes, reduction in land value, and destruction of brand value, loss of sales, consumer boycotts, and high chances of non-financing, high probabilities of insurance non-renewal, contingent risk, and legal risks and compromised corporate image.

Among the organizational factors, environmental conditions exert influence on all organizational activities including accounting. Originally, these pressures emerged in relation to the external reports, environmental information in the annual and other financial reports and environmental reporting and the preparation of the environmental accounts. However, to address the environmental issues, there are changes that need to be made to the internal management and this then need to be reported through changes in the management accounting systems.

Evaluations from traditional management accounting perspective tend to overemphasize the cost of poor environmental behavior and underemphasize the benefits and costs of better environmental performance. For example, a recent UK government campaign found out that due to inefficiency companies wasted 30% of the total energy cost. There is scope to enhance management of energy utilization, which would lower the associated environmental cost of energy generation by 30 per cent as well as trim organizations energy costs by the same percentage.

### **Environmental Management Accounting (EMA)**

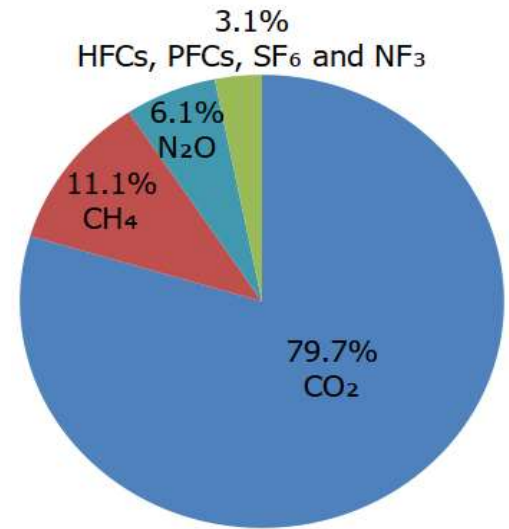
EMA entails the creation of financial and non-financial data and the subsequent analysis of the same to aid internal environment management. It is an expansion of traditional financial management accounting since it creates ways of recognizing and assigning costs of environments (Bennett, 1998). Some of the major uses of EMA include product costing, budgeting, investment evaluation, determination of costs and benefits of environmental initiatives, and establishing quantifiable performance standards.

EMA embraces all of the management accounting concerns, works with the similar techniques, and encompasses as many disciplines as the traditional management accounting does. Considered EMA terminology rather imprecise and saw it as a type of conventional accounting adopted to ascertain environmentally inflicted repercussions in monetary terms, application-related impacts on systems in physical measures (Burritt R. L., 2001).



They have come up with the nature of data collection that makes up EMA, which includes internal/external, physical/monetary, past/future time, short/long-term, and ad hoc/routine.

In this context, Bennett and James (1998) offer a perspective on the range and scope of EMA as well as models such as The Environment-Related Management Accounting Pyramid as tools for assessing as well as for designing EMA practices. EMA entails collecting non-financial and financial environmental information that is there turned into useful information about the organization through management accounting techniques such as performance measurement, operational budgeting and costing.



### Greenhouse Gases

Greenhouse gases include seven gases that directly affect climate change: Greenhouse gases include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), chlorofluorocarbons (CFCs), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), sulfur hexafluoride (SF<sub>6</sub>) and nitrogen trifluoride (NF<sub>3</sub>). These gases are reported in CO<sub>2</sub> equivalent and relates to Gross Direct Emissions that result from human activities. These are Carbon dioxide emissions only from Fuel combustion and these data are from the International Energy Agency. Other air emissions include sulfur oxides or SO<sub>x</sub>, nitrogen oxides or NO<sub>x</sub>, carbon monoxide or CO and volatile organic compounds or VOC, except methane. There are units in thousand, tones per capita, kilograms per capita, thousand tones CO<sub>2</sub> in million tones and tones per capita.

**Figure 1** (Overview of greenhouse gases. EPA., 2024)

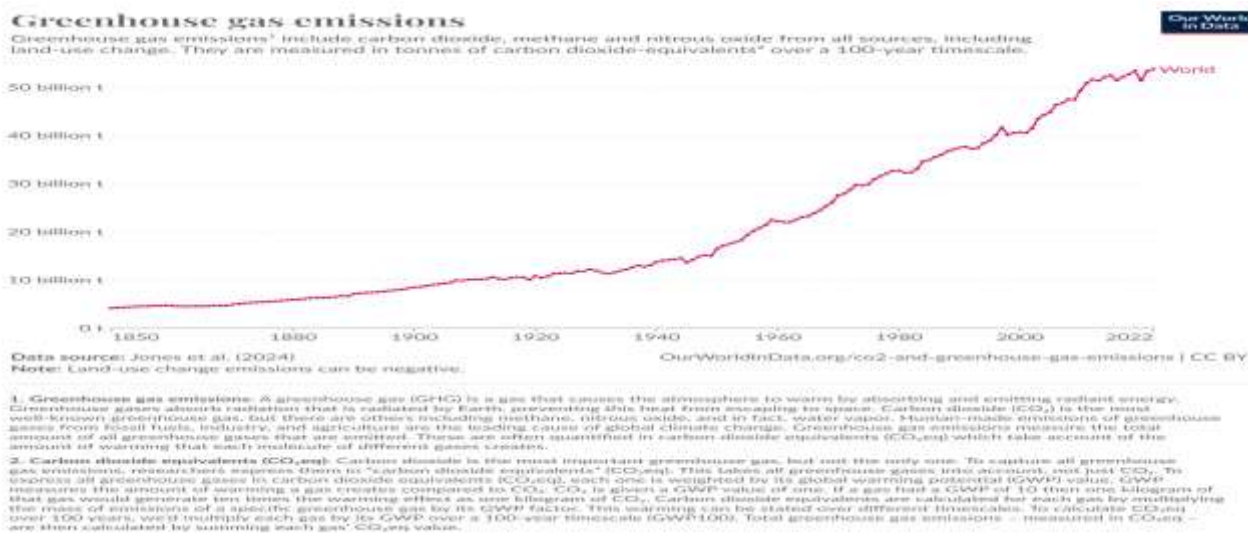
Global greenhouse gas emissions result from various human activities, with many sectors playing an important role in this escalating environmental issue. One major contributor is the transport sector, which relies heavily on petroleum-based fuels such as petrol and diesel. These fuels power cars, planes, ships and other large transport vehicles, releasing large amounts of greenhouse gases that further exacerbate global warming.

Electricity generation is another major factor. Much of the world's electricity comes from burning fossil fuels such as coal and natural gas, which emit large amounts of carbon dioxide and other harmful gases into the atmosphere. This reliance on fossil fuels for energy production is a critical driver of climate change.

The industrial sector also contributes significantly to rising global temperatures. Factories and production facilities require a great deal of energy to produce goods and services, much of which is sourced from fossil fuels. Consequently, the industrial sector's carbon footprint remains significant.

Furthermore, both the commercial and residential sectors add to greenhouse gas emissions, especially using fossil fuels for heating and cooling systems. The daily demand for energy in homes and businesses further exacerbates the issue.

Finally, agriculture is a vital source of global greenhouse gas emissions. Growing certain crops, such as rice, along with raising livestock (especially cows, sheep and goats), releases methane and other greenhouse gases into the atmosphere. These agricultural practices increase



(2024.) **Figure 2**

As it can be seen from the graph that, the global emission of greenhouse gases can be observed in the pie-chart entitled 'Greenhouse Gas Emissions' where emissions are measured in terms of tons of CO<sub>2</sub> equivalent; the graph presents the data from 1850 to 2022. From the data, a continuously increasing

trend in was realized going up from eight. Three percent in the first twenty years of the twentieth century to 9.25 percent in the last twenty years of the twentieth century, though the increase is evidently much steeper starting from the middle of the twentieth century.

**Historical Growth:** In the period 1850 and the middle of the twentieth century, the concentration of GHGs in the atmosphere rose gradually as countries across the world became industrialized. The emissions were still considerably low in comparison with the times marked by significant fluctuations in the second half of the twentieth century. This rise in emissions after 1950 can be attributed to the post Second World War economic development, subsequent industrialization and the global utilization of fossil energies as the driving power.

**Acceleration in Emissions:** From the graph, one can clearly see the cause of the dramatic rise of GHG emissions from the 1970s, which was a result of increased industries, energy usage, and deforestation to create space for agricultural land. It also includes development of developing countries hence the increase in emissions during this period.

According to the data, in 2022 the emissions rose to approximately 50 billion tonnes of CO<sub>2</sub> equivalent meaning that the global emissions continue to rise despite the awareness and actions towards climate change.

**Status:** If the above analysis is made, based on the graph it will be seen that the world is still in the process of emitting GHGs in 2022 and later years at an alarming rate and there is no real hope of a vast reduction in emission. This trend is dangerous to climate change since it leads to extreme weather conditions, rise in sea level, and other havoc effects.

## **1.2. Research Problem and Question**

Understanding that climate change is a significant danger, and its effects touch various parts of our daily lives since it affects every part of the world, leading to many issues such as:

**High Temperatures:** Global warming has implications that go beyond the physical world and its effects extend to health and performance of economies. Where there are high temperatures, different activities may lead to effects such as; High Temperatures increase mortality rates especially among vulnerable groups like aged people, infants and sick persons. In addition, heat is known to decrease occupational productivity due to heat stress especially in industries that operate under high environmental conditions such as agricultural industries and construction companies (EPA, 2020).

Extreme heat also threatens the infrastructure: roads may melt, railway tracks bend and buildings demand more cooling system, which overwhelms power stations and causes blackouts. The mentioned challenges work in synergy making social inequalities worse since individuals with poor health care services or little access to cooling solutions are the most affected.

**Droughts:** Due to climates, fluctuations, several regions in Europe and other countries have noticed an enhancement in the period, intensity and duration of the drought periods. Meteorological or water deficits that imply less availability of the water resource due to deficits in rainfall and high evaporation ratios linked with high temperatures present significant issues to water security challenges. This is different from water rationing which means a long-term condition where people are restricted in the amount of fresh water they use because of its over usage. Drought is a severe threat to agriculture as it results to crop failure, low yield or high food prices hence they adversely affect those at the lower end of the economic scale. The energy sector is also affected; especially in those sectors largely dependent on hydro power where the flow of water has, reduced meaning less power is generated. Source of public water supply systems are being stretched in a way that rationing and competition for the resource are inevitable in many cases. For example, out of the approximately 9 billion EUR lost to drought in Europe each year, around seventy percent is incurred by the agriculture industry, the energy sector, and public water supply (Commission, Consequences of climate change, 2024).

**Floods:** Various weather changes such as climate change and global warming are likely to cause more precipitation hence making flooding incidents to be more frequent and severe in many areas. Most floods are because of persistent rainfall resulting to fluvial floods that is, flooding because of water surging over its natural edge. The floods, which can occur and cause death, people to be displaced and properties to be destroyed. Pluvial floods occur where short, definitely intense rainfall occurs, and the water does not reach any water courses and is common in most parts of Europe and other developed countries. It should be noted that these floods could easily overload the intermediate sewerage systems and cause the streets, homes and businesses to flood rapidly. Floods have a tremendous economic effect costing expenses toward emergency, repair, and recovery and loss of production. In addition, there are cumulative effects necessary arising from water borne diseases, which emanate from floods and pollution of water sources.

**Sea-Level Rise and Coastal Areas:** One of the worst and most obvious effects of climate change is the increased sea-level, mainly due to thermal expansion of seas, enhanced melting of glaciers and

Antarctic ice cap. Citizens of coastal regions are in danger of flooding, especially low lying areas, which may experience perennial flooding. This not only puts at risk the lives and source of livelihood of millions of people residing in low lying coastal areas but also the infrastructure that is necessary for our continued survival namely; ports, roads, and sewage works. A change of the source water quality due to intrusion affects the quality of water used in agriculture and by consumers. Further, there is exacerbation of the effects of hurricanes and typhoons due to frequent and higher levels of sea surges due to increase in sea levels. Climate migration, where people have to leave their homes due to rising sea levels, will continue to grow creating more social and economic problems that will not only occur in the area but also in the area to which the victims will be relocated. (Commission, Consequences of climate change, 2024)

**Biodiversity:** Climate is an important determinant of life processes it requires a shift in the focus from phenology, habitat occupancy, carrying capacity, species identity, vegetation characteristics and population turnover rates. When the temperatures get high and the patterns of precipitation are disturbed, many organisms are displaced to new areas resulting in the destruction of ecosystems and the loss of species 'diversity.' For those species which cannot move from one area to another the chances of their extinction rocket. Land and resource use changes that are attributed to climate change also affect habitat requirements and distribution of species. Population losses are also felt directly on other services that are fundamental for human survival including pollination, water purification and soil fertility. Some of the actions that must be taken to ensure the conservation of the species in the face of climate change include an integration of the conservation of the bio diverse species in the overall approaches towards combating the climate change issue.

**Soils:** Global warming may exacerbate different concerns that are related to soil health such as erosion, loss of organic matter, salinization, and reduction in the population and diversity of soil, landslides, desertification, and flooding. It is necessary to mention that soils are also one of the major components that help to store carbon and act as a sink for atmospheric carbon dioxide. Consequently, climate change has underlying connections with changes in atmospheric CO<sub>2</sub> concentrations, increase in temperature and alteration in precipitation regimes on the storage of carbon in the soil. These shifts can make the stored concentration of carbon to be released into the atmosphere thus increasing global warming. Degraded soils also lose the land's ability to support agriculture that reduces food production thereby increasing food insecurity. In addition, the depletion of the soil biological stock that is used in decomposition and absorption of nutrients is a sign of a weakened ecosystem to climate change.

Combating the looming problem of soil degradation will only be next possible through adoption of appropriate use and management of soil hence the need to embrace sustainable land management practices and policies aimed at soil conservation and restoration.

All these issues drive me to explore innovative solutions through environmental management practices to reduce greenhouse gas emissions. Therefore, my research focuses on answering this question: How can environmental management accounting practices help reduce GHG emissions in organizations under strict environmental regulations? By thoroughly analyzing this question, I aim to propose potential solutions that are not only effective in reducing emissions but also practical for organizations to implement. These solutions will consider the economic, social, and environmental dimensions of climate change, ensuring that organizations can contribute to global efforts to mitigate climate change while maintaining their operational and financial viability.

### **1.3. Objectives of the Study**

The main aim is to look at the possible strategies that organizations can adopt in managing the environment to ensure that greenhouse gas emissions are contained and the effects of climate change are fought. In particular, I will discuss EMA practices and their impact on an organization's ability to mitigate emissions. I will also set up recommendations that may serve to improve the environmental performance of organizations.

The research will consider how the current legal systems can incorporate the practices of environmental management accounting and the probable difficulties that the organizations would face in putting those practices in place. All these factors need to be considered in the policy formulation that would encourage good environmental practices rather than compliance with the law.

In addition, the research taps into the steps being undertaken toward using the technologies and innovations to upgrade the practice of EMA. The research will, therefore, critically evaluate the adoption of current solutions through carbon accounting software and life cycle assessment, finding in what ways technology can boost environmental management efficiency and assure the provision of information with further relevance for decision-making.

Moreover, this research will engage in a conversation on the effectiveness of EMA practices in relation to corporate culture and leadership. It explores the commitment that comes from organizations toward sustainability, led by the degree of leadership while embedded within the organizational culture, and

how that affects the effectiveness of the implemented policies and practices for environmental management. In that respect, this phase of the research adds insight into the human and organizational elements that are critical in the creation of meaningful change in the environment.

This study further compares how the global regulatory and local regulatory environments influence the implementation and effectiveness of EMA practices. Case studies from different geographical areas and sectors will be analyzed in order to identify the success factors and difficulties of integrating EMA practices with IMS requirements and country-specific legislation. This comparison will provide a broad view on how different types of institutional environments can either enhance or hinder the implementation of sound environmental management policies.

In conclusion, the primary purpose of this research is to suggest possible measures that can close the existing gap between environmental laws and their enforcement. These measures can help organizations reduce the scale of their greenhouse gas emissions, become more sustainable, and contribute globally to the fight against climate change. More specifically, this research contributes to providing a better understanding by policymakers, business management, and environmental managers in raising a more strategic movement for acceptance within regulatory requirements and dealing with any occasional environmental impacts.

#### **1.4 The significance of the study**

This is an important study because it will help us understand how companies can utilize EMA to reduce the amount of their GHG emissions, a very critical issue in mitigating the climate crisis. For these reasons, there are various grounds on which this research proves to be of significance.

Development and enforcement of policies: This study may find its findings to be effective in developing more practical and implementable environmental policies and regulations. To be achieved out of the determination of the relationship between EMA practices and GHG emissions reduction is a way of enabling the regulators to develop regulation that may encourage the organizations to practice the best methods in environmental management.

Organizational improvement: The findings from this study will assist organizations in understanding how to align EMA practices within their operating organization. A company can improve its environmental management system and its overall sustainability performance by inculcating such practices.

Sustainability and environmental impact: The broad goals regarding sustainability issues, if successfully implemented, can be achieved through EMA practices that have been discussed as the first two objectives. This study would be useful to organizations as it could help reduce their effect on the environment and place them in line with the rest of the globe as regards efforts to reduce climate change.

Economic benefits: The economic consequences of the implementation of EMA practices will also be investigated since it may lead to cost savings from energy efficiency and from waste reduction. These financial benefits may serve as a driver for organizations to adopt sustainable practices since this will prove that environmental responsibility and profitability can coexist.

Contribution to academic knowledge: Finally, this study adds to the existing body of literature on environmental management and accounting. It provides empirical evidence about the effectiveness of EMA practices in reducing GHG emissions, which may be relevant for future research and academic discourse.

## **1.5. Scope and Limitations**

### **Scope of the Study**

The study focuses on the implementation of Environmental Management Accounting practices in organizations and how such practices can be utilized to manage and control greenhouse gas emissions. It will go further to elaborate on how environmental and financial information is integrated toward internal management, decision-making, and helps a business improve its general environmental performance. EMA practices are examined as a vehicle by which to lower emissions but also to increase efficiency by combining environmental sustainability with fiscal goals.

The geographical scope will be aimed at companies that operate under strict environmental regulations. This is true not just for regions of the world such as the European Union, which has started to put full environmental policies in place, such as the EU Emissions Trading Scheme, but also for the Middle East, slowly moving towards a sustainable environment despite its traditional economy based on fossil fuels. In addition, peculiar organizations are those that are global in nature and therefore have to contend with varying environmental legislations in every jurisdiction. These have been selected because they involve different regulatory regimes and, therefore, would enable an analysis of the richness with which EMA practices adjust to different legislative environments.



The selected industry sector will also capture a wide range of industries, and special consideration will be given to the ones with considerable greenhouse gas emissions. Critical in the list of sectors are manufacturing, energy, and transportation, which altogether emit large quantities of greenhouse gases globally. These sectors are very important, for not only an overview of the effectiveness of EMA practices but also to understand in detail the peculiar difficulties of high-emission sectors in reducing their environmental impacts.

This study will also explore how regulatory frameworks play a role in shaping EMA practices. It will look into how the existence of environmental regulations drives companies towards the same and how the state of compliance affects the company's environmental performance. Analyzing the interaction of regulatory conditions with organizational behavior, the study will search for an answer to whether strict regulations act as a stimulus for improving sustainability or simply force minimal compliance.

An important part of this research will be made up of case studies and empirical data. Thus, an attempt is made here to choose case studies from a wide range of organizations, industries, and regions to appreciate the implementation of EMA practices and to know their efficacy. These will help analyze in detail how EMA systems are structured, how environmental and financial data are integrated, and how these practices impact overall corporate sustainability. Empirical data will be gathered through primary data collection methods in the form of interviews with some key stakeholders, such as environmental managers, financial officers, and sustainability leaders. In this regard, the qualitative findings from interviews will put the quantitative findings to offer an understanding of EMA's role within organizations.

### **Limitation of the Study**

Despite the potential contributions that this study may bring, several limitations must be acknowledged. The key challenge lies with availability and quality of data. Most often, data on environmental management, and in particular greenhouse gas emissions, does not seem to be available on a consistent or high-quality basis. In that respect, either organizations lack comprehensive data related to their environmental practices, or they present incomplete or outdated data. These data limitations are likely to be problematic for the analysis when the overall impact of EMA practices, taking into account various sectors and regions, is to be determined.

The other limitation is with respect to the generalizability of findings of this particular study. This study analyzed particular industries and geographic locations, and as such, the results may not be generalizable. A good example is that which works out well in the European Union or Middle East cannot be directly transferred to other parts of the world with different economic conditions, industry structures, or regulatory environments. This may limit the generalizability of the conclusions from the study, particularly to industries or regions that were not part of the case studies.

Another critical limitation lies in the fact that regulations vary from one country to another and from one region to another. The environmental laws and regulations vary largely between jurisdictions, from very stringent in the European Union to mild in other jurisdictions. Since this study will focus on regions with stringent environmental concerns, it may not reflect a holistic understanding of how organizations in less stringent environments behave. This regulatory gap could have an impact on the conclusion of the research, and therefore the results cannot be generalized to areas where a different legislative approach toward environmental management is practiced.

Time is also a constraint to this study. In-depth interviews and comprehensive data collection from many organizations may be a time-consuming task, and the current short-term frame of the study may not permit the gathering of such detailed information as needed. In this sense, some of the data may not be complete or exhaustive in its nature, meaning that there is a possibility of affecting the robustness of the analysis.

Finally, the study may have an interview bias. Data collected through interviews at times may be based on the personal views, experiences, or biases of the respondent. The opinions of the effectiveness of EMA practices by different stakeholders can be said to be in a harmonious dichotomy, and that will shape the conclusion by which the interviews will be drawn. Although efforts will be made to minimize this type of bias through the cross-referencing of interview data with empirical evidence, it still poses a potential limitation that could impact study findings.

## **Chapter 2: literature Review**

### **2.1 Climate Crisis and its Impact on Organizations**

The impacts of climate change on organizations are significant , affecting everything from daily operations to long-term strategic planning. Companies must recognize the importance of building resilience and adaptability to ensure sustainability in a changing climate. As It is a massive discontinuous change that causes changes in the global average temperature, disturbance in precipitation patterns, and occurrence of extreme weather events (Adelekan, 2022)

Climate change impacts include changes to our weather, coasts and oceans, and the natural and built environment. These impacts are localized, and the way they impact your business will vary depending on your industry, global location and vulnerability such as what your business facilities are made from, and the services it depends on (strategies T. I., 2024, pp. 2-5).

Adding more complexity is the impacts of climate change from multiple natural disaster events; including exposure to drought, bushfires, and floods in short succession.

Impacts of climate change on business can be direct or indirect:

Direct impacts affect your business significantly, such as physical damage from floods or bushfires, or forced closures.

Indirect impacts are the flow-on effects of climate change or extreme events, such as a supply chain being disrupted by extreme weather, or income being reduced .As each business is unique in its location, operation, and supply chains, it is important to identify the specific climate risks to your business sector and location, and plan accordingly.

#### **Effects on small businesses**

Small businesses are the life blood as they encompass the backbone of the economy; they offer the community services that are critical for it; they offer employment opportunities in communities; and they define the attributes of places that people hold dear. Whenever climate change affects small business operation in a community, then a ripple effect on everyone in the community is witnessed.

The agricultural impacts of climate change through extension of the effects have severe consequences to small businesses. Climate change is adding some sorts of weather incidences in that it intensifies the

occurrence of such events. This puts more pressure on business since it can be vulnerable to several severe events within a short time such as droughts, fires, floods among others . The effects of that range by the business location, industry, and susceptibility. Taking into account that in the case of small-sized companies, the matter becomes more serious, as :

Small companies lack the financial reserves that enable them to face such crises, which may lead to permanent or temporary closure. These companies rely heavily on local supply chains or networks , which may sometimes lead to large losses due to delays and disruptions in the delivery of products.

Such small-scale companies do not have sufficient funds to insure long-term climate change risks and may sometimes lead to the failure of the organization as a whole or cause the loss of a large number of jobs.

### **Effects on medium sized businesses**

In the case of the medium business, climate risk vulnerability is unpredictable and is closely related to the business's industry. medium business may face climate risk intra supply chain disruption, problems of comfort and energy efficiency of the buildings and others and climate risk legal liability. Food and nutrition security and health of the employees and the manner in which this is affected by climate change is also relevant.

Civilization, and especially agriculture, forestry and fishing industries are most vulnerable to adverse effects of climate change disasters. Most of these business operations require natural resource inputs, as do virtually all business operations. However, other sectors like retail trade, tourism and manufacturing are also vulnerable all classes of business are under threat from climate changes. Medium-sized companies are also affected by climate crises, although this impact is less than their small-sized counterparts are, due to the fact that medium-sized companies have a more stable infrastructure (Williams, Understanding the Role of Climate Change in Business Disruptions., 2020).

However, it is worth noting here that although these companies have more financial resources, they incur heavy losses in times of climate crises because they depend on a complex supply network. They also suffer from high costs to improve energy efficiency, adaptation, and compliance with strict environmental policies.

## **Effects on large-sized organizations**

The large-sized organizations are likely to feel consequences of climate change on all organizational levels, across multiple activity domains and their strategic plans for the future sustainability:

Supply Chain Disruptions in large organizations are intricate, and mostly multi-tiered and cross national. These supply chains are at risk to be severely affected by climate change through climate disruptions by means of severe events including floods, hurricanes, and wildfires among others. These disruptions give rise to possibility of delays in manufacturing processes, additional cost, and problems in procuring inputs (Carter, 2020). In addition to supply chain, The Regulatory and Compliance Pressures play a crucial role as the Measures taken by governments across the globe towards mitigation of climate change impacts exert pressure on large organizations. They include; increased environmental legalisms, carbon trading and certification on green undertakings. Such laws can be extremely expensive and necessitate fundamental changes in structure of work as well as goals and objectives. Furthermore the Reputation and Brand Value Mainly for these large organizations operate in the public domain and therefore their strategies and actions towards climate change are rapidly followed and reported. This is because, leaving climate risks unmanaged, can cost firms their brand equity, consumer trust, and reduce their brand worth. On the other hand, proactive climate action has benefits that can boost the company's image and people's trust in it. Also Financial Risks and Investment Challenges one of the most important challenge for large-sized organization as the Global warming has a lot of balance sheet risks for the big firms, say the dangers of loss in the value of fixed input and rising insurance premiums. Due to climate risk assessments, investors are starting to factor in climate risk within investment decisions and the availability of capital and cost of financing will impact big business which will be seen not to be ready to endure climate change (Williams, Understanding the Role of Climate Change in Business Disruptions, 2020). The operational Efficiency and Energy Costs that an optimization of day-to-day operations as well as an efficient management of energy consumption must lay at the center of any strategy. Energy intensity and greenhouse gas emissions reduction can result in major operations alterations. Big structures may require integration of new technologies, modifications to structures, and transition to green energy in order to address climate effects. Although, these changes may spawn long-term cost benefits, the required initial financial commitments are often high. Getting more deeper we can say that Employee Health and Productivity is impacted by Climate change as its impacts are expected to bring about not only significant changes in climate and ecosystems, but also dramatic changes in social and economic system parameters

(Monika Winn, 2011, p. 159). The climate change can also have impact on the health of the employees and company productivity as many industries involve activities that are carried out in outside environments or extreme climate conditions. It could thus mean that large organizations require putting in place measures to enhance the health of their employees, and this may include enhancing the working conditions, providing health benefits and possibly readjusting working hours to suit the effects of the heat and other climate change occurrences. Also Market and Competitive Risks, Thus, it can be seen that as the market moves due to climate change the large organizations may come across new threats. Hence any company that either cannot invest in innovation or cannot adjust to the new market conditions that would require sustainable products and services stands to lose market share to the new entrants. On the same note, large organizations could require exploring other products to sell or markets to venture into in a low carbon economy (Brown, 2021). Those all lead to Long-Term Strategic Planning as The climate change causes large organizations to reconsider the long-term business models. This entails taking climate risks into account when making investment decisions, change of business models in line with a low carbon economy and integrating sustainability in organizational processes. Failing to do so put the future sustainability and profitability of the organization at risk.

To enhance the knowledge of the extent to which climate change influences organizations, few areas that will help us to focus on are as follows. First and quite evidently one can mention the rise of the frequency and magnitude of severe storms. Such extreme events like storms, floods, droughts, and wildfires are happening more often and in more severe manners, posing threats to organizations by posing interruptions and exploiting procedures as well as leading to destructions and increased expenses. Recent incidences include the bushfires in Australia and the heat waves, floods in Europe, and Hurricanes in the U. S. which indicate how businesses should be ready for these increasing risks.

This is especially so when the environmental changes are gradual as these present of equal serious challenges. One specific impact is coastal flooding with concerns to businesses with infrastructures and operations that are located in such low lying areas which may be affected by sea level rise. These areas could be submerged in water by increase in sea levels that comes with melting of the Arctic ice caps. The last problem is ocean acidification which affects industries in fishing and tourism that depends on health of marine ecosystem. This is especially so where the business relies on mature environment for its supply chain needs.

Climate change also has an impact on supply chain and operations. Due to climatic changes there may be problems in supply chain and fluctuations in the prices and many more problems. In order to mitigate these risks, companies feel the necessity to increase the robustness of supply networks. In addition, fluctuations in climate as determined by weather and temperature are influential in producing variation, most notably in sectors such as farming and energy and manufacturing. These industries are highly sensitive to changes in climate, and thus operations adjustments will be required if things are to continue to run as usual.

At least from a financial angle, it becomes easy to explain the effects of climate change. There are several problem areas one of which is the increase in insurance costs. Climate change has been a major factor causing availability of higher risks to affect the market in which insurance premiums have risen, and in some cases; some assets cannot be insured. Also, there are effects such as asset valuation can be affected. Building located in threat high risk-prone areas tend to be vulnerable to forces of severe climate weather conditions.

Legal and mandatory requirements are also on the rise due to the rising global governmental environmental standards required in fighting climate change. This means that the cost implication for these companies to meet these standards, policies and regulations are a bit high. In addition to these legal responsibilities, firms have to disclose aspects on environmental responsibility and measures that they are undertaking towards the making of such disclosures. This makes it important for organizations to implement effective Environmental Management Systems that can facilitate the capturing and reporting of the efforts in a proper manner.

At individual, at organizational, and at great level, there are concerns of strategy and competition. In the climate change conscious new markets are emerging and customers are willing to pay for sustainable products and services and businesses that will not adapt to these markets will lose out. At the same time, there are opportunities for the organizations that innovate the climate change response: they will be able to obtain competitive advantage. The emergence of a new product or the enhancing of operations can assist organizations to remain competitive in a new market.

Last but not the least, dealing with risks and responding to climate change is the last class which should be building. Business entities in this respect have to find ways how to reduce vulnerability to climate effects, and this would entail designing better structures, sourcing supplies from multiple areas and centres, and holding more accommodating operations.

Also, organizational strategies need to be developed on capacity for learning and adaptation in order to be able to cope with both the immediate and the future impacts of climate change on those businesses. This means the continued knowledge and preparation process and establishment of the ‘surge management’ for various climate situations mainly because climate change has become a reality in the world (Monika Winn, 2011)

## **2.2. Environmental Regulations and Compliance related to gas emission and climate change**

Environmental regulations and compliance related to gas emissions and climate change are key components of global efforts to mitigate the harmful effects of climate change. These regulations are designed to reduce greenhouse gas (GHG) emissions, implement sustainable practices and encourage organizations to adopt environmentally friendly technologies. Compliance with these regulations ensures that companies adhere to standards that reduce their environmental impact, thereby contributing to global climate goals .

Governments around the world have implemented a range of regulations to reduce emissions and promote climate action. These include emissions trading schemes, carbon taxes and sector-specific regulations limiting the amount of greenhouse gases that can be emitted. Compliance with these regulations is not only a legal obligation, but also a strategic necessity for organizations seeking to maintain their reputation, avoid penalties and contribute to broader societal goals.

The effectiveness of environmental regulations and the compliance mechanisms that enforce them depend to a large extent on rigorous monitoring, reporting and verification processes. These processes ensure that organizations closely monitor their emissions and take the necessary measures to reduce them. In addition, continuous reviews and updates of regulations are crucial to adapt to new scientific findings and technological advances, ensuring that climate policies remain effective in reducing global emissions and combating climate change.

As one of the world's most important economic players, the EU is working hard to reduce carbon dioxide (CO<sub>2</sub>) emissions, which are the most impactful on the environment, through Carbon Border Adjustment Mechanism (CBAM) which are a carbon tax on imported products in line with World Trade Organization (WTO) standards.



Being one of the largest economies of the globe, the European Union has set its goal to mitigate the climate change issue worldwide. An important part of it is cutting down on carbon dioxide (CO<sub>2</sub>) emissions which are major culprits for global warming. To this end the EU has developed what is known as the Carbon border adjustment mechanism, which is considered to be a trailblazer policy that seeks to limit imported emission of CO<sub>2</sub>. The CBAM is planned as a carbon tariff on imports that put the carbon content of goods coming to the EU market in compliance with the bloc's environmental policies (Martinez, 2021). This mechanism complies with the rules of the World Trade Organization (WTO) thereby affording it recognition within the international trade laws.

The main rationale of the CBAM is to prevent the phenomenon referred to as 'carbon leakage'. Carbon leakage is defined here as the shift on the production of emission-intensive goods within the EU to countries which have less restrictive measures on emissions of greenhouse gases. This shift can further erode the EU's climate objectives by outselling emissions instead of cutting them across the world, the manufacturing emissions, in this case, are being shifted. By setting the carbon tax also on importers to reflect the level of the CBAM, it aligns carbon costs of domestic and imported manufactured goods; the CBAM applies the EU's Emission Trading System (ETS) carbon price to imports. This not only provides a level playing field but also check the pollution shift to the areas with low set standards (Carter, 2020).

The CBAM targets industries that are particularly carbon-intensive and significant contributors to global greenhouse gas emissions. These sectors, such as fertilizers, iron and steel, cement, aluminum, electricity, and hydrogen, play a vital role in the global economy but are also some of the largest sources of carbon dioxide. By focusing on these industries, the CBAM aims to bring about substantial reductions in emissions both within the EU and across global supply chains. The mechanism is currently in a transitional phase from 2023 to 2025, with full implementation planned for 2026.

In another framework, the European Commission adopted in March 2023 the Green Claims Initiative to counter the falsification of some companies' environmental statistics and mislead consumers about the environmental advantages of their products, which requires a lot of explicit and clear evidence by companies about the results of the policies to reduce emissions of toxic gases, especially carbon dioxide .

The major principles of the Green Claims Initiative are aimed at guaranteeing that the information disclosed by the businesses is truthful and easily understandable. One of the fundamental elements is

the adherence to the scientifically proven facts and the most recent technical information. The environmental claims that companies make must be backed by sound science, and the current technology. This helps in making sure that any statement that is made about a product's effect on the environment is correct and also in harmony with the current environmental science and technology (ISO, 2000).

One of the key components of this program is the life cycle approach where an organization is supposed to estimate the effects of a particular product on the environment at each stage of its utilization. Beginning from the procurement of the raw material to the usage of the product and even to disposal, the companies have to take responsibility for all the impacts on the environment. This approach of life cycle assessment guarantees that all aspects of environmental impact of a product are considered and not just the specific phase.

In addition, there is a call for business to undertake a robust impact assessment when making an assessment on their products. This means that environmental claims cannot be partial or biased but should encompass all the aspects of the environmental impact of the product. Any such claims would be distorted if there was a partial or biased look at the matter at hand (Commission, Guidance on Making Effective Environmental Claims, 2021).

Another important principle is the coverage of the whole product life-cycle, which responds to the requirements of the marketing concept concerning the necessity of being transparent. Businesses are expected to state if their environmental statements pertain to the whole life cycle or only a segment of it. This avoids giving the consumer a wrong impression that a certain product is fully eco-friendly when in fact only some aspects are eco-friendly.

It also challenges the companies to do more than meet the legal requirements of the country. While it is still possible to just follow the rules of the law in corporate sustainability, it is now expected that businesses need to show that they are making a positive impact to sustainability. This can be useful in separating the real environmental concern from the 'green' hype where companies give unsubstantiated or exaggerated environmental claims.

Finally, the initiative calls for the assessment of trade-offs. This requires managers to carefully consider whether improving one environmental aspect of a product could potentially worsen another. Such an

approach ensures a balanced, responsible representation of a product's environmental impact, avoiding situations where solving one problem inadvertently creates another.

However, there are more guidelines to prescribe under the Green Claims Initiative, especially, the need to disclose consistent reporting on GHG offsets. Companies need to offer full transparency as to how they are managing to compensate for their emissions either by direct mechanisms or through investments in other businesses. For transparency is essential in creating consumer trust and guarantee that not all the statements made concerning the environment are mere gimmicks but actual strides made in the right direction.

The Green Claims Initiative is an EU regulation and as such its effects are expected to be not limited to European countries alone. The local and foreign companies that are doing businesses in the EU region may directly be affected by these regulations as well as other companies that may indirectly be impacted by them (Kumar P. &., Carbon Markets and International Trade: An Economic Analysis. Journal of Global Policy, 2021). The legal action coupled with environmental claims will induce the firms that export products to EU or who compete with firms in the EU to adhere to these high standards to protect their market share so Even if your company is not based in the EU, there may be direct or indirect consequences from current and future EU regulations related to climate change on your business.

Also, the initiative may pose a likelihood of facilitating global progression towards implementing measures relating to the curb of green washing and other general measures that relate to environmental claims.

### **Compliance as one of the Strategic Solutions toward Climate Change and Global Warming:**

Compliance is changing from just being a set of rules which companies have to obey, local and international laws into a legal, social, ethical and strategic management tool. For the businesses of today this transition implies much more than simple compliance with the rules, but rather the taking of responsibility for the stewardship of the climate of the planet in the twenty-first century. It is therefore wise that companies take necessary measures in conserving the environment, as it is an added advantage in the market as the awareness for environmental conservation increases. Consequently, compliance is not merely the practice of minimizing risks, it is the practice of propelling a company to be a market leader in an emerging and sensitive area that is environmental responsibility.

Going Beyond Risk Management: Due to changing environmental Landscape, companies are now expected to expand their management of climate changes, as being perceived only as challenges. Rather, they are encouraged to use measures that include the direct action that seeks to lessen green House gas emissions. This means going beyond managing the effects of climate change; it means thinking proactively about how organizations can reduce the harm being done to the environment. When supported by sustainability, companies change their attitude and become less defensive and more active following overall environmental policies and the world's trend toward sustainability.

Mechanisms of Compliance: Cognitive and Behavioral Methods are included Observance of climate-related commitments in the corporate world can be realized through also internal and external policies. Internally, organizations engage in self-regulation measures which include preparing lengthy environmental policies and formulating environmental standards within supply chain agreement (Peters, 2019). These internal measures assist in making environmental compliance as part of the firm, hence enhancing compliance effectiveness .

Outside the organizational boundaries, compliance is supported by means of environmental legislation, climate change disclosure, and other regulations. These external mechanisms make sure that the companies are answerable to the public and shareholders and other regulatory organizations. These internal and external efforts coalesce to build a strong foundation for both compliance with environmental laws and for driving corporate effort to mitigate emissions of greenhouse gasses.

### **2.3. GHG gas emission: what they are and why they are important to address**

Greenhouse gases (GHGs) are crucial to understanding the dynamics of climate change, as these gases trap heat in the Earth's atmosphere, creating a 'greenhouse effect.' This effect is necessary to maintain life on Earth by keeping the planet warm, but the excessive release of greenhouse gases is causing significant changes to our climate. When these gases are emitted into the atmosphere, they trap heat, leading to a variety of environmental changes those impact ecosystems, weather patterns, and human life (EPA, 2020).

One of the more well-known greenhouse gases is carbon dioxide or CO<sub>2</sub> for short. CO<sub>2</sub> is released into the atmosphere by the consumption of fossil fuels such as coal, natural gas and oil, burning of candles, turf, landfill and dump sites, trees and other forms of biological matters. In the same regard, other commercial activities also emit CO<sub>2</sub>, and this is evident to activities like cement production. While, carbon dioxide is washed out back naturally through carbon cycle by, plants from the

atmosphere, but manufactured emissions rate exceeds this natural capability to sequester CO<sub>2</sub> hence raising the levels of CO<sub>2</sub> in the atmosphere and therefore experiencing global warming.

Another very important greenhouse gas is Methane (CH<sub>4</sub>). Emissions of methane occur in the extraction, processing, and transportation of fossil fuels mainly coal, gas, and petroleum. Furthermore, it is released from agricultural activities especially from livestock, and the decomposition of solid waste in wastes disposal sites including landfill sites. What is more, the amount of methane is not as large as that of carbon dioxide; however, it contributes to the heat retention in the Earth's atmosphere much more effectively and has to be addressed in the fight against global warming.

Quite likewise, nitrous oxide or N<sub>2</sub>O is also another greenhouse gas emitter, although not very frequently mentioned. Nitrous oxide is released in soil through activities such as farming, the usage of land, and various industrial processes as well as from the burning of fossil fuels. It is also produced during the treatment of the water and wastewater. Nitrous oxide is much more effective, global warming wise, than CO<sub>2</sub> but it is released in much smaller quantities than methane or CO<sub>2</sub>. It has a very long residence time which may be defined as the time it takes before it can no longer impact on the greenhouse effect, thus is also another player in the greenhouse effect.

The main fluorinated gases comprising hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride and nitrogen trifluoride are synthetic gases causing climate change. There are gases which are used in industries, trade and even in domestic uses such as refrigerator gases, air conditioning gases and gases used in industries. Thus, all fluorinated gases are of significant concern because of their GWP that is they are effective at trapping heat in the atmosphere more than carbon dioxide on a molecule for molecule basis. All the same, since they are emitted in lesser volumes, their intensity makes them even more damaging to the climate. For example, hydro fluorocarbons are thus used as the substitutes to ozone-depleting substances such as chloro fluorocarbons but they are very much involved in global warming.

Some of the greenhouse gases are emitted through natural processes but the most significant and the most detrimental are emitted through human activities especially in the generation of energy through fossil fuel consumption. Fossil fuels have become essential in today's world where they are used for heating homes, cars as well as factories. Unfortunately, this fossil fuel consumption results in emission of high levels of CO<sub>2</sub>, methane, and other greenhouse gases.

The emissions are also held to be accountable for climate change characteristic features such as high temperatures, shifts in precipitation patterns, ocean acidification, droughts, and wildfires among others.

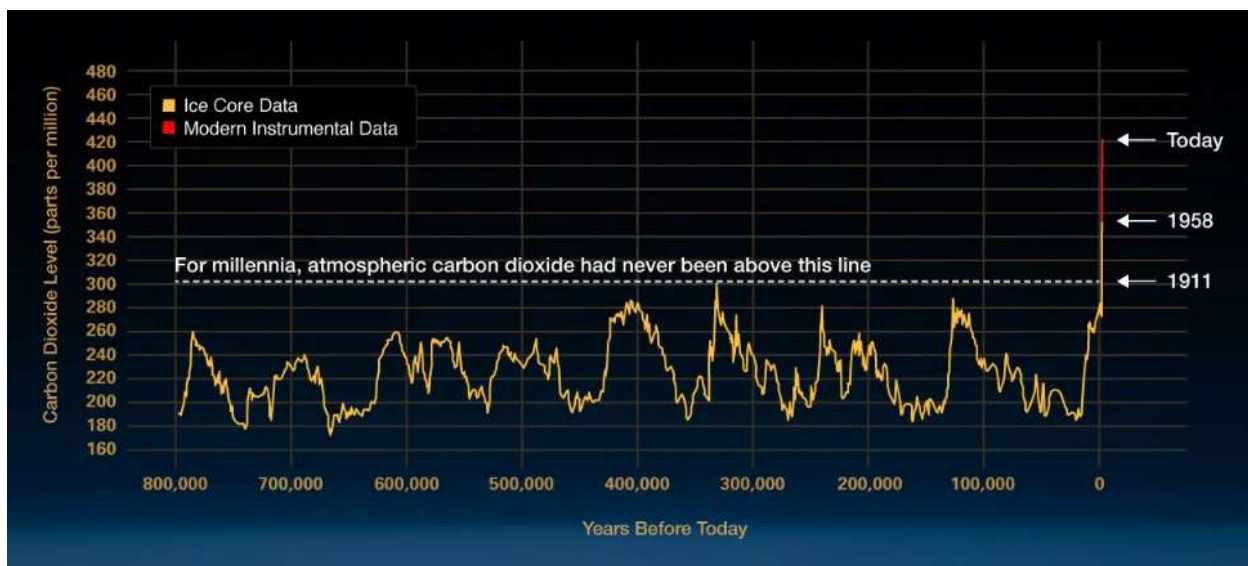
It is important to combat greenhouse gas emissions, and more so first and foremost. These gases not only cause the global temperatures to rise but also trigger other environmental issues such as increased cases of weather-related disasters, loss of species and diseases. Thus, for combating climate change ramifications, there is a need to curb the emission of GHG by shifting towards cleaner sources of energy, improving the energy efficiency metrics, and acting sustainably at the industrial level.

There are two significant characteristics of these emissions one of them is the Radiative Efficiency which means their Capacity to Transform Consumed Energy by capturing heat energy from the sun and then emit the energy toward Earth surface (ClimatePartner). This process is one of the causes of the greenhouse effect that involves gases which heat the green house and result in worsening of global warming. The degree to which a gas warming depends on its radiative efficiency: the more efficient a gas is at radiating, the better it is at absorbing infrared radiation. For instance methane, CH<sub>4</sub> is even most effective greenhouse gas than that of carbon dioxide, CO<sub>2</sub> in that the ability of the former to trap heat is several folds greater than the latter despite the fact that the latter is present in the atmosphere in much greater concentration. Awareness of the emissivity of various gases is necessary in order to determine their effect on the increase of global temperature and the urgent measures that are needed for preventing the emission of the worst greenhouse gases.

The other significant characteristic is the Lifetime of Greenhouse Gases we can say the duration of time that greenhouse gases remain in the atmosphere is termed the atmospheric lifetime and is one of the most important considerations controlling a gas's effects on climate (ClimatePartner). There are however instances where the lifespan of this kind of gas will differ greatly in regard to another type of gas. For instance, methane's atmospheric lifetime is approximately one decade, which indicates that this substance is undertaken chemical reactions and get out of the atmosphere more quickly as compared to other gases. Nevertheless, for a short amount of time that it stays within the atmosphere, methane provides an excellent ability to retain heat, therefore plays a significant role in short-term global warming. CO<sub>2</sub> on the other hand has an atmospheric lifespan of hundreds to thousands of years. The intuitive points relate CO<sub>2</sub> which can stay in atmosphere, oceans and land surface for centuries after its release impacting on climate of the planet. This long lasting presence of Carbon dioxide makes it especially dangerous as its contribution to global warming enhances other changes that may be

continuous and even irreversible in the Earth's climate system. It is therefore important to appreciate the fact that different greenhouse gases have varying lifetimes, taking longer to clear the earth's atmosphere, and thus useful in planning for long-term climate change remedy.

In addition to have been mentioned is that According to NASA, the current warming trend is different because it is clearly the result of human activities since the mid-19th century and is proceeding at a rate not seen for the last several thousand years.<sup>1</sup> It is undeniable that human activities have produced atmospheric gases that have trapped more of the sun's energy in the Earth's system. This excess energy has warmed the atmosphere, oceans and land, and widespread and rapid changes have occurred in the atmosphere, oceans, cryosphere and biosphere.



**Figure 3** (NASA. (n.d.). NASA Climate Change: Vital Signs of the Planet.)

This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO<sub>2</sub> has increased since the Industrial Revolution.

Historical carbon dioxide levels: The amount of carbon dioxide in the atmosphere has fluctuated over the past 800,000 years, ranging from about 180 to around 280 parts per million (ppm). These deviations relate to natural phenomena like ice ages and interglacial. It is these cycles that have contributed to the recent trends by human activities.

The rise of carbon concentrations: According to the chart, carbon dioxide became off-scale high during Industrial Revolution since the end of XVIII century. This increase is displayed by a steep slope at far right of graph as indicated by red line. The greatest increase comes after 1958 when CO<sub>2</sub> reached up to record level (280 ppm), and now it is above 400 ppm. What does this rise signify? For sure, there is more CO<sub>2</sub> than it ever was for the last eight hundred thousand years only in our times now. In addition, broken lines on graph depict that some thousands of years have not witnessed any higher levels of CO<sub>2</sub> than 280 ppm. Human beings are directly responsible for causing this rise through their actions like burning fossil fuels and deforestation that releases large amounts of carbon dioxide into the atmosphere.

## **2.4.Environmental Management Accounting (EMA)**

### **2.4.1. Definition and Principles of EMA**

Environmental Management Accounting is a system that revolves around the identification, collection and analysis of physical and financial data related to the organization's environmental costs. Therefore, it is a crucial tool to know the organization's environmental performance, facilitate the company's sustainability process and assist in making decisions related to the environment in order to raise the organization's economic, social and environmental level.

This therefore implies that while endowing the system with the capacity to capture and control all the direct organizational costs resulting from involvement in environmental activities, it also tends to occlude the entire external cost cost resulting from the same activities. For example, communal external costs entailing the acquisition of natural resources at a cost to the environment; the impact of pollution on the populace's health over the long haul or the loss of forests, and thus, species' habitat, are not seen within this rather myopic internal cost-centered framework. Thereby, focusing on exclusively financial factors may limit the view of the work of the organization and impact on the environment and can lead to its inefficiency in solving problems of the organization's environmental footprint.

### **Key Principles of Environmental Management Accounting (EMA)**

EMA or Environmental Management Accounting is considered to be a core concept that combines environmental and cost information to assist in managing the environmental loads and achieving the



maximal economic value added. Nine generic principles exist when undertaking EMA and which make it effective in enhancing sustainability and the organizations' decisions.

It is also noteworthy that EMA, like all modern methodologies, presupposes interdiction of physical and monetary information. This principle incorporates physical information including energy consumption, material throughputs and waste emissions together with financial data along with costs of environmental impacts, funds outlay towards environment, and fines for infringements. Through integration of these two types of information organizations are in a position to monitor their effects on environment and in addition, they can be in a position to discover some of the methods of cutting costs. For instance, an organization may find that cutting on the amount of wastes or increasing efficiency in energy utilization can greatly reduce both the environmental impacts of the organization and the costs associated with the impacts.

Another important principle is the internal focus in organizations. EMA focuses on the internal cost and more specifically on the environmental cost. Thus, organizations get an idea of the expenses due to their negative impact on the environment like disposal, energy usage, emission regulation, among others. This internal focus enables organizations to identify areas within the companies where improvements can be made; various ways through which costs can be cut. Nevertheless, this approach is highly effective when it comes to improving the internal performance of an organization, but it may not totally consider the external environment within which an organization operates for instance the impact it will have on the surrounding community or the ecosystem. Therefore, though EMA can help to improve internal sustainability it may be necessary to use other environmental management models in order to get the best results.

Environmental Management Accounting (EMA) has also other sections, one of them is Environmental Cost Accounting (ECA). ECA aims at capturing cost of environment which is not captured by the conventional accounting models. This can be attributed to the fact that ECA allows for extra costs to be included such as those associated with pollution control, waste disposal and use of resources among others. It enhances the quality of financial reporting and identifies other administrative environmental costs which are normally masked under overheads. In this way, the work of ECA does not only improve the level of transparency but also ensures organizations approach more effective and rational use of resources in relation to sustainability.

Thus, following these principles, EMA also aims at the maximum achievement of environmental and economic impacts. EMA enables discovery of sources of wastes and establishes the extent of energy consumption and emissions before proposing ways of slashing them to enhance organizational efficiency. Thus, EMA can be considered valuable for organizations that look for an improvement of economic performance, accompanied by a decrease in the negative impact on the environment.

There is also stakeholders' engagement as one of the main principles of EMA. The global Environmental Management also acknowledges a major role of the stakeholders in EMA both internal and external of the company for instance, the employees, management, Government authorities, local and international communities and investors (strategies T. I., 2024). Hence, this engagement assists in integrating organizational practices with environmental goals and objectives or the perceived societal expectations hence creating a common relevancy to the social conscience of the company.

Integration of sustainability concerns is arguably one of the biggest principles of EMA. EMA creates sustainable development because it involves environmental and economic factors in an organization's decision-making. This way the decision makers can balance between impacts of the environment in the longer run and financial gains indicating a way of making more profit in the process of saving the environment. For instance, a company that has EMA data may decide to make investment in new technologies such as energy efficient technologies. Although this may involve some investment at the beginning, the bottom benefits that include cost cutting and eco-friendly impacts, are likely to be high. Thus, through taking the above steps, EMA is able to guarantee that sustainability is incorporated within the broader organizational strategic approach rather than be looked at in isolation.

Moreover, EMA promotes the development of new business models that support the circular economy, which focuses on recycling products and reducing waste. By evaluating the true cost of sustainable practices, EMA helps organizations adopt measures that reflect both environmental and societal welfare. As stakeholders—including consumers, investors, and regulators—become more concerned with transparency and sustainability, EMA plays a critical role in improving the accuracy of reporting. It allows companies to demonstrate how they are addressing environmental challenges while balancing financial considerations.

## **2.4.2. Development and Evolution of EMA Practices**

### **Evolution of Environmental Accounting**

In the last 20 years, environmental accounting has evolved to a commendable extent and encompasses environmental, economic, and social considerations within an organization. All these significant advances have rapidly altered how businesses integrate sustainability within their accounting systems, expanding the scope and influence of Environmental Management Accounting (EMA).

One of the most significant progressions in environmental accounting was done in the year 2002. An international framework got developed, which was the first formal EMA framework. It compelled firms to account for both monetary and material data that related to the environment. The logic behind this reasoning was as follows; the scope of the framework had a major objective of ensuring that there were environmental considerations in the overall accounting system of a company. This way, it would guarantee that environmental impacts did not go unnoticed in financial reporting (Burritt R. L., *Contemporary Environmental Accounting: Issues, Concepts, and Practice.*, 2000).

The other key turning point is in the broadening of the scope to which EMA is applied. Earlier, EMA was strictly practiced within the precincts of waste management and Material Flow Cost Accounting (MFCA). The scope of application now cuts across a wide range of environmental issues, some of which include carbon management, water accounting, energy management, and even biodiversity. The extension into these areas manifests new awareness of the interlinking nature of diverse environmental issues and the significance of addressing them by the businesses in a holistic manner.

Besides the changes in functional scope, the substantive scope of EMA has also shifted. At this time, EMA is embedded within Strategic Management Accounting (SMA) systems, focusing on compliance with standards of sustainability and achievement of social responsibilities. Concerns such as modern slavery, health management accounting, and gender inequality become front-burner matters at this stage of development. In doing so, and by making EMA take in the wider social issues, it not only advances further into environmental sustainability but also into corporate social responsibility.

The spatial scope of EMA has also advanced beyond the boundaries of individual organizations to issues on supply chain management. This is very important because the sustainability of products and an overall environmental performance of a company are substantially influenced by supply chain. As such, practice for EMA has advanced to include the consideration of the environmental and social impacts brought about by the entire supply chain. For instance, new accounting methods have started including factors associated with planetary boundaries as well as the indirect outcomes of business activities in measuring these impacts. New frameworks and standards have included these in order to understand the bigger and wider effects of corporate efforts in sustainability.

One of the recent inclusions in EMA is the incorporation of new indicators and comparative frameworks. It is known for using more and more non-financial, social, and environmental indicators for progress measurement compared to the conventional financial ones; now the reference points of planetary boundaries and that of the United Nations SDGs are considered as integrands of this process. More so, such developments underscore the need for strong policies that can steer organizations in the direction of ensuring desirable environmental and social results (Nations, 2015).

Secondly, the role of accountants in EMA has evolved quite considerably. More so, the accountant is not solely to concentrate on the financial information but they need to incorporate sustainability data in every aspect of organization. This has opened new management positions, such as sustainability officers and carbon managers that signify the growth in complexity and importance of sustainability in business enterprises. The changing role of the management accountant may further pinpoint the need for continuing research on ways these professionals may serve organizations better in their own sustainability transformations.

Finally, major technological developments have played a fundamental role in the birth and development of EMA. This evolution is reinforced by computerization and the growing reliance on external information sources, such as sustainability reports. Technologies are also available, such as SAP systems and artificial intelligence, to facilitate the incorporation of environmental data into the corporate decision-making process. Indeed, demand exists for the need to further study the ways these technologies can fully enhance EMA procedures and encourage sustainable business operations.

We can say that the development of Environmental Management Accounting has taken place over the last two decades with the changing need to carry out environmental and social responsibilities of a business organization. EMA needs to grow as new frameworks, technologies, and roles are being integrated into an organization for sustainability and minimization of environmental effects from business operations.

## **2.5 Carbon accounting for internal decision making: characteristics and instruments**

Carbon accounting is a system for monitoring and quantifying the amount of emissions of toxic gases that cause global warming resulting from human activity or we can say in this regard resulting from an organization, whether directly, such as the practices resulting from the company itself from heating buildings, generating energy and so on, or indirectly through emissions resulting from the practices of suppliers and end consumers of the company's products. It is also known as a company's carbon footprint, its ultimate purpose to assist the organization in decision-making process in order to mitigating the GHG emissions and to adhere to with environmental regulations (Burritt R. L., Carbon accounting: A framework for decision making in corporate governance., 2010).

A carbon accounting system operates based on fundamental principles that organizations must follow to effectively measure and manage their carbon emissions. One of the initial steps in this process is to establish clear organizational boundaries. This involves defining the reporting period and determining whether a company has subsidiaries or joint ventures that should be included in the carbon accounting process. Setting these boundaries ensures consistency and clarity in emissions reporting across the entire organization.

Another crucial principle is defining reporting boundaries. This requires organizations to identify the sources of their emissions, whether they arise from direct activities, such as fuel combustion, or indirect sources, such as electricity purchases or supply chain activities. In cases where certain emission sources are excluded from the report, the rationale for such exclusions must be clearly justified and presented transparently. Transparency in the reporting process is essential to maintain the credibility and integrity of the carbon accounting system.

Subsequently, organizations must collect and verify relevant data. This includes data related to raw materials, facilities, purchased goods and services, and supply chains. Ensuring the accuracy and reliability of this data is vital for producing an accurate assessment of an organization's carbon

footprint. Any discrepancies or gaps in data collection can undermine the validity of the entire carbon footprint.

The most important result of the carbon accounting system is to Calculate the company's carbon footprint at various levels. Internal reporting, including emission figures and carbon intensity to help make comparisons with previous years' results. External reporting to the company's home country, customers and external organizations. This varies greatly in terms of disclosure and transparency. Identify opportunities to reduce emissions in the future Developing more environmentally friendly products Trading carbon credits, where one carbon credit is equivalent to one tonne of CO2 emissions.

### **Key Characteristics of Carbon Footprint**

A comprehensive measurement is one of the fundamental characteristics of carbon accounting. This process involves the systematic quantification of emissions across various activities within an organization. Emissions are categorized into three scopes: Scope 1, which covers direct emissions from activities and assets owned or controlled by the organization; Scope 2, which includes indirect emissions from purchased electricity, heating, cooling, and steam; and Scope 3, which encompasses other indirect emissions from the entire supply chain and product use. Among these, Scope 3 is often the largest source of emissions, and its accurate measurement presents the greatest challenge in carbon accounting. Precise quantification across all scopes is critical, as it provides the foundation for effective carbon management. By identifying all emission sources, organizations can pinpoint key areas where reductions can be achieved.

Integration with business processes is another essential aspect of carbon accounting. Rather than being a standalone activity, it is integrated into broader business processes. For instance, in manufacturing systems, carbon accounting tracks emissions throughout the entire product lifecycle, from raw material extraction to production, distribution, and disposal. This integration allows organizations to align their environmental objectives with operational efficiency, enabling them to make strategic decisions that promote both sustainability and profitability.

A major focus of modern carbon accounting practices is on supply chains. In today's global trade networks, where supply chains are often complex and multi-layered, it is crucial to account for emissions not just from direct operations but also from suppliers and other partners across the value chain. Managing supply chain emissions requires collaboration with suppliers to collect accurate data,

set reduction targets, and implement sustainable practices across all stages of the supply chain. This holistic view ensures that companies capture their total carbon impact, which is essential for comprehensive environmental management.

Carbon accounting tools and techniques play a vital role in helping organizations measure, monitor, and report on their emissions. These tools enable businesses to manage their carbon output more effectively and make informed decisions to minimize harmful environmental impacts. One widely used tool is the Life Cycle Assessment (LCA), an analytical method used to measure the environmental impact of a product, process, or service throughout its entire lifecycle. This approach helps organizations identify which stages contribute the most to carbon emissions and where reductions can be made. Other carbon footprint measurement tools, such as the Greenhouse Gas Protocol and the Carbon Trust's Carbon Footprint Calculator, assist companies in calculating their total carbon balance across different activities, such as energy use, transportation, and waste generation.

Energy Management Systems (EnMS) also contribute significantly to carbon accounting by monitoring and controlling energy consumption within organizations. These systems aim to reduce both total energy use and the associated greenhouse gas emissions. ISO 50001, an international standard for energy management, offers a framework for organizations to establish energy efficiency goals and integrate carbon management strategies into their broader energy management practices.

A well-integrated Carbon Management Program is key for managing emissions across an organization. Software solutions such as Sphera Sustainability Solutions and the Microsoft Carbon Calculator help track emissions, manage carbon credits, and ensure compliance with environmental regulations. These programs provide companies with the tools to systematically reduce their carbon footprint while meeting legal and sustainability goals.

An organization's Greenhouse Gas Inventory provides a current accounting of its emissions, encompassing both direct sources (such as company-owned vehicles) and indirect sources (such as electricity consumption). Standards like the Greenhouse Gas Protocol provide a framework that simplifies GHG accounting and reporting, making it easier for organizations to follow internationally recognized methods when developing their emissions inventories.

Carbon audits are an important part of this process. These audits measure the amount of carbon emitted by an organization and identify areas where emissions can be reduced. In addition to helping

companies reduce their environmental impact, carbon audits also ensure that they meet regulatory requirements and adhere to sustainability goals.

In some regions, Emissions Trading Systems (ETS), often referred to as cap-and-trade systems, offer economic incentives for organizations to reduce their emissions. Under these systems, companies can buy or sell emission allowances based on a set cap of total regulated emissions. The European Union Emissions Trading System (EU ETS) is one of the largest carbon trading schemes in the world, providing a market-based approach to reducing greenhouse gas emissions.

Emerging technologies like block chain are also influencing carbon accounting by adding transparency and traceability to emissions data. In supply chains, block chain technology allows stakeholders to record and verify emissions data in a secure and reliable manner, enhancing the accuracy and integrity of carbon reporting.

Finally, Environmental Product Declarations (EPD) provides standardized information about the environmental impact of a product, often based on life cycle analysis. EPDs serve as communication tools between businesses, consumers, and stakeholders, helping them make more informed decisions about the sustainability of the products they use or sell.

## 2.6 Difference between Carbon accounting and Financial accounting

| Differences                  | Financial Accounting  | Carbon Accounting   |
|------------------------------|---|---|
| <b>Purpose and Focus</b>     | Tracking and reporting an organization’s financial transactions and position.<br><br>It aids in decision-making for investors, creditors, regulators, and other stakeholders. | Measuring, reporting, and reducing an organization’s GHG emissions.<br><br>Its primary goal is to understand and manage an organization’s environmental impact and contribution to climate change .         |
| <b>Measurement and Units</b> | Uses monetary measurements to quantify assets, liabilities, revenues, and expenses, ultimately presented in a monetary unit, such as a currency.                              | Quantifies emissions in terms of carbon dioxide equivalents (CO <sub>2</sub> e).<br><br>It employs specific emission factors and conversion rates to convert different greenhouse gases into a common unit. |



|                                |  |  |
|--------------------------------|--|--|
| <b>Stakeholders</b>            | Caters to a broad range of stakeholders, including investors, creditors, analysts, and regulatory bodies that require financial information for decision-making. | Addresses a more targeted audience, including regulatory bodies, environmental organizations, socially conscious investors, and consumers interested in a company's environmental practices. |
| <b>Regulatory Requirements</b> | Universally mandatory for organizations subject to financial reporting regulations and standards.  | Some organizations are compelled to report carbon emissions due to regulatory mandates, while others voluntarily report them to demonstrate their commitment to sustainability.              |

Table 1 (Kaur, 2024)

If we conduct a comparison between financial accountancy and carbon accountancy as it can be shown from the table above provides side-by-side differentiation of financial accounting and carbon accounting wherein the objective, unit of measurement, interested parties, and legal requirement are indicated. We can conclude that all these differences are significant when it comes to establishing how these two forms of accounting are useful in performing their functions in organizations. beginning with Purpose and Focus While financial accounting is major, concern is the identification and recording of an organization's financial activities or financial statement. This includes; creating records for assets, liabilities, revenues and expenses. The purpose of financial accounting is to provide information to different users in the decision-making process, these includes: It is important for evaluating the financial standing of an organization and management of funds in an organization to include investment and credit amongst others. The Carbon Accounting focuses on the assessment, reporting and management of the Greenhouse Gas (GHG) emissions of an organization. The objective here is to be able to predict and respond adequately to the organization's effects on the environmental system most specifically the climate change system. Carbon accounting, in contrast, is about non-financial assets, where the primary goal is to minimize an organization's carbon footprint and support the fight against climate change. Moving to Measurement and Units Financial Accounting records the financial transaction of an organization and measures it using financial units. These measurements are generally

accepted having well-defined parameters, which mean they should be comparable across different organizations financial statements. Use of monetary units makes it easy for the different users of financial statements to understand and analyze them from the differing perspectives.

On the other hand Carbon Accounting measures the emissions in CO<sub>2</sub> equivalent or CO<sub>2</sub>e as it is commonly referred to. This measurement system computes several greenhouse gases to a sole universal equivalent in view of a standard GWP that gives an overall picture of a firm's detrimental effect on the environment. Carbon accounting is a set of calculations, which utilizes factors such as emission and co-efficient factors with a view of determining the overall emissions of breadth of the organization. In terms of Stakeholders we can see that the general user of financial accounting is broad and comprises investors, creditors, analysts, and regulatory authorities. These stakeholders need sound financial information to make the decision in respect of investment, loans and legal aspects. Financial reports are thus prepared to present financial information in a form suitable for use by a large community that requires financial information for economic decisions.

However the stakeholders in carbon accounting are relatively more specific and include environmental agencies, sustainable investors, environmental NGO's and consumers, want to know specific information concerning the company's environmental profile. These stakeholders are particularly concerned with a firm's corporate social responsibility with special reference to carbon footprint. Carbon accounting therefore serves a more niche audience made of organizations that are interested in sustainability and corporate responsibility. Ending with Regulatory Requirements , Although many managers are not actively involved in financial accounting, it is compulsory throughout the world for all organizations that are bound by reporting financial regulations and standards. These regulations enable stakeholder to have confidence on the financial information disclosed by these organizations by preparing it in a consistent and transparent manner.

The issue of Carbon Accounting has its unique regulatory necessities. Some organizations have to disclose their carbon emissions because of compliance with legal requirements, especially in countries that have set stringent environmental standards. However, there are also companies that declare their CO<sub>2</sub> emissions on their own for primary environmental reasons. I must admit that this sort of reporting can often be used by organizations in order to improve their image and show that they are committed to minimizing their negative effect on the environment.

Thus, comparing the specifics of financial and carbon accounting, it can be stated that, although both types of accounting are indispensable for assessing an organization's accountability, they operate in different planes and address different issues. While financial accounting deals with the economic performance of an organization carbon account deals with the environmental performance of organizations. Both of them are vital in the current business world, where financial performance and environmental stewardship cannot be fully separate. The better appreciation of these two types of accounting requires the definition of both, so that different stakeholders can make sound decisions within the conventional financial and environmental realms.

## **Chapter 3: Methodology and Empirical**

In today's global business environment, Environmental Management Accounting (EMA) has become indispensable for organizations seeking to reduce their environmental impact while maintaining financial sustainability. This growing significance of EMA stems from the increasing need to balance environmental responsibility with corporate profitability. By employing EMA, organizations not only track their environmental costs but also contribute significantly to long-term sustainability strategies, particularly in reducing greenhouse gas (GHG) emissions. Through an analysis of case studies from diverse industries, it becomes evident that EMA is more than a mere tool for environmental accounting; it plays a pivotal role in shaping corporate sustainability strategies across different sectors.

### **3.1. Research Design and Approach**

In conducting this research, a qualitative research design was adopted to gain a comprehensive understanding of the complex nature of EMA practices. Qualitative research is particularly suited to explore the experiences and perceptions of key stakeholders involved in the implementation of EMA, as noted by (Creswell, 2013). This method enabled the study to delve into the challenges and nuances organizations face in adopting EMA, while also shedding light on how these practices impact GHG emissions within companies.

By employing a multiple-case study approach, this research design offers a deep investigation into EMA practices within various organizational contexts (Yin, 2018). The decision to use multiple case studies is essential, as it allows for comparisons across organizations. These comparisons help in identifying common strategies as well as distinctive approaches adopted by different firms in their attempts to reduce GHG emissions through EMA. Such cross-comparison not only highlights the contextual differences between the organizations but also underscores how these differences shape the adaptation and success of EMA practices. Furthermore, the research provides insights into the best ways to implement EMA in various sectors, emphasizing the importance of tailoring practices to specific organizational contexts.

Data collection for this research was primarily based on semi-structured interviews with key managers and subject matter experts across the case companies. These interviews serve as a valuable tool in capturing the lived experiences of individuals directly involved in EMA practices (Bryman, 2016). The flexibility of the semi-structured format allowed the researcher to explore specific areas of interest while gaining in-depth insights into the successes, challenges, and lessons learned during the

implementation of EMA. This method not only enriched the data but also presented personal-level narratives that reflect the realities of EMA adoption in diverse organizational environments.

The thematic analysis of the qualitative data further reinforced the study's findings. The thematic analysis offered a systematic yet flexible approach to understanding the data, ensuring that the findings remained closely aligned with the raw documents and case studies. This approach was instrumental in identifying recurring patterns and themes that emerged from the interviews, which, in turn, helped to answer the central research question.

To gather comprehensive insights into EMA practices across different sectors, the data collection methods combined interviews and document analysis. This dual approach provided a rich and diverse data set, deepening the understanding of how EMA affects organizational performance and sustainability strategies. Interviews were conducted with representatives from industries as varied as the refrigerators and air conditioning sector, transportation, food chains, and cement production. The deliberate selection of these sectors enabled the study to capture a broad spectrum of perspectives and concerns related to EMA, facilitating a more generalized understanding of how EMA is applied in different contexts.

The companies chosen for the interviews operated across Egypt, Saudi Arabia, the United Arab Emirates, and Italy. Such a diverse sample allowed for a more global understanding of the challenges and opportunities presented by EMA in various organizational and environmental contexts.

The interview process was conducted online, a method that allowed for greater inclusivity of participants from different regions. Participants were selected through purposive sampling, focusing on individuals with experience in EMA and involvement in environmental initiatives within their organizations. This careful selection ensured that the data collected was both relevant and insightful, offering a multi-dimensional view of EMA practices from the organizational and sub-organizational perspectives.

The interviews centered around key research questions regarding the existing EMA practices in the companies, the effectiveness of these practices on environmental performance, the challenges encountered in their implementation, and the future strategies for EMA within the organizations. The semi-structured nature of the interviews enabled a deep dive into these areas, allowing for a comprehensive exploration of the issues at hand.

To maintain confidentiality, all interviews were recorded, transcribed, and anonymized, ensuring that the privacy of the participants was respected, particularly when companies requested confidentiality. This careful handling of sensitive information enabled participants to engage openly and honestly in the discussions, ultimately enriching the research with candid insights into the complexities of EMA practices.

Given that, we can easily understand how EMA practices not only serve as a tracking mechanism for environmental costs but also drive long-term corporate sustainability strategies. Through a qualitative lens, this research sheds light on the critical role that EMA plays in reducing GHG emissions and supporting sustainability goals across diverse industries and regions.

### **3.2 Data Collection Methods**

The data collection for this study involved a combination of interviews and document analysis to gather comprehensive insights into Environmental Management Accounting (EMA) practices across different sectors and regions. This approach provided a rich and diverse data set, helping to deepen the understanding of EMA's impact on organizational environmental performance and sustainability strategies.

#### **3.2.1 Data Collection from Interviews**

To collect relevant data on EMA practices, interviews were conducted with representatives from various industries, including the refrigerators and air conditioning sector, a transportation company, a food chain company, and a cement company. These sectors were deliberately selected to allow for a broad examination of EMA practices across different industries, capturing a range of perspectives and concerns. The diversity of industries also facilitated the identification of generalized ideas about how EMA is applied in different contexts.

The semi-structured nature of the interviews allowed for flexibility, enabling the researcher to probe deeper into areas of interest and gain a comprehensive understanding of the issues at hand. All interviews were recorded, and then transcribed for analysis. To ensure the privacy of the participants, the identities of the interviewees and the information shared during the interviews were kept anonymous, particularly in cases where companies requested confidentiality. This approach allowed for honest and open discussions while protecting sensitive information.

Totally, 12 interviews were conducted with various managers and sustainability experts across six companies. The interviews were conducted either online or via phone calls, depending on the availability and location of the interviewees. The table below provides a detailed overview of the interviewees' positions, interview dates, formats, and durations for each company. No recordings were made, as consent for recording was not obtained.

| <b>Company Name</b>               | <b>Interviewees' Position</b>                                    | <b>Interview Dates</b>                  | <b>Interview Format</b> | <b>Length of Interview</b>  | <b>Translation</b>      | <b>Transcription</b> | <b>Recording</b> |
|-----------------------------------|--|---|-------------------------|---|-------------------------|----------------------|------------------|
| <b>DP World</b>                   | Health, Safety, and Environment Supervisor                       | 17 August, 4 September                  | Online                  | 40 minutes each   | Translated into English | yes                  | No               |
| <b>CAREL</b>                      | Group Sales & Marketing Manager (previously Sustainability Chef) | 26 August                               | Online                  | 40 minutes  | Conducted in English    | yes                  | No               |
| <b>Elsowedy Electric</b>          | ESG Managers   | 19 August (Phone), 8 September (Online) | Phone call / Online     | 15 minutes (call) and about an hour for the online meeting.                               | Translated into English | yes                  | No               |
| <b>Al Hatab Bakery</b>            | ESG Manager, Branch Manager                                      | 17 and 24 August                        | Online                  | 30 minutes each   | Translated into English | yes                  | No               |
| <b>Heidelberg Materials Egypt</b> | Sustainability Chef  | 10 August (Phone), 25 August online     | Phone call / Online     | The call was just overview of the meeting 10 -15 minutes and the online meeting was about | Translated into English | yes                  | No               |

|                         |                           |                         |        |                    |                            |     |    |
|-------------------------|---------------------------|-------------------------|--------|--------------------|----------------------------|-----|----|
|                         |                           |                         |        | 45 minutes         |                            |     |    |
| <b>Orange<br/>Egypt</b> | Sustainability<br>Manager | 29 August               | Online | 1 hour             | Translated<br>into English | Yes | No |
| <b>Vacsera</b>          | ESG Team<br>Member        | 23 August,<br>27 August | Online | 30 minutes<br>each | Translated<br>into English | Yes | No |

**Table 2** “interviews overview”

### 3.2.2 Data Collection from Document Analysis

In addition to the interviews, document analysis was conducted to supplement the findings and provide additional insights into the case studies. The documents selected for analysis were chosen based on their relevance to the research questions and their ability to provide detailed information about EMA practices, tools, measurements, and future trends. Beginning with the

Selection Criteria the, documents used for analysis included industry reports, corporate sustainability reports, academic papers, and regulatory documents, all of which were directly related to EMA practices. These sources were selected for their capacity to offer a large volume of relevant data on the subject, providing an in-depth look at EMA across different contexts. Moving to Purpose and Integration of the document analysis was to complement the information gathered from the interviews, offering an external perspective on how EMA is applied in different settings. The insights gained from the documents helped to expand the understanding of EMA practices within the selected companies. By integrating the results of the document analysis with the interview data, the study was able to develop a more comprehensive picture of EMA practices, issues, and developments. Then the focus shifted to Data Extraction and Analysis Content analysis of the documents yielded valuable information on how EMA has been implemented, the tools and instruments used to assess and manage environmental impacts, and the outcomes achieved. This analysis also revealed emerging trends in EMA, such as the growing role of management in promoting sustainability. The findings from the



document analysis were crucial in identifying new developments in EMA and understanding the broader context in which these practices are evolving.

### **3.3. Data Analysis Methods**

In the process of analyzing data for this study, a systematic approach in the interpretation of the qualitative data that was gathered from the interviews as well as the documents was followed.

Qualitative Data is got from Interviews While analyzing the inter-views that have been conducted a process of thematic study was used to draw primary data. This included passing through a process of categorizing, comparing and concluding on patterns (themes) in the responses to the interviews. The first step involved taking a textual record from the interviews to respond to specific questions by the key responsible individuals but at the same time give them an opportunity to elaborate on any issues they consider relevant and of importance. The details collected from these interviews also formed the basis of a report that summarized the climate change strategies of the respective company with special emphasis on their efforts towards minimization of GHG emissions. Meanwhile, the above generated report shows and offers a broader outlook of the participants' perspective and an insight on how EMA is being practiced to counter the impacts of climate. while Document Analysis was a source of collecting data The data which was collected by document analysis were analyzed by content analysis technique. This approach included the process of carefully going through the selected documents in the course of the study to identify information that is pertinent to the objectives of the study. The work being conducted was the examination of the literature with the aim at identifying how EMA practices are depicted, the tools and methods used by the companies and the results that are associated with the implementation of EMA practices. The results obtained from the document analysis were then incorporated together with the interview data to form a broader perspective of EMA implementation across the sectors and regions. Then Data Triangulation method is conducted to improve the credibility of the findings by comparing data collected from the interviews with data collected from the documents. This approach was useful in making sure that the results are valid and also gives a better understanding of the EMA practices in the organizations that were under study.

### **3. 4. Validity and Reliability**

Credibility was given much consideration right from the initiation of the study period to its completion. The study considered validity as well as reliability for increasing the credibility of the findings and making the research generalizable across diverse contexts (Lincoln, 1985).

To address the Validity , the development of the questionnaires was done in line with the literature on Environmental Management Accounting (EMA) practices. This heterogeneity enhanced the generalizability of the findings for other organizational settings and also helped ascertain that the conclusions were valid beyond the investigated contexts. Then going to Reliability the continual and organized approach in data collection and analysis ,composed using a semi structured interview guide to ensure that the participants have the freedom to express themselves to the fullest while at the same time following a standard format of interview. This specific approach to the interviews ensured that subsequent interviews were much more consistent and therefore the general reliability of the data was improved.

The study was also conducted systematically through thematic analysis for the allocation as indicated. The process of coding was well explained and documented and should another researcher conduct the same study he or she would most likely get similar results. This made the study to have enhanced methodological transparency hence increasing its reliability. To objectify the analysis even more, only the up-to-date and relevant documents were used while analyzing the documents, which also helped me to use only strictly relevant and precise data in my document analysis. This way the focus of the study was to ensure that there is consistency in the collection and computation of data to ensure that the results that are obtained are accurate and consistent that can be repeated.

### **3.5. Ethical Considerations**

Ethical considerations played a central role in the design and execution of this study, ensuring that participants' rights and privacy were respected at all stages of the research process (Orb, 2001). The study adhered to established ethical guidelines to maintain the integrity of the research and protect all those involved. Informed Consent Before the commencement of the interviews was crucial , the purpose and scope of the study were clearly explained to all participants. This included outlining the type of data that would be collected and how it would be used. Participants were informed of their right to voluntarily participate in the study, with the understanding that they could withdraw at any point without having to provide a reason. This transparent communication ensured that all participants gave informed consent before contributing to the research. then Confidentiality was a priority throughout the study. Strict policies were adhered to in order to protect the identities of the participants and the organizations they represent. To maintain anonymity, the names of the companies involved were not disclosed in the final report. All data was carefully collected, securely archived, and accessible only to the research team, ensuring that the privacy of participants was preserved. The research was conducted

in compliance with the ethical rules and regulations of Padova University. Prior to beginning the study, ethical approval was obtained from the relevant university authorities, and permission was also granted by the research supervisor. This approval process ensured that the study met all required ethical standards before data collection commenced. And The using of the data collected was solely for the purposes of this study. No data was shared with external parties or used for purposes outside the scope of the research. Following the completion of the study, all data was archived in accordance with the policies of Padova University, ensuring that the research was conducted responsibly and in line with institutional regulations.

### **3.6. Overview of Selected Organizations**

In this section, we present an overview of organizations selected in this research in terms of their industry, key activities and relation to EMA practices.

#### **1. DP World Company**

DP World is a global supply chain solutions provider headquartered in the United Arab Emirates particularly in Dubai. Serving the cargo logistics, port terminal, maritime related services and free zones the company has developed into one of the leading global logistics giants. Created in 2005 by the fusion of the Dubai Ports Authority and the Dubai Ports International, DP World now manages 70 million containers, which represents roughly 10% of the world traffic of container. With 82 marine and inland terminals in more than 40 countries and territories, DP World plays a critically important role in international supply chain. Since 2016 the company has gone beyond port management and has been engaging in more diverse value chain activities. EMA is an important topic for investigation due to its connection to the essential area of DP World – sustainability and environmental management.

#### **2. CAREL Company**

CAREL Industries S. p. A. is an Italian based company that deals in control solutions in air conditioning, refrigeration, heating systems and systems in humidification and evaporative cooling. It is committed to the provision of energy saving products and solutions that reduce the pressure on the environment through bundling of cutting edge technologies and tailored services. CAREL products find application in the commercial, industrial, and residential buildings. The company boasts of its policy of improvement research and innovation, which has been a key driver in the growth of the company in the last five decades. Thus, CAREL's approach to environmental issues as one of the major

corporate objectives combined with company's focus on energy saving and sustainability makes it relevant to analyze EMA practices within the sphere of manufacturing industry.

### **3. El Sewedy Electric company**

A global leader that has evolved from a local manufacturer of electrical products into an integrated infrastructure solutions provider; with over 19,000 employees and with recorded revenues of more than USD 5 billion in 2023. Operates in five key business sectors: Wire, Cable & Accessories, Electrical Products, Engineering & Construction, Digital Solutions, and Infrastructure Investments. With a strong presence in 19 different countries, 31 production facilities spread across African and Asian countries including Egypt, Algeria, KSA, Qatar, Indonesia, Pakistan, and Tanzania. We export a wide range of high-end products to over 110 countries worldwide. At the heart of their approach is an all-in-one integrated Engineering, Procurement & Construction (EPC) service, enabling us to deliver the most complex turnkey projects on time and with the highest efficiency.

A vital part of its mission is ensuring that the communities where we operate develop and flourish. We work to facilitate the global transition toward a sustainable energy future, whereby we established green energy projects and smart cities across Africa, the Middle East, and Eastern Europe. In alignment with our 2030 sustainability strategy, aiming to extend and enhance their positive impact, provide energy services to a growing customer base, and drive decarbonization, digitalization, and sustainable transition in Egypt and beyond.

### **4. Afran Al Hattab Company**

Al Hatab Bakery has a deep-rooted passion for baking and commitment to quality, which has led to the establishment of 17 branches across Saudi Arabia. Each location offers a diverse selection of freshly baked goods, including an impressive range of local and international specialties. The bakery is more than just a place to purchase bread and pastries; it brings the art of baking to life, using wholesome ingredients and traditional methods passed down by experienced chefs. Al Hatab Bakery also emphasizes its dedication to sustainability, integrating environmentally friendly practices in its production processes, such as the transition to electrified ovens and machines, which significantly reduce their carbon footprint. The bakery believes that the flavors of the world should be enjoyed responsibly, which is why they are committed to reducing their environmental impact while delivering the finest products to their customers.

## **5. Orange Egypt**

Orange Egypt is a leading telecommunications provider in Egypt, offering a wide range of mobile, internet, and digital services. As part of the global Orange Group, it serves millions of customers and plays a significant role in the country's telecom sector. The company is also committed to sustainability, incorporating Environmental Management Accounting (EMA) practices to reduce carbon emissions, improve energy efficiency, and promote environmental responsibility. Through initiatives like the use of renewable energy, waste management, and energy-efficient technologies, Orange Egypt aligns itself with national and international environmental goals while continuing to expand its services across Egypt.

## **6. Heidelberg Materials Egypt**

a prominent player in the construction materials industry, particularly in cement production. As part of the global Heidelberg Materials Group, the company operates multiple plants in Egypt, focusing on sustainability and environmental responsibility. It has implemented Environmental Management Accounting (EMA) practices to reduce its carbon footprint, including investments in alternative fuels, waste heat recovery systems, and renewable energy projects. By adhering to stringent environmental regulations and ISO certifications, Heidelberg Materials Egypt is committed to reducing greenhouse gas emissions and improving energy efficiency, positioning itself as a leader in sustainable practices within the cement industry.

## **7. Vacsera Egypt**

also known as the Holding Company for Biological Products and Vaccines, is a leading Egyptian entity in vaccine production and biological products. It plays a critical role in public health, both in Egypt and across the region. Vacsera follows stringent Environmental Management Accounting (EMA) practices, focusing on waste management, energy efficiency, and health and safety standards. By adhering to international standards such as WHO and OSHA guidelines, as well as ISO 14001 certification, Vacsera ensures its operations are environmentally sustainable. The company is dedicated to reducing greenhouse gas emissions and improving overall environmental performance, contributing significantly to Egypt's healthcare and pharmaceutical sectors.

Building on the qualitative methodology outlined above, the next section presents a series of case studies that explore the unique challenges and strategies companies employ to reduce GHG emissions

### **3.7. Environmental Management Accounting Practices in Action**

Environmental Management Accounting (EMA) is increasingly recognized as a critical tool for organizations to track and manage environmental costs while aligning business operations with sustainability goals. EMA integrates both financial and non-financial data, allowing companies to assess the economic and environmental impact of their activities (Schaltegger S. &, 2000)

#### **3.7.1. Case Study 1: DP World – Reducing Green House Gas Emissions in its Sustainability efforts**

A good example of the understanding is DP World, an Emirati multinational logistics company whose sustainability policy entails the minimization of GHG emissions. The subject of this report is the measures taken by DP World to reduce its impact and contribute to the change of the logistics industry. DP World has put forward its sustainability plan of action named “Our World, Our Future” with the purpose of making the company sustainable in its functioning and especially in terms of the minimized emission of GHG. As “Sustainability initiatives in logistics, such as reducing GHG emissions, are increasingly critical as the industry seeks to balance operational efficiency with environmental responsibility “ (McKinnon, 2015) .The strategy emphasizes sustainable development of the economies and societies, the need for the economic growth not to harm the environment and people.

Beginning with Climate Change Mitigation and Emissions Reduction as it is considered a paramount concern in DP World and it is keen on assessing the energy used in operations. Through energy efficiency and innovative practices it has managed to reduce its emission by 13% from its baseline year. This has been a great achievement by DP World in its fight against global climatic change through reduction of carbon footprint.

In addition there is a Water Conservation policy as The management of water is essential to DP World, but the firm also understands that water and climate issues are linked. DP World’s programs are to address the challenges of safe supply of water, preservation of the oceans, and the conservation of species. All these measures are part-and-parcel of the efforts to support the blue economy which is inextricably related to the issue of minimizing the ecological footprint of the logistics and trade processes. The 2030 Water Blueprint involves a commitment to impact at least 100 water-stressed river

basins. This scheme corresponds to the worldwide campaign on water deficit and adds to the company's objectives of minimizing the effects of climate change.

In Egypt the company works with Green River Organization for cleaning the Nile River from pollution and organic waste that play a big role in decreasing the GHG emissions (Hosny, 2024). The company reduces the potential of degradation of these materials to produce greenhouse gases such as methane and carbon dioxide when the plastic is recycled. Moreover, where ecosystems are cleaner, they are more capable of supporting lives of fish and others that have carbon sequestering attributes which will result in reduced GHG.

Further, the use of plastic tool for preparing the products and replacing it with biodegradable cartons which is also known as eco-carton or sustainable carton has a direct effect on cutting the GHG emissions. The manufacture and degradation of plastic use a lot of energy in the form of carbon, used in the formation and degradation of plastics. As the eco-friendly cartons are used instead of the plastics which are usually non-recyclable and hazardous to the environment, the company is cutting down the carbon emissions of its packaging materials (Hosny, 2024). This shift also has the effect of decreasing emissions during production but more importantly, at the end of the lifecycle of these cartons, it is easier and far less damaging to the environment, because they degrade and do not give off noxious gases. Altogether, these social projects indicate that the company is concerned with the climate issue and plays an active part in combating climate change through tangible activities. Furthermore Renewable Energy Utilization is pivotal in DP World as today it has been able to post excellent results as it continues to source most of its energy from renewable sources; the company today uses 61% renewable energy. This shift not only helps to decrease the dependency on the fossil fuels but it is also very effective in decreasing the overall GHG emissions of the company. Through the adoption of cleaner electricity DP World has established a good practice of sustainable energy use in the logistic industry. The Current and Future Challenges revolve around applying problem-solving strategies to deal with international concerns such as climate change is the phenomenon of social loafing concerning group work. This is perhaps evident when people or teams create a culture of overdraft or dependency on others, hence fostering the problem of no cooperation or effort. In this case, this problem is especially acute because combating the crisis of global warming is possible only with the involvement of all sorts of stakeholders: individuals, corporations, local governments, and the world community. That is why when some of the parties fail to contribute, probably believing that others must compensate

for their shortfall, it is a let-down to the realization that, in order to solve the environmental problems in the world, there must be cooperation.

Also, another considerable challenge is in the form of geopolitical crises, especially wars, which have greatly affected sustainability processes. For instance, it has practically become impossible to manage and impose sustainability policies owing due to the continuous wars in the Middle East, especially in the sea areas (Hosny, 2024). Such policies may be costly for the firms that adhere to them, especially during a war or conflict when looking for a compensation for the losses may be challenging. Therefore, the expense incurred when implementing sustainability measures is costly than the actual benefit it produces, this has made many organizations to pull out their support for sustainability measures. Thus the tendency of not investing in sustainability during conflict period underlines the weakness of environmental politics when facing economic and political crisis.

### 3.7.2. Case Study 2: Carel – Reducing Green House Gas Emissions in its Sustainability efforts

Carel is a world class company involved in control solutions for air conditioning, refrigeration & heating with its origin in 1973 has been equally conscious about environment and sustainable development. The CAREL has adapted its technologies and strategies in the last fifty years to reflect changes in the awareness of the need to become environmentally conscious and made sustainable development an essential part of their business model. This paper describes how CAREL, through the following sustainability practices, increases global GHG emission: product-related innovations and organizational practices.



Figure 4 (industry, 2024)



From the foundation of Product Innovation for Environmental Impact Reduction, the key focus in sustainability strategy at CAREL is to create environmentally friendly products that will enable its clients to be more sustainable. The company aims at developing energy efficient, networked products that utilize the most efficient controls in operation to perform their task in the most efficient manner possible. “The use of energy-efficient technologies, such as variable speed compressors in HVAC systems, has been shown to significantly reduce GHG emissions and improve sustainability in building management” (Hepbasli, 2014). Hence For example, the CAREL’s HVAC/R systems produce innovations like variable speed compressor utilizing the BLDC technology in applications like heat pump. These systems when used combined with natural refrigerants such as CO<sub>2</sub>, propane (R290), and ammonia (R717) have very low emissions and hence eliminated most GHG emissions in cooling and refrigeration processes.

Among them is the HEOS (High Efficiency Showcase) system that changes a supermarket’s refrigeration system from centralized to distribute. This results in energy savings to the extent that the energy used for each refrigeration cabinet can be fine-tuned for maximum efficiency. Also in the HVAC sector, CAREL’s adiabatic humidification technology enables humidity variation with substantially lower energy expenditure than others. These innovations do not only enhance energy efficiency but also contribute to the global phase out of high GWP refrigerants, which are even thousand times worse than the CO<sub>2</sub> emissions once let into the atmosphere.

In addition to very comprehensive environmental policy, CAREL also actively contributes to the elaboration of intelligent geothermal systems with the help of Geofit research cooperation. This initiative aims at improving on the existing geothermal systems in order to decrease environmental footprint, especially on heating and cooling applications under difficult climatic conditions. In CAREL, sustainability applies inside the organization as a way to implement sustainable practices in all its works. The company has embarked on small-scale projects to explore the practicality of using renewable energies aplenty in its array of production plants that has been certified on the implementation of ISO 50001:2018 on energy management system. This certification guarantees that CAREL manages to use energy efficiently, minimize on energy consumption and also lower the greenhouse gas emissions. For instance, in 2022, the company implemented the change of lighting system at certain locations such as the Croatian factory and Hygromatik and the usage rate improvement of Multiple production line in China. : All these initiatives taken together saved more than 219,800 kwh of energy (Carel, 2023).

Adopting sustainability internally, CAREL also pays attentions to the training on ESG standing for Environmental, Social, and Governance for the employees. This training enables employees of the company beginner level to middle level and even executive level understand the sustainability goals that the company has and their part in them. Through promoting culture of sustainability, CAREL ensures that the workforce of the company is proactive in responding to its environmental goals. The company knows that there is a constant acceleration of technology, and the arising demand for new methods of education, nevertheless, the company stays loyal to the tendencies and works on overcoming the challenges through the constant acquiring of knowledge. However, CAREL experiences the following challenges in its sustainability strategy; The fast growing technology demands that the company must invest in innovation and efficiency of its products in energy consumption and environmental conservation (Ometto, 2024). Moreover, with the advancements in the area of education and training it is crucial to find new approaches that could help employees to be prepared for the corresponding responsibilities towards sustainability.

Moving to the future, CAREL is planning the further development of natural refrigerants as the best replacement for synthetic refrigerants. Some of the ongoing project undertaken on behalf of the company in the retail food sector shows commitment to moving away from conventional technologies to advance variable speed technologies and natural refrigerants such as CO<sub>2</sub>. The primary strategy of CAREL in the medium term is to elevate the proportions of renewable power used with an aim of counteracting emissions. The company achieved a 85% of renewable electricity equivalent in the year 2022 along with the prevention of 5,351 tCO<sub>2</sub>eq of CO<sub>2</sub> emissions. CAREL plans to take the percentage up even higher, thus consolidating its position as an industry leader in sustainable production.

### **3.7.3. Case Study 3: Elsewedy Electric Company- Reducing Green House Gas Emissions in its Sustainability efforts**

#### **GHG Emission Reduction Initiatives:**

Elsewedy Electric has also flexibility its boundary for organizing and operation for the 2023 carbon footprint by including all its 24 active plants. In Egypt these efforts have been particularly aim on the emission factually from some of those outlets like EGYTECH Factory and Special Cables (UIC) Factory which are some of the large emission sources companies under the umbrella of the

organization. These factories have had energy efficient measures and taken up renewable energy to mitigate on their emissions under the Scope 1 and Scope 2. The transition to renewable energy sources in manufacturing sectors is pivotal for reducing carbon emissions and achieving sustainable production (IRENA., 2020).

The EGYTECH factory in Egypt started a project of establishing solar lampposts in the year 2023 and the project started working from February 2023. This alone has created a reduction of 1. 93 mtCO<sub>2</sub>e and the factory has kick-started the process of embracing renewable energy in its business. This project is among the efforts to adopt renewable power in all the company's facilities in Egypt.

It is quite shocking to note that elsewhere Electric has realized a third of the emissions from procurement of raw materials. Earlier, in 2022, it started extending its carbon assessments to emissions that arise from the purchase of raw materials. For example, the UIC factory experienced a 20% decrease in the total emissions in 2023 with comparing to 2022 mainly due to the lack of steel purchase for manufacturing. This begs the questions whether this shift of gears is one to begin maximizing the usage of these materials and perhaps explore for more sustainable ones.

**Waste Management and Water Conservation:** Otherwise, the firm elaborates on emission reductions in the area of waste disposal and water management. In Egypt they have reached measures to control the discharges that are associated with disposal of waste and treatment of wastewaters. For instance, the company included the emissions that originated from the solid waste disposal and wastewater treatment undertaken in the organization's Egyptian factories because they add up to the organization's general carbon footprint, and at the same time, one can single out areas that can be improved.

**Employee Engagement and Commuting:** On the employee commuting, the company has embarked on minimizing the emission level by advising its employees to change their ways of commuting and has included the same in the Scope 3 emission level. In Egypt, the emissions resulting from their employee commuting were quantified and included in the emissions, which helped the company review possible areas of emission management such as encouraging employees to share a ride or employer-provided transport.

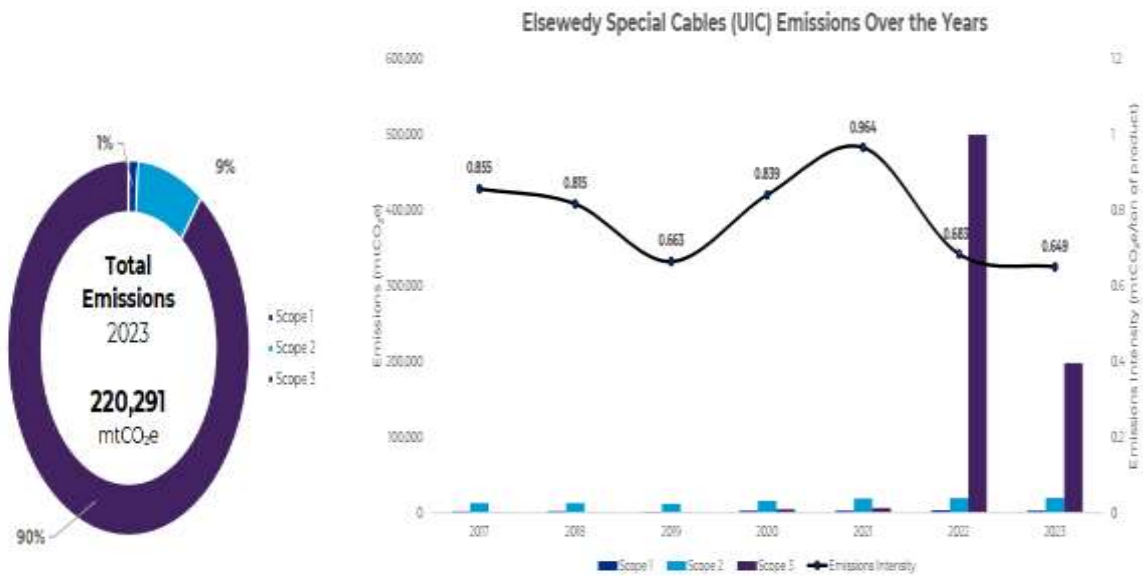


Figure 5 (Elsewedy Electric. (2023). Carbon Footprint Report 2023.)

#### Analysis of Emissions Over the Years: Analysis of Emissions Over the Years:

The graph on the right represents the emissions of Elsewedy Special Cables (UIC) for the period of 2017 to 2023 with a classification of Scope 1, Scope 2, Scope 3.

The Scope 1 emissions (emissions from the Company's own operations) hover in the low percentages for the years. While Scope 2 emissions which is the indirect emissions from the electricity, steam, heating and cooling that is purchased by the company also reflects a small fluctuation meaning that the company's energy use is also relatively stable. Scope 3, indicates considerable fluctuation, especially compared with the year 2022, where erratic movement occurs. This could be due to various reasons which could easily be external for instance increased material purchase or other supply chain section which are usually more difficult to manage (Bassiouny, 2024).

Emissions Intensity (measured as mtCO<sub>2</sub>e/ton of product) has higher values throughout the year 2021 but lowers down in the year 2022 and 2023. This means that the company has achieved better efficiency of creating goods that have less carbon impact in the recent years although other emissions (particularly Scope 3) were higher.

The second image ( on the left ) provides a detailed breakdown of the total emissions for 2023, showing that The emissions of Scope 3 cover the highest percentage of the total emissions where it

stands at 220,291 mtCO<sub>2</sub>; 90% of the total emissions. This high percentage affirms the fact that the company's value chain activities inclusive of raw material extraction, production, and distribution have huge effects.

Emission within Scope 1 is at 9% while that of the Scope 2 emissions is at 1%. This goes to show that emissions in absolute terms from the company's own processes and the use of energy are less than those arising from the company's supply chain and product life cycle emissions.

Collectively, these visuals show the areas that need the most attention in regard to emissions in order to be a focal area for improvement by Elsewedy Special Cables (UIC). The company's efforts should mainly be directed towards handling the Scope 3 emissions since these are the greatest contributors to the company's emissions. Such measures may include partnering with vendors/suppliers on how to cut down their emissions, enhancing the efficiency of supply chain or the sustainability of the raw materials used in production. Also, the analysis of the emissions standards shows the reduced emissions intensity over the recent years, which is the evidence of the fact that the company is gradually improving their products and finding ways to minimize the negative impact on the environment, which needs to be further developed.

Moving to the Future Plans of Elsewedy Electric the aims is to go on with its sustainable development, especially within Egypt. Energy: The company is still heavily dependent on non-renewable energy source and the company should take necessary measures in order to increase the use of renewable energy and also improve the overall energy intensity of the firm. Further, the company also intends to issue more EPDs and upgrade its carbon footprint values for Scope 3, which forms the bulk of emissions (Bassiouny, 2024).

#### **3.7.4. Case Study 4: Afran Alhatab – Reducing Green House Gas Emissions in its Sustainability efforts**

##### **Overview**

A case study is the Al Hatab Bakery, a leading bakery Company in Saudi Arabia that has been in the vanguard on matters sustainability and reduction of Greenhouse gases emissions. This report provides an explanation of how the operations of the bakery affects as well as support environmental sustainability in its operations and strategies.

In contrast to DP World's logistics-focused sustainability plan, Al Hatab Bakery prioritizes energy conservation and organic product sourcing as part of its EMA practices.

The companies in Saudi Arabia like, Al Hatab Bakery has invested on electrification of its production line and have been using electrical machines and ovens, electrical means of heat production. The food industry, especially bakeries, has a significant opportunity to reduce its environmental impact by transitioning to renewable energy sources and improving energy efficiency in production (Röös, 2015). That we can see in The transition from the use of fossil fuels such as gas, coal and oil to the use of electricity especially the renewable electricity in the baking processes lowers the carbon footprint tremendously. It also optimizes the Internal energy efficiency as well as reduces greenhouse gases emission hence the company's GHG emissions reduced as well (Saeed, 2024).

Al Hatab Bakery has implemented several key sustainability initiatives that not only improve operational efficiency but also contribute to reducing its environmental impact. Central to these efforts are its strict quality control procedures, educational programs on energy conservation, and a focus on organic and healthy products, all of which are designed to promote sustainability while supporting the company's growth.

Strict Quality Control Procedures is also adopted Al Hatab Bakery prioritizes effective quality control procedures that play a crucial role in minimizing waste during the production process. By ensuring that resources are used efficiently, the bakery is able to reduce unnecessary costs associated with product defects and wastage. This approach not only conserves resources but also significantly reduces the emissions that would have resulted from the overuse of materials. The bakery's commitment to quality and efficiency translates into reduced energy consumption and lower greenhouse gas (GHG) emissions, thus aligning with its broader sustainability goals.

In addition to quality control, Al Hatab Bakery has instituted organizational programs aimed at raising awareness about energy conservation. These initiatives target employees and the wider community, with a particular focus on educating younger generations about the importance of reducing energy use. Through these efforts, the bakery promotes sustainable practices that encourage environmental stewardship. By educating the next generation, the bakery fosters a culture of energy conservation, leading to reduced energy consumption and lower GHG emissions over time.

Al Hatab Bakery's commitment to sustainability is further reflected in its product offerings, which include a range of organic and healthy products. The bakery places a strong emphasis on effective supply chain management, ensuring that the ingredients used in production are relatively unprocessed and environmentally friendly compared to conventional alternatives. Organic farming, which produces many of the bakery's raw materials, is known for releasing lower levels of carbon dioxide into the atmosphere. As a result, Al Hatab's focus on organic products contributes to the reduction of GHG emissions across its product portfolio, aligning with its commitment to sustainability.

The bakery's approach to sustainability is also supported by its strong financial health. By offering the right products to customers, Al Hatab has successfully expanded its customer base and increased sales, without compromising its investment in sustainable practices. The company's economic stability ensures that it can continue to develop and enhance its sustainability initiatives, creating a positive feedback loop that supports both environmental and business goals.

Despite these successes, Al Hatab Bakery faces challenges in fully integrating sustainability into its financial systems. One of the key issues is the distinction between financial accounting and carbon accounting. This lack of integration can hinder the bakery's ability to accurately measure and control its emissions, making it more difficult to make informed decisions about sustainable development. Addressing this challenge will be crucial for the bakery as it seeks to further improve its environmental performance (Saeed, 2024). Although EMA is a powerful tool for managing environmental costs, its implementation is often hindered by several challenges. A lack of technical expertise, high costs of technology upgrades, and regulatory uncertainties can impede progress. Furthermore, the misalignment between financial accounting and carbon accounting presents a significant obstacle for businesses looking to track and report emissions effectively (Schaltegger S. G., 2017). These challenges are particularly evident in resource-intensive industries, where accurate carbon accounting is crucial for sustainable decision-making (Bebbington, 2018)

Looking ahead, Al Hatab Bakery has outlined several initiatives to enhance its sustainability efforts. The company plans to adopt eco-friendly waste disposal measures, which will further reduce its environmental footprint. Additionally, Al Hatab intends to continue expanding the electrification of its production processes, reducing its reliance on fossil fuels and moving toward cleaner, more sustainable energy sources. These initiatives are expected to drive the company toward greater environmental responsibility while maintaining its commitment to quality and efficiency.

### **3.7.5 Case Study 5 : Environmental Management Accounting (EMA) at Orange Egypt**

While DP World's sustainability plan focuses heavily on operational efficiency and logistics, other industries, such as telecommunications, have approached EMA from a renewable energy perspective. Orange Egypt, for example, has made significant strides in adopting solar power, reflecting a broader shift towards cleaner energy solutions in high-energy industries.

Orange Egypt, a leading telecommunications provider, has established itself as a front-runner in sustainability through its innovative Environmental Management Accounting (EMA) practices. These practices are integral to reducing greenhouse gas (GHG) emissions, minimizing environmental impact, and aligning with Egypt's national sustainability strategies. Despite facing various challenges, Orange Egypt's commitment to environmental responsibility continues to drive its success.

The telecommunications industry has increasingly adopted renewable energy sources, such as solar power, to reduce GHG emissions and promote environmental sustainability (Baliga, 2011).

One of the core strategies that Orange Egypt employs is the adoption of solar energy to power its buildings and grid sites. While this transition to renewable energy posed a significant threat and challenge to the company's infrastructure, it ultimately led to an enhancement in energy conservation. In addition to solar power, Orange Egypt has entered into power purchase agreements (PPA) to secure renewable energy sources, ensuring a long-term commitment to green energy.

The company has also focused on waste management, adhering to circular economy principles. This has led to the introduction of eco-friendly SIM cards and biodegradable bags, reducing plastic waste and promoting sustainability. Furthermore, the implementation of the Green ITN program, aimed at reducing the energy consumption of IT networks and systems, showcases the company's dedication to integrating sustainability across all operational facets (Environment, 2024).

Modern GHG reduction strategies are increasingly focused on supply chain integration and the use of life-cycle assessments (LCA) to measure emissions across all stages of production. By accounting for Scope 3 emissions, companies can take a holistic approach to carbon footprint reduction (Huang, 2021). Orange Egypt's proactive environmental practices have culminated in an impressive 18% reduction in CO<sub>2</sub> emissions in 2023. This achievement is largely attributed to the company's shift towards renewable energy, particularly its use of solar power and renewable energy sources for grid



operations. Energy efficiency has also been a key focus, with energy-saving measures implemented in data centers, buildings, and network operations.

The company's adoption of circular economy principles further contributes to its environmental goals. By switching to eco-friendly SIM cards, Orange Egypt has not only reduced plastic waste but has also decreased its overall carbon footprint, reinforcing its leadership in the telecommunications industry as a sustainable entity.

Environmental regulations have played a pivotal role in shaping Orange Egypt's EMA practices. The company has aligned its sustainability objectives with Egypt's National Climate Change Strategy 2050 and Vision 2030. This alignment underscores the company's commitment to supporting national and global efforts to mitigate climate change. Regulatory requirements, including emissions reduction targets and compliance with the National Telecom Regulatory Authority, ensure that Orange Egypt remains compliant while expanding its sustainability initiatives.

To accurately monitor and report its GHG emissions, Orange Egypt has deployed a range of tools. Carbon emissions tracking are central to the company's efforts, particularly in measuring energy consumption at network facilities and sites. Progress toward climate goals is assessed using predefined climate KPIs, which are independently verified by third-party organizations such as Climate Inc. This transparency ensures that the company remains accountable to its stakeholders and maintains credibility in its sustainability efforts.

Orange Egypt's sustainability journey is not without its challenges as Economic pressures present a significant hurdle, as the company must balance the operational costs of implementing sustainable technologies with the need to remain competitive in the telecommunications market. Additionally, maintaining regulatory compliance amidst evolving environmental laws, both locally and internationally, requires constant vigilance.

Supply chain management poses another challenge. Ensuring that all suppliers adhere to the company's sustainability principles can be difficult due to the diversity of the supply chain. However, Orange Egypt continues to work toward greater sustainability across its value chain, recognizing the importance of a holistic approach to environmental management.

Beyond the reduction of GHG emissions, Orange Egypt's EMA practices have delivered numerous other benefits. One significant advantage is the cost savings derived from the company's shift to

renewable energy and energy-efficient technologies. By reducing energy consumption, Orange Egypt has been able to lower its operational expenses, demonstrating the financial viability of sustainability initiatives.

The introduction of circular economy principles has led to a reduction in waste, further enhancing the company's environmental performance. Additionally, Orange Egypt's leadership in sustainability has bolstered its corporate reputation, especially among stakeholders who prioritize environmental responsibility. This enhanced reputation translates into increased trust and loyalty from customers, partners, and regulatory bodies (Orange, 2023).

While Orange Egypt has made significant strides in its EMA practices, there are areas where additional support could further enhance its sustainability efforts. Advanced training programs for employees on sustainability, resource efficiency, and climate management would enable the workforce to actively contribute to the company's environmental goals. Additionally, increased investments in advanced tools for monitoring and managing emissions and resource use would help optimize the company's sustainability operations.

Collaboration with stakeholders, particularly suppliers, is another area where Orange Egypt could benefit. Strengthening these partnerships would ensure that sustainability principles are upheld throughout the supply chain, further enhancing the company's environmental impact.

Orange Egypt is committed to the continuous improvement of its EMA and GHG management practices. The company has established clear KPIs and formed a dedicated climate department to regularly evaluate performance against climate targets. This ensures that Orange Egypt remains on track to achieve its sustainability goals.

Employee engagement also plays a crucial role in fostering a culture of sustainability within the organization. Over 1,000 employees participated in Orange Egypt's first climate campaign, raising awareness and promoting collective responsibility for environmental stewardship.

Innovation remains at the heart of Orange Egypt's strategy. The company continues to explore and adopt renewable energy solutions, such as solar-powered sites and smart city technologies. By staying at the forefront of technological advancements, Orange Egypt ensures that its sustainability practices remain cutting-edge and effective in addressing environmental challenges. (Orange, 2023)

### **3.7.6 case Study 6: Environmental Management Accounting (EMA) at Heidelberg Materials Egypt**

Heidelberg Materials Egypt, a major player in the building materials industry, has made significant strides in implementing Environmental Management Accounting (EMA) practices aimed at reducing its environmental impact. The company's commitment to sustainability is reflected in its efforts to lower carbon emissions, increase operational efficiency, and comply with environmental regulations. Through various initiatives, Heidelberg Materials Egypt is not only addressing the challenges of greenhouse gas (GHG) emissions but also positioning itself as a leader in sustainability within the industry. As “The cement industry is one of the largest contributors to global carbon emissions, but innovative practices, such as using alternative fuels and waste heat recovery, can significantly reduce its environmental impact” (Crivener, 2018).

Heidelberg Materials Egypt has set ambitious carbon emission reduction targets, aiming to cut emissions by one-third from 2019 levels by 2030, with the ultimate goal of achieving net-zero emissions by 2050. This commitment is supported by increased investment in alternative, non-fossil-based fuels across its plants in Helwan, Kattameya, and Suez. By transitioning away from traditional fossil fuels, the company is taking significant steps to lower its carbon footprint (Materials, Sustainability and Carbon Footprint, 2023).

A key EMA practice in the company's strategy is the installation of a waste heat recovery system at the Helwan plant. This system captures waste heat generated during cement production and converts it into electrical energy, leading to a reduction in energy consumption and CO<sub>2</sub> emissions. Such initiatives are central to Heidelberg Materials Egypt's broader sustainability agenda and contribute directly to its carbon reduction goals.

The implementation of these EMA practices has yielded measurable results in reducing GHG emissions. Renewable energy projects, such as the utilization of alternative fuels in cement production and the installation of solar energy systems in some plants, have played a key role in minimizing the company's carbon footprint. These projects also contributed to a decrease in cement production and sales, reflecting a shift towards more sustainable business practices.

The waste heat recovery system at the Helwan plant alone has the potential to reduce CO<sub>2</sub> emissions by 40,000 tons annually, representing a significant step in Heidelberg Materials Egypt's sustainability

journey. Furthermore, the company has achieved an 80% reduction in dust emissions, vastly improving air quality and reducing the overall environmental impact of its operations.

Environmental regulations play a crucial role in shaping Heidelberg Materials Egypt's EMA practices. The company complies with Egypt's legal environmental and quality management standards, as evidenced by its ISO 14001 and ISO 9001 certifications. This compliance ensures that the company adheres to stringent environmental regulations set by the Egyptian Ministry of Environment, and its plants are regularly audited by the Egyptian Environmental Affairs Agency (EEAA).

Heidelberg Materials Egypt's close affiliation with government bodies ensures that its operations not only meet but also often exceed the regulatory requirements. This proactive approach helps the company stay ahead of the curve in a rapidly evolving regulatory landscape (Materials, sustainability , 2023).

To effectively manage and reduce GHG emissions, Heidelberg Materials Egypt employs several tools for measurement and reporting. Carbon footprint reporting is a key component of the company's sustainability efforts, covering direct, indirect, and third-party emissions across its plants. These reports provide a comprehensive view of the company's carbon emissions, enabling Heidelberg Materials Egypt to track progress toward its emission reduction targets.

Energy monitoring systems have also been implemented across all plants, allowing the company to track energy consumption in real-time. This data is used to optimize energy use and minimize emissions through strategic energy planning. Additionally, the waste heat recovery system at the Helwan plant provides critical information on the amount of CO2 savings generated through energy recovery.

Despite its successes, Heidelberg Materials Egypt faces several challenges in implementing EMA practices and complying with environmental regulations. Cement production is inherently energy-intensive, making it difficult to significantly reduce energy consumption without substantial investment in advanced technologies like waste heat recovery and renewable energy.

Managing Scope 3 emissions—those generated by the supply chain and external processes—poses another challenge. Since these emissions fall outside of the company's direct control, reducing them requires collaboration with suppliers and partners to ensure that sustainability principles are upheld throughout the value chain.

In addition to the direct environmental benefits of reducing GHG emissions, Heidelberg Materials Egypt has experienced several other advantages from its EMA practices. Investments in alternative fuels and waste heat recovery systems have led to improvements in operational efficiency, reducing energy costs and decreasing the company's reliance on non-renewable energy sources.

The company's 80% reduction in dust emissions has not only contributed to better air quality in the surrounding areas but has also improved working conditions for employees. This focus on environmental and operational sustainability has enhanced Heidelberg Materials Egypt's reputation as a responsible and innovative leader in the industry.

Heidelberg Materials Egypt is committed to continuous improvement in its EMA practices and GHG emissions management. The company has set clear, binding targets to reduce carbon emissions by 30% by 2030 and to achieve net-zero emissions by 2050. These ambitious goals drive Heidelberg Materials Egypt to invest in innovative technologies and renewable energy solutions.

Collaboration with the Egyptian government and adherence to international sustainability standards further ensures that Heidelberg Materials Egypt remains on track to meet its emissions reduction targets. The company's dedication to improving its environmental performance will enable it to continue leading the industry in sustainability for years to come.

These findings underscore the argument put forward by Burritt and Schaltegger (2010) that EMA is not merely a reporting tool but a framework for strategic decision-making in sustainability. Orange Egypt's use of renewable energy reflects this shift towards integrating EMA into core business practices, particularly in high-carbon industries.

### **3.7.7 Case Study7: Environmental Management Accounting (EMA) at Vacsera**

Vacsera, a leading Egyptian company specializing in vaccine production, has integrated Environmental Management Accounting (EMA) practices into its operations to minimize environmental impact, reduce greenhouse gas (GHG) emissions, and enhance operational efficiency. With a strong commitment to health, safety, and environmental sustainability, Vacsera aligns its EMA efforts with both national and international standards. Through these practices, the company seeks not only to reduce emissions but also to build a stronger corporate reputation in the pharmaceutical and healthcare

sectors. Energy efficiency and proper waste management are crucial for minimizing the environmental impact of pharmaceutical manufacturing, particularly in reducing GHG emissions (Kümmerer, 2019)

At the core of Vacsera's EMA strategy is its adherence to strict waste management protocols. These protocols, developed in line with guidelines from the World Health Organization (WHO) and the Occupational Safety and Health Administration (OSHA), ensure the proper handling and disposal of chemical and biological waste. This compliance with high global standards reinforces Vacsera's commitment to minimizing environmental risks in its manufacturing processes.

In addition to waste management, Vacsera has made significant strides in energy management by seeking innovative ways to reduce energy consumption in its manufacturing plants. This effort is complemented by the company's adherence to the ISO 14001 Environmental Management System, which assesses the environmental impact of its vaccine production activities (Vacsera Egypt , 2024). By maintaining ISO certification, Vacsera demonstrates its commitment to continuous improvement in environmental performance.

Vacsera's EMA practices have a direct impact on reducing GHG emissions. The company has adopted energy-efficient processes and optimized waste management systems to minimize emissions associated with its operations. The careful management of chemicals and other hazardous materials ensures that GHG emissions are kept to a minimum, while the use of renewable energy sources in some operations further supports this effort.

By focusing on energy efficiency and renewable energy, Vacsera has reduced its environmental footprint, demonstrating the effectiveness of its EMA practices in managing GHG emissions. These practices are essential not only for regulatory compliance but also for positioning Vacsera as a responsible leader in the healthcare and pharmaceutical industries.

Vacsera's EMA practices are shaped by both Egyptian and international environmental regulations. The company is fully compliant with national health and environmental laws, as well as global standards such as those set by the International Organization for Standardization (ISO). Holding ISO certifications, including the ISO 14001 for environmental management, underscore Vacsera's dedication to upholding sound environmental management practices.

The company also works closely with regulatory bodies to ensure that its operations are in line with the latest environmental and health safety standards. This collaboration enables Vacsera to adopt EMA techniques that control emissions, promote sustainability, and ensure the safe production of vaccines.

Vacsera employs several methods to quantify and communicate its GHG emissions. Energy monitoring systems are in place to track fuel consumption rates in chemical processing plants and research centers. These systems provide real-time data that allows Vacsera to manage energy use efficiently and minimize its environmental impact.

Additionally, Vacsera conducts regular waste and emission audits to assess its compliance with environmental standards. The frequent surveillance audits required for ISO 14001 certification ensure that the company remains in compliance with international environmental regulations. These audits play a critical role in Vacsera's ability to monitor and report its GHG emissions accurately and transparently.

Despite its successes, Vacsera faces several challenges in implementing EMA practices. One of the primary obstacles is the need for technological upgrades to improve energy efficiency. The implementation of higher-efficiency technologies requires significant capital investment, which can be a barrier to more widespread adoption of EMA practices.

Regulatory compliance also presents a challenge. As international environmental standards evolve, Vacsera must continually adapt its processes to meet new requirements while maintaining the highest levels of vaccine production quality and safety. Balancing these demands can be difficult, but the company remains committed to upholding both environmental and operational standards.

In addition to reducing GHG emissions, Vacsera's EMA practices offer several other benefits. The company's focus on health and safety has contributed to a significant reduction in workplace injuries and fatalities, improving the overall well-being of employees. Furthermore, the reduction in chemical and waste emissions has enhanced the environmental quality of the areas surrounding Vacsera's facilities.

Another key benefit of Vacsera's EMA practices is the improvement in its corporate reputation. By adhering to international safety and environmental standards, Vacsera has established itself as a leader in sustainability within the healthcare and pharmaceutical industries. This reputation has helped the

company strengthen its relationships with stakeholders and secure its position as a responsible corporate citizen.

To further optimize its EMA practices, Vacsera would benefit from additional investments in renewable energy. Although the company has already begun integrating renewable energy sources into its operations, expanding the use of green energy would help reduce its environmental impact even further.

Advanced training for employees is another area where Vacsera could enhance its EMA practices. Periodic seminars on environmental safety and waste disposal would help ensure that all employees are aligned with the company’s sustainability goals and fully equipped to implement EMA practices effectively.

Looking beyond these initial successes, Vacsera aims to deepen its commitment to energy efficiency through investments in electrification and renewable energy. As Vacsera is committed to continuous improvement in its EMA practices and GHG emissions management. The company conducts regular audits and maintains its ISO certification to stay abreast of the latest environmental laws and standards. These audits allow Vacsera to identify areas for improvement and make adjustments to its operations as needed.

In addition to regular audits, Vacsera continues to invest in new technologies that minimize emissions and improve operational performance. By embracing technological innovation and maintaining strict environmental standards, Vacsera is able to enhance its EMA practices and ensure long-term sustainability.

| <b>Company Name</b> | <b>Industry</b>                | <b>Key EMA Practices</b>  | <b>Environmental Strategies</b>                              | <b>Challenges Faced</b>                                | <b>Outcome</b>  |
|---------------------|--------------------------------|---|--|--|---|
| <b>DP World</b>     | Logistics                      | Electrification of equipment, use of renewable energy, waste management | “Our World, Our Future” strategy, 61% renewable energy usage | Geopolitical crises, social loafing among stakeholders | 13% reduction in GHG emissions, cleaner logistics processes |
| <b>CAREL</b>        | HVAC and Refrigeration Systems | Use of energy-efficient technologies                                    | Innovation in product design,                                | Investment in new technologies, need for               | 6,220 GWh energy saved, significant                         |



|                                   |                                       |  |   |   |   |
|-----------------------------------|---------------------------------------|--|---|---|---|
|                                   |                                       | (variable speed compressors, natural refrigerants)                                 | renewable energy integration  | employee education on sustainability  | reductions in GHG emissions   |
| <b>Elsewedy Electric</b>          | Electrical Infrastructure             | Adoption of renewable energy sources, carbon footprint analysis                    | Solar energy projects, carbon assessments for raw material procurement        | High emissions from raw material procurement, supply chain issues                   | Reduction in Scope 3 emissions, energy-efficient operations                   |
| <b>Al Hatab Bakery</b>            | Food Industry                         | Electrification of ovens and machines, sustainable packaging                       | Focus on energy conservation, transition to renewable electricity             | Difficulty integrating financial and carbon accounting, high costs of raw materials | Reduced carbon footprint, improved operational efficiency                     |
| <b>Orange Egypt</b>               | Telecommunications                    | Use of solar energy, waste management (eco-friendly SIM cards, biodegradable bags) | Circular economy principles, energy-efficient technologies, Green ITN program | Economic pressures, supply chain management difficulties                            | 18% reduction in CO2 emissions, cost savings from energy-efficient operations |
| <b>Heidelberg Materials Egypt</b> | Cement Industry                       | Use of alternative fuels, waste heat recovery systems                              | Carbon emission reduction targets (net-zero by 2050), ISO 14001 compliance    | Energy-intensive processes, difficulty managing Scope 3 emissions                   | Significant reduction in GHG emissions, 80% reduction in dust emissions       |
| <b>Vacsera</b>                    | Pharmaceutical and Vaccine Production | Waste management protocols, energy-efficient processes, renewable energy use       | Adherence to WHO and OSHA guidelines, ISO 14001 certification                 | Need for technological upgrades, evolving international environmental standards     | Reduced environmental footprint, improved corporate reputation                |

**Table 3** : showing the findings related to EMA practices among the chosen companies.

In conclusion, EMA has proven to be a critical tool for reducing GHG emissions and driving sustainability across various industries. Whether through renewable energy initiatives, waste management, or efficiency improvements, the case studies demonstrate that EMA is central to long-term sustainability strategies. Moving forward, it will be crucial for industries to continue refining these practices and integrating them into broader corporate strategies to meet global environmental goals.

## **Chapter 4: Discussion, Conclusion, and Recommendations**

### **4.1. Discussion of Findings**

The results of this study strongly support the assumption that the presence and implementation of Environmental Management Accounting (EMA) practices are critical in minimizing greenhouse gas (GHG) emissions across industries. Through the integration of EMA, organizations were found to adopt a more structured approach to sustainability issues, which translated into measurable improvements in environmental performance. These findings align with prior research, such as that of Burritt and Schaltegger (2010), who argued that EMA is not merely an environmental reporting tool but a strategic framework for decision-making aimed at sustainability.

By conducting detailed interviews with key managers and performing document analysis, several themes emerged. These include the need for EMA to be integrated into existing Management Control Systems (MCS), the challenges arising from the application of EMA across international locations and diversified industries, and the specific outcomes achieved in terms of emission reductions. The study thus confirms and expands on the current literature by illustrating the industry-specific and context-dependent nature of EMA practices.

Another major implication of this study is Industry-Specific Approaches that EMA practices vary from one industry to the other, as postulated by Schaltegger and Burritt (2017) affirm that factors of industry heavily influence the adoption of EMA. For example, in the case of the DP World, the measures and efforts that were employed on the need to enhance the flow of cargos and the general operation of ports was key in addressing emissions. Such a strategy is aligned with Bebbington et al. (2014), who pointed out that operational productivity may be defined as an important means of lowering the impact on the natural environment in industries with high levels of logistics. Through adopting of electric equipment along with the overall replacement of diesel and marine fuel, DP World got rid of 13% emission level against the baseline, moreover the boosts of the renewable energy usage to 61% in 2022. This case illustrates how EMA can inform managerial decisions in order to balance resource utilization for efficiency and application of technologies in sustainability objectives.

On the other hand, CAREL, is an HVAC and refrigeration company, implemented EMA practices, by developing new ways of energy management and use of green refrigerants like CO<sub>2</sub> and propane. This

strategy poses within the framework of Porter and van der Linde's (1995) hypothesis that the socio-political pressure towards innovation can enhance the economic and ecological efficiency. EMA practices applied to carel's services, such as variable speed compressors and natural refrigerants helped its clients save 6,220 GWh by 2022 proving that this sustainable business model is not only applied internally but also in its products and services. This has implications with Burritt et al. (2002) who posited that EMA could take its benefits to product and service life cycles thereby further underlining the responsibilities of the companies as stewards of the environment.

This study also highlights the influence of regulatory frameworks on the development of EMA practices, particularly in regions with stringent environmental laws. Companies located in the European Union (EU) tend to implement more comprehensive EMA systems, which is consistent with findings by Larrinaga-Gonzalez and Bebbington (2001), who argue that regulatory environments significantly shape corporate environmental strategies. For instance, DP World, operating within the EU regulatory framework, demonstrated superior environmental performance and advanced EMA adoption. This suggests that EMA, when combined with strong regulatory support, enhances the organization's ability to meet both legal requirements and corporate sustainability goals. These findings are in line with the work of Delmas and Toffel (2004), who emphasized the role of external pressures in driving the implementation of environmental management practices.

While there were positive notes recorded across the different cases reviewed in the study, the researchers also noted various barriers to the implementation of EMA especially where the market structures are less mature or in emerging economies. These challenges are reflected in case of Al Hatab Bakery where problem areas like overlapping between financial and carbon accounting posed as a barrier to synthesizing EMA. This problem validates the works of Qian et al. (2011), who pointed out that a deficiency of linkages between financial and environmental accounting is a significant impediment to efficient EMA implementation. However, the following challenges affected the business operations of the Al Hatab Bakery. One major challenge was the high cost of raw materials used in the production process; Another challenge was and the effects of climate change, endurance of burning fuel in the production process. In an effort to control the above challenges Al Hatab Bakery utilized renewable energy in its production and made efforts to using environmentally friendly packing materials. This case illustrates that newcomers to EMA can undergo significant environ and finan gains if they take the time and effort to implement innovative measures. Some of these challenges are

familiar with Burritt and Saka (2006) who suggested that while adopting EMA, there are initial costs and the resistance that comes from organizational practices.

The seven research studies presented in this work also confirm MCS' strategic importance to the successful application of EMA. Literature review, for example in the work of Henri and Journeault (2010) suggests that there is a need to integrate MCS with EMA for better environmental decision. In this study, the integration of EMA into CAREL's MCS improved its capability to record and communicates environmental performance in relation to sustainability goals, manage environmental issues systematically and support sustainable change. This finding goes with the view of Ferreira et al. (2010) who noted that by using MCS, environmental considerations can be integrated into the strategic management.

Similarly, DP World was able to identify areas specific to the monitoring system concerning Overall Equipment Effectiveness (OEE ) where improvement in energy conservation emission reduction could be made. This supports the realization that while MCS on its own may not create measures for improving the organizational as well as environmental performance MCS integrated with EMA can come up with valuable information needed to improve performance. The results confirm that to regard EMA as the instrument to advance sustainability, an organization's MCS need to be sufficiently adaptive to contain environmental factors and goals.

The conclusion of the research reveals a wealth of evidence concerning the significance of EMA in leading successful sustainable change cross-industry. The findings show that EMA practices differ within the industry and regulatory environment; however, the linkage with management control systems and the effect of the regulatory frameworks define success factors for EMA. There are, however, some issues still to be solved, especially concerning some companies operating in emerging markets; however, it makes sense to pay attention to the following advantages of EMA: These findings ensure the validity of the literature, and extend an understanding of EMA implementation in order to achieve both environmental and company goals in organizational settings.

## **4.2. Summary of key findings**

Several insightful observations emerge from the findings of this research regarding the impact of environmental management accounting (EMA) practices on reducing greenhouse gas (GHG) emissions

across different industries. The findings reveal the benefits and challenges of using EMA in different organizational contexts, focusing on the critical role of decision-making processes, regulatory frameworks, and the integration of management control systems. These key findings not only contribute to the academic understanding of EMA, but also provide valuable lessons for practitioners and policymakers aiming to advance sustainability goals.

The research clearly demonstrates that EMA practices contribute significantly to reducing greenhouse gas emissions when effectively integrated into organizational processes. EMA acts as a strategic tool to guide companies towards environmental improvements by facilitating data-driven decisions. For example, the electrification of DP World's equipment and shift towards renewable energy sources has played a crucial role in reducing its carbon footprint, consistent with previous studies that emphasize the importance of operational efficiency and technological innovation (Schaltegger and Burritt, 2017). CAREL's adoption of energy-efficient refrigeration technologies and switching to natural refrigerants, such as carbon dioxide and propane, has not only led to significant energy savings, but also to significant emission reductions. These results emphasize EMA's effectiveness in transforming environmental practices and promoting sustainability in various sectors.

As this research shows, EMA practices are not standardized across the industry; instead, they depend on the peculiarities of the sectors' operations and the nature of the external environment. For instance, while at DP World, the activities were directed towards efficiency in dealing with logistics so as to curb emissions, at CAREL, the work was more directed towards achieving energy saving products and technology within the HVAC and refrigeration industry. The variety of the strategies used is probably explained by the difference of EMA for distinct industries, which pointed out by Burritt & Saka (2006) as a result in understanding of which the EMA must be adjusted to the specific environmental challenges and the characteristics of operation of the industry in question. Thus, the proper strategies of EMA for every sector have to be derived according to the general conditions of the environment and unique conditions of operation.

By applying the system's complexity perspective, it is found that external regulatory pressures are the most critical enabler/ inhibitor of the implementation and performance of EMA practices. The study shows that companies located in the countries with high levels of environmental legislations, for example in European Union, possess better EMA systems and moreover, have improved environmental performance. This finding corroborates the view that has it that the regulatory framework greatly

influences firms' direction towards best environmental practices as averred by Delmas and Toffel (2004). The compliance of DP World with the standard environmental legislation of the European Union paved way for the implementation of stringent measures, on sustainability that reduced emissions. This analysis stresses the role of regulatory bodies in encouraging the improvement of environmental performance of corporations and avails evidence for implementing regulation as a potent means for diffusion of EMA practices among firms.

However this approach is not without its unique difficulties, especially for organizations located in emerging markets or industries with low degree of regulation. Evaluating the case of Al Hatab Bakery, it is obvious that some practical problems arise when separating the specificity of financial and carbon accounting that could have prevented consistent implementation of EMA in the company management systems. This is in support of the work done by Qian et al. (2011), where they identified that the integration of environmental and financial accounting is normally characterized by some fairly major problems in organizations. Also, measuring value added of EMA is still challenging; a good number of organizations fail to justify the cost of implementing EA systems due to lack of standardization of environmental accounting techniques. However, the study also shows that with such challenges, all is not lost because as the case of Al Hatab Bakery has demonstrated the companies can get it right with the passage of time and hard work.

The Management Control Systems (MCS) appear to be one of the most important findings of this research because of their importance in enabling EMA practices. Indeed, the integration of EMA in the existing MCS in the case organizations including CAREL, ELSEWEDY and DP World enabled the monitoring and reporting of environmental performance leading to improvement of organizational decisions and sustainability goals. That is why Ferreira et al. (2010) also stressed that the integration of EMA with MCS should be established in order to guarantee the integration of environmental goals with other organizational strategies. EMA and MCS also assisted these organizations to link environmental and operational goals and objectives, which also aided enhancement of environmental results.

EMA practice was also found to have strategic and financial impact in the study as revealed earlier. The findings showed that organizations implementing EMA successfully were able to minimize the effect of their operations on the environment, to reduce the operational costs, and gain a better competitive positioning on the market. For instance, when CAREL started to build energy-efficient

products in its production line, it was able to cut emissions while gaining more customers in the process because the call for eco-friendly products was growing. This finding is in concordance with the argument made by Porter and van der Linde on the effects of environmental regulation in promoting environmental and economic gains. Moreover, companies that put into practice EMA strategies claimed to have gained increased corporate status reputation because their environmentally conscious policies offered them a niche market of environmentally sensitive customers and suppliers.

### **4.3. Implications for Practice**

This study has provided some significant implications for organizations, policymakers, and practitioners of EMA and sustainability as follows: Such implications bring into consideration of managerial steps and concerns that will enhance the performance on environmental status, the downward trend on GHG emissions, and the inclusion of sustainability in the setup of organizational processes.

The research has shown that organizations need to adapt EMA practices according to the industry they belong to and working environment they operate in. The two case studies of DP World and CAREL show that each EMA story is unique; no two are alike. It is important that each company understands the key environmental issues that it faces and develops EMA practices commensurate to these concerns. For example, a logistics firm, DPW, may set objectives which pertain to improving transportation and energy while a manufacturing firm like CAREL may set goals relating to product development and energy.

One of the most significant pressure sources that encourage EMA practices implementation are regulatory frameworks. Those organizations that participate in industries that require compliance to strict environmental standards should exploit the legal frames to-up their sustainability efforts. Besides, working with regulations ensures that organizational does not face legal repercussions but at the same time, then ensures it's recognized for being sustainable, which makes the organization more competitive. In turn, policymakers should go on maintaining and enhancing the environmental regulations to promote the use of EMA practices across organizations.

EMA and MCS can be integrated so that sustainability goals can be implemented and succeeded in an organization. It is therefore recommended that organizations integrate environmental goals into their extended management systems so as to adequately model and monitor them. From this integration, it is



easier to link environmental objectives and corporate strategies so that sustainability transforms into a strategic orientation in organizational activities rather than pursuing it as a specific project.

What this means is that organizations should have a long-term view towards when they are implementing EMA practices. Despite the fact that sustainable processes may not generate profits, the future advantage that many companies can draw from include cost savings, reduced risks, and better positioning. For instance, investment in energy efficiency measures and natural refrigerants observed in CAREL is likely to have delivered reductions in emissions beyond compliance, as well as market competitive advantages in the sustainable HVAC solutions domain.

From the challenges highlighted in the study it becomes clear that the transition to EMA and linking it to the traditional financial accounting is a complex process that requires facing various challenges ranging from the lack of standardizing frameworks for EMA to the complexities connected with the implementation of the suggested approach. In other occasions, some challenges may be overwhelming to some organizations and, hence, should engage in training and capacity building to be able to handle such difficulties effectively. Also, there is a need for companies to engage the industry associations and the government to establish common EMA frameworks that may help in ease of undertaking as well as reporting processes.

Essential for the management of EMA practices is appropriate mobilization of stakeholder. Companies should publicize their sustainability endeavors to the stakeholders such as the consumers, investors, policy makers and employees among others. Awareness about the environmental situation and disclosure of the environmental performance as reflected in the DP World and CAREL provide confidence to the stake holders about the sustainability policies of the organization. All this, in its turn, can help to increase brand awareness or even customer loyalty.

Employer monitoring and administration should be seen as a process of unceasing improvement and change and as such organizations should get used to the constant changes in the application of EMA. As problem change, so must the solutions that are applied to them, which is especially important for environment issues. Therefore, companies should continue to keep their minds more open to embrace any new technologies, methodologies, and approaches for improving on their environmental performance. For instance, practices that have emerged as core feature of sustainability at DP World involve the company's constant explore for new ways of incorporating use of renewable energy sources in their logistics processes.

Finally, based on the practical suggestion of this study it can be emphasized that the Environmental Management Accounting should follow strategic, integrated and long-term approaches. Through the implementation of EMA practices that fit in its environment, utilization of regulatory structures, inclusion of sustainability into management systems and systems improvement- innovation, organizations can cut down on emissions of GHG and at the same time gain competitive advantages in the global environment.

#### **4.4. Policy Recommendations**

Giving the observations made in the course of this research the following policies can be recommended for enhancing efficacy of EMA practices as applied by industries and for the management of greenhouse gas emissions: The following recommendations are intended for policymakers, industry regulators and heads of organizations to strengthen the supporting framework for sustainable organizations and promote the development of the best practices on environmental management. Strengthen Regulatory Frameworks for EMA, as The governing bodies need to encourage firms to implement strong regulatory measures that require the integration of EMA into the business processes. Such rules should prescribe the standards of communication of environmental information, emission standards, and the implementation of environmental issues in strategic organizational processes. For instance, increase in the breadth of the prevailing environmental regulations and policies for instance asking organizations to include carbon management and reporting within their EMA practices. This would make sure that organizations are not only ‘Getting by with the laws’ as well as contributing to the sustainability vision of their respective countries and the entire world.

Standardize EMA Practices Across Industries as EMA has become an important research area and the demand for standardized frameworks for its implementation across the various industries cannot be overemphasized. It is therefore prudent for policymakers together with the industry stakeholders to engage in the development of standardized guidelines and practices of EMA. This would also facilitate easier adoption of EMA by organizations; especially SMEs in the organization’s operations. Standardization would also ensure more refined and meaningful comparison and evaluation of the various organizational and industrial environmental performances so as to increase fairness and credibility of the data presented.

There is a need for the implementation of financial incentives like tax credit, subsidies or grant to the organization for their instance at EMA practices. These incentives may be made contingent upon certain results on emission of greenhouse gases or on energy conservation. For example, big companies that have attained the set reduction of emissions as per the EMA could be provided with an option of enjoying charges on their corporate tax or government funding on their sustainability projects. Such incentives would reduce the overall cost of companies adopting EMA to be less and many firms would be willing to invest in environmental management.

Given challenges it is possible to conclude that to implement EMA successfully policymakers should emphasize education and capacity-building initiatives that will help increase knowledge and competence of management and accounting professionals. It may consist of sources that can contribute to the training, workshop and certification courses on EMA, carbon accounting and sustainability reporting. In this manner the desired goals of businesses, organizations and institutions with respect to environmental management will be met because professionals who are conversant with EMA will enable various organizations to incorporate EMA in their operations.

EMA practice should be promoted through Public Private Partnership (PPP), the PPP should involve the Governments, companies and NGOs in implementing EMA practices. It may enable organizations to learn from each other, compare notes, borrow ideas, materials and implement technological aspect of EMA easily. For instance, it would be possible for partners to collaborate on creation of specialized EMA tools for particular industries or on any studies on the environment effects of different business activities. These would ensure that integrations are made that would aid in formulation of a better aligned and synchronized approach towards sustainability of sectors.

Despite this, it is equally important for the policymakers to encourage companies to engage in voluntary environmental reporting. This could be done by acknowledging and incentivizing those organizations which not only complied but also reporting their environmental information on their own. For instance, the signing of companies into an official certification or 'label' based on quality environmental reports to stakeholders would yield better results by making such companies enjoy a competitive edge. Voluntary reporting would also aid the promotion of organizational culture strength, and enhanced environmental management.

The governmental authorities should encourage both the application of EMA and sustainable practices as well as the development of the related research as an important priority. It may encompass a state's

capitation for R & D programs for EMA tools, technologies and methodologies; and for demonstration projects in the reduction of emissions and improvement of resource efficiency. The increase in innovation is important in making sure that organizational adapt to the emerging environmental issues hence improving the sustainability standards.

These policies address the facilitative conditions for EMA adoption and manner in which policies can support industries in enhancing the practical application of EMA. Policymakers can make a significant contribution to the development of global sustainable environmental policies by proposing sustainable strategies and legislation to support organizations' environmental initiatives as well as reduce their GHG emissions and enhance their environmental performance in order to combat climate change.

#### **4.5. Limitations of the Study**

While this study provides valuable insights into the role of Environmental Management Accounting (EMA) in reducing GHG emissions, there are certain limitations that may have influenced the results and their overall applicability.

One limitation relates to the scope of case studies. The study examined only a small number of sectors, including logistics, heating, ventilation, and air conditioning systems, the food industry, cement, telecommunications, and pharmaceuticals. Although these case studies offered in-depth information, they may not provide a comprehensive view of how EMA is applied across different industries. As a result, the findings may not be entirely relevant to sectors not represented in the study, or they may only be partially applicable if those industries operate under significantly different conditions.

Another limitation concerns the geographical constraints of the research. The organizations involved were primarily located in specific regions, such as the European Union, the Middle East, and North Africa. This focus makes the findings more applicable to the regulatory and market conditions in these areas. However, the study may not fully capture the challenges that organizations in other regions, with differing regulatory environments and market dynamics, might encounter. Thus, the results may not be generalizable to a global context.

The study also faced data collection limitations. Interviews with key managers and document analysis were the primary methods of gathering information. While these qualitative approaches provided rich data, there is a possibility of bias, such as self-selection or the subjective views of the interviewees. Additionally, the study did not incorporate internal performance reports, such as financial or

environmental data, to evaluate the overall effectiveness of EMA practices. Including these quantitative elements could have enhanced the findings by offering a more holistic view of EMA's impact on organizational performance.

Another constraint was the temporal limitations of the study. Conducted as a cross-sectional analysis, the research provided a snapshot of EMA practices at the selected organizations during a specific time period. However, environmental management and accounting are fields that frequently evolve in response to changes in legislation, market demands, or technological advancements. Consequently, the findings may not fully reflect the long-term trends or developments in EMA practices.

Lastly, the study primarily focused on large and medium-sized organizations, which tend to have more resources and greater capacity to implement EMA practices. As a result, the unique challenges and opportunities that smaller organizations face were not extensively explored. This limits the generalizability of the findings to smaller firms, which may have different constraints and capacities in adopting environmental accounting systems.

These limitations should be taken into account when interpreting the study's findings, as they may affect the extent to which the results can be applied to other industries, regions, or organizational sizes.

#### **4.6. Suggestions for Future Research**

Any other research in the future regarding EMA will need to expand the scope of its industries into one that will cover many other industries, such as heavy manufacturing, agriculture, and high-tech industries that were not included from this study. This could provide further insight into how the different business environments are implementing EMA practices and ways of solving sector-specific challenges. Besides, a comparative study of EMA practices taken from different geographic regions such as North America, Asia, and Africa, where regulatory enforcement also differs, can provide interesting insights into how local legislation and market conditions influence the success of EMA. Quantitative research, for example, might track several key metrics, including reduced emissions, cost savings, and improved resource efficiency over time. It would therefore hint at long-term benefits of EMA, underlining impact on profitability and sustainability. Additionally, further investigation should be done as regards EMA's usage within an SME environment, taking into account that these organizations have particular difficulties in terms of personnel and financial resource shortages.

It would also be very interesting to study the opportunities behind new emerging technologies like AI, block chain, and IoT in extending EMA's precision and productivity. Longitudinal studies of EMA adoption over several years may yield detailed information on how practices change in response to both dynamic regulatory environments and pressures related to the market. Drawing from environmental science, economics, and management, an interdisciplinary approach would give more comprehensive a framework of EMA that takes account not only of the financial and technical issues but also of those social and cultural factors influencing EMA implementation.

#### **4.7. conclusion**

Therefore, this research work substantiates the importance of applying Environmental Management Accounting (EMA) to minimise GHG emissions and enhance sustainability in different sectors. The studies reveal that both EMA practices of cost and value show that organizations integrate them with management control systems improve organizational environmental cost control and also improve decision making for the organisations superior long term profitability (Burritt & Schaltegger, 2010). However, it also reveals drawback in utilizing approach of EMA, especially in small-scale organization and area with low demanding regulation (Qian et al., 2011). It is wiser if the future efforts will start focusing on applying the EMA on more industries and geographic locations besides incorporating technologies to enhance environmental performance (Schaltegger & Burritt, 2017).

Moreover, the study suggests that EMA strategies should be modified depending on the issues that are characteristic for a particular industry or country and requirements of the corresponding regulations. Hypothesis For organizations that operate in areas with relatively stringent environmental standards, the higher the level of EMA systems, the improved the resultant environmental impacts (Delmas, 2004). Mitigating these regional and sectoral differences will be critical in improving the EMA practices and extend its use across numerous industries.

## **Appendices**

### **Interview Questions**

1. Can you describe the key environmental management accounting practices that your organization has implemented?
2. How have these EMA practices contributed to the reduction of your organization's GHG emissions?
3. How do environmental regulations influence your organization's adoption of EMA practices?
4. What methods or tools does your organization use to measure and report GHG emissions?
5. What are the main challenges your organization faces in implementing EMA practices and complying with environmental regulations?
6. Can you share some of the benefits your organization has experienced as a result of implementing EMA practices, beyond GHG emissions reduction?
7. What kind of support or resources (e.g., training, technology) does your organization require to enhance its EMA practices?
8. How does your organization ensure continuous improvement in its EMA practices and GHG emissions management?

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