Enhancing Corporate Environmental Performance of Large Companies: A Fuzzy Cognitive Mapping Approach

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Enhancing Corporate Environmental Performance of Large Companies: A Fuzzy Cognitive Mapping Approach

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Executive Summary

The global wicked problem of environmental sustainability issues forces us to work on understanding the collective and complex nature of our current systems. Large businesses and organisations are known to play a crucial role in influencing environmental sustainability, with their impact on the environment being significant and multifaceted. The ever-increasing environmental concerns have put large companies under scrutiny from different stakeholder groups like regulators, consumers, employees, investors, activists and non-governmental organisations (NGOs). Consequently, corporate environmental sustainability and performance have become a strategic priority. However, the corporate environmental landscape has evolved into a complex system of interdependencies due to dynamically changing regulations and stakeholder expectations. Furthermore, corporate environmental performance (CEP) is a multidimensional construct influenced by a complex interplay of internal organisational factors as well as external business environment factors. As a result, companies often struggle to make effective decisions to enhance CEP, leading to a gap between ambition and effective action toward corporate environmental sustainability.

The existing literature presented a critical gap in understanding the interactive and holistic effects of the most critical factors influencing CEP. Building on the knowledge gap and the identified problems, the primary objective of this study was to support large companies in the Netherlands in improving their CEP by analysing and identifying the interplay of the most critical factors within technological factors, organisational culture, corporate governance, and external stakeholder pressures that significantly impact CEP. Hence, the following central research question was formulated:

How can large companies utilize the interplay of technological factors, organisational culture, corporate governance, and external stakeholder pressures to enhance corporate environmental performance?

The study adopted an inductive, semi-quantitative research design, utilizing the fuzzy cognitive mapping (FCM) approach. Initially, a literature review was conducted to conceptualize CEP and identify factors associated with it. Then, data was collected through 10 semi-structured interviews with experts from various stakeholder groups, including large companies, consultants, academia, and research organizations. Furthermore, qualitative content analysis of the interview transcripts was performed to identify the factors influencing CEP and the relationships among them, leading to the development of individual FCMs. These individual FCMs were subsequently combined into an aggregated FCM. Then, a structural analysis of the aggregated FCM was conducted to determine the nature and importance of the factors identified. The aggregated FCM was further condensed (simplified) to facilitate more in-depth analysis. Finally, to formulate strategies that might enable large companies to improve their CEP, the findings from the structural analysis were integrated with an analysis of the pathways through which different factors influence CEP. This resulted in three sets of strategies: the first based on high centrality factors, the second on high direct impact factors, and the third on low centrality transmitter concepts.

The results identified 26 critical factors influencing CEP within the broad categories of technological factors, organisational culture, corporate governance and external stakeholder pressures. Furthermore, the developed aggregated FCM demonstrated how these factors interact to influence CEP by highlighting the complex causal interrelationships between the identified factors. Moreover, the study formulated 14 strategies that might enable large companies in the Netherlands to enhance their CEP. The first two sets of strategies defined 12 priority strategies. Furthermore, the third set of strategies provided two guiding strategies to enhance the effect of the variables involved in the priority strategies.

Furthermore, the study establishes that interactions among various factors significantly influence CEP. Hence, it emphasizes that future research should take an integrated and holistic approach when investigating the impact of factors influencing CEP. Moreover, the study encourages companies to formulate strategies that include the interactive effects of different factors to create a more holistic approach to enhancing CEP. By considering the interplay between the identified factors, companies can develop more nuanced and effective strategies that do not merely target individual factors in isolation but rather address the broader system of influences. In addition, the study provides an FCM template that companies can use as a decision-support tool, enabling them to understand the potential outcomes of different strategic choices and allowing them to simulate how changes in one area might affect others. By using the FCM, companies can devise specific strategies by taking into account their unique circumstances, industry, and external environment.

In conclusion, the study highlights the importance of an integrated and holistic approach to improving CEP, considering the complex interplay between internal and external factors. The study contributes to the academic field of corporate sustainability and management by filling a significant knowledge gap concerning the interplay of critical factors influencing CEP. The findings provide insights for companies to enhance corporate environmental sustainability, ultimately contributing to broader global sustainability goals.

The study recommends future research to focus on validating the developed FCM and the strategies to improve CEP. The findings can be validated by integrating quantitative methods such as regression models, organizing workshops with focus groups, and conducting scenario and sensitivity analyses.

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List of Abbreviations

CEP	Corporate Environmental Performance
FCM	Fuzzy Cognitive Mapping
ESG	Environmental, Social, and Governance
GHG	Greenhouse Gas
SBTi	Science Based Targets Initiative
CDP	Carbon Disclosure Project
IFC	International Finance Corporation
UNEP	United Nations Environment Programme
ISO	International Organization for Standardization

1 Introduction

1.1 Background and Context

In a period of unprecedented environmental change, environmental sustainability stands as one of the most significant challenges confronting humanity (Arora, 2018). The 2023 annual report from the United Nations Environment Programme highlights that most of the Sustainable Development Goals are off track, pointing to slow action on the triple planetary crisis — climate change, nature and biodiversity loss, and pollution and waste — as a major driving force (United Nations Environment Programme, 2023).

Urbanization, land use, global trade, and industrialization have negatively impacted nature, biodiversity, and ecosystems worldwide (World Health Organization, 2023). Furthermore, solid waste generation is predicted to grow from 2.3 billion tonnes in 2023 to 3.8 billion tonnes by 2050 (United Nations Environment Programme & International Solid Waste Association, 2024). Moreover, the global water crisis is already affecting approximately half of the world's population (Valo, 2023). Additionally, the world is not on track to meet the Paris Agreement goals (Mooney, 2023). Hence, immediate and collective efforts across all sectors of society are necessary. The push towards environmental sustainability encompasses efforts to reduce waste, minimize pollution, limit greenhouse gas (GHG) emissions and promote the efficient use of resources to maintain ecological balance and support long-term ecological stability and life (Patterson, 2024).

Businesses and organizations play a crucial role in influencing environmental sustainability, with their impact on the environment being profound and multifaceted. Industrial activities exert considerable pressure on the environment, primarily through emissions to the atmosphere and water ecosystems, waste generation, and resource consumption (European Environment Agency, 2024). Alarmingly, large listed companies are projected to exceed the emissions threshold required to keep global temperature increases below 1.5 degrees Celsius by April 2026 (Reuters, 2023). Furthermore, only 18% of the largest 2000 companies in the world are on track to reach net zero by 2050 (Accenture, 2023). Additionally, a third of companies associated with deforestation have not established any policies on the matter (Horton, 2023). Furthermore, companies are noticing a higher risk related to water issues but are still using more water (CDP, 2019).

Given the increasing environmental concerns and the increasing focus on the organisations' environmental impact, businesses are required to address environmental sustainability. Companies are facing high pressure to act on climate change from many different stakeholder groups — from regulators to consumers to employees (Deloitte Global, 2022). It is found that 90% of global institutional investors revise investments if companies do not at least consider environmental, social and governance criteria (ESG) within their business model (EY Global, 2021). In light of this situation, more organizations are starting to take measures to address environmental sustainability. For example, the percentage of companies reporting on climate-related risks or opportunities, board oversight, and climate-related targets increased significantly between fiscal years 2020 and 2022 (TCFD, 2023). Furthermore, by the end of 2023, over 4000 companies set emissions reduction targets through the Science Based Targets Initiative (SBTi) (Science Based Targets, 2024). Moreover, companies across many sectors are setting strategies for nature conservation and restoration (Choi et al., 2023). It is evident that businesses are increasingly committing to ambitious sustainability pledges; however, there are still outstanding questions about the meaningful steps towards actual improvement towards environmental sustainability (Talman, 2023).

As a result, companies must prioritize corporate environmental sustainability and performance. The concept of corporate environmental performance (CEP) reflects the effects that business activities produce on the natural environment and highlights the degree to which firms are committed to eco-friendly actions to protect the natural environment (Ameer & Khan, 2023). Companies that measure, manage and communicate their environmental performance are inherently in a favourable position; these organizations understand how to enhance their operations, reduce their costs, comply with regulatory requirements and stakeholder expectations and take advantage of new market opportunities (Defra, 2011). However, the multifaceted and evolving nature of corporate environmental sustainability presents various challenges for companies, as businesses must adapt to the continuously changing regulations, technology, market preferences and stakeholder expectations.

1.2 Problem Statement

While corporate environmental sustainability has become a strategic priority and choice, the diversity of its topics and implications has evolved into a complex system of interdependencies, each with diverse fields of action (Klein et al., 2022). Consequently, business strategy must adapt to this complex, dynamic, and challenging sustainability-driven future business environment (Klein et al., 2022).

Although organizations acknowledge the necessity for environmental sustainability and many have declared net zero targets, there remains a gap between their long-term goals and short-term concrete actions (Capgemini, 2022). Many firms struggle to implement strategies that can successfully enhance the environmental sustainability of their processes (Jirakraisiri & Badir, 2021). According to a report from the Capgemini Research Institute, the business case for implementing sustainability measures is substantially misunderstood or underestimated (Capgemini, 2022). The research found that only half of the executives (out of 2,004) state that their company has a defined list of sustainability initiatives to be implemented in the next three years (Capgemini, 2022). The report also found that the gap in ambition and action is partly because many organizations lack a collective vision and centralized coordination around sustainability efforts across their operations (Capgemini, 2022).

The problem also lies in the significant gap in understanding and effectively improving (Meuer et al., 2020). CEP is a multidimensional construct, influenced by diverse stakeholders and a complex interplay of factors both within the organization and its external environment (Dragomir, 2018), making it challenging for companies and policymakers to make strategic decisions to enhance CEP. Subsequently, companies and their managers lack clear guidance on how to prioritize and leverage various attributes to achieve the greatest impact on their CEP. By exploring diverse factors and the underlying mechanisms through which they affect CEP, the study would provide valuable insights that can inform strategic decisions, managerial decision-making and policy formulation.

The practical significance of this problem extends beyond the academic interest, highlighting the urgent need for businesses to not only contribute to global sustainability goals but also to adapt to a rapidly changing environmental landscape (Klein et al., 2022). Understanding the nuances of CEP and the interplay of the most influencing factors is necessary for developing targeted and effective strategies that can lead to legitimate and measurable improvements in environmental performance.

1.3 Extant Literature and Knowledge Gap

The extant literature on CEP primarily focuses on two areas: the measurement of CEP and the factors influencing CEP.

A variety of methods have been used by researchers to measure CEP (Trumpp et al., 2013). For instance, Braam et al. (2016) measures CEP through the aggregate of GHG emissions, waste, and water usage. In contrast, Iatridis (2012) defines it based on the ratio of hazardous waste production in tonnes to net sales. Meanwhile, Dahlmann et al. (2019) focuses on the percentage change in GHG emissions as an indicator of CEP, whereas Kassinis & Vafeas (2006) employs the logarithm of toxic release values for this purpose. The diversity in measurement highlights the multidimensional nature of CEP Dragomir (2018). Therefore, it is necessary to appropriately define CEP.

In addition to measurement, a substantial number of studies have investigated the link between different factors and CEP. Within this, the link between financial performance and environmental performance has been widely studied. Several studies have found a positive relationship between environmental performance and financial performance (Hanjani & Kusumadewi, 2022; Shi, 2022; Verma et al., 2022). Various studies also indicate mixed results. For example, Aslam et al. (2022) indicates a negative relationship between environmental performance and financial performance, whereas Munjal & Malarvizhi (2021) and Setiawan & Honesty (2021) find no significant relationship between the two variables. The results demonstrate that the relationship between environmental performance and financial performance is not straightforward and can depend on various factors.

Apart from financial performance, various studies have investigated the link between other factors and environmental performance. Some studies have focused on the link between organisational culture and environmental performance (Adebayo et al., 2020; Bakhsh Magsi et al., 2018; Ong et al., 2019). Other studies

have focused on the relationship between corporate governance and CEP (Abedin et al., 2023; Hong et al., 2021). Several studies have also focused on the influence of external stakeholder pressures on environmental performance (Jiang & Fu, 2019; L. Wang et al., 2020). Moreover, some studies have considered the effect of technological factors on CEP (Ren et al., 2023; Vachon, 2012).

In addition, various studies have focused on exploring and investigating the determinants, factors, attributes or characteristics of CEP from a holistic perspective rather than limiting the study to a single factor. For instance, Liu (2024) investigates the determinants of CEP by analysing different corporate governance factors, ranging from CSR-linked compensation incentives, CSR committees and strategies, environmental targets, and board structure. This study provides a foundation for future research for further exploring the nuanced relationships between specific corporate characteristics and environmental performance (Liu, 2024). Furthermore, Afzal & Lim (2022) underpins resource-based theory to investigate the organizational factors influencing the sustainability performance of construction organizations; however, it does not consider other factors like organizational structure and external business environment. Moreover, it also does not consider the interplay of factors. In addition, the study by Gold et al. (2022) examines various attributes that influence corporate sustainability practices and performance; the research takes into account firm-level attributes, industry-specific factors, stakeholder pressure, and country-level attributes. Even though this research covered a wide range of factors, it did not consider the interaction between factors. Furthermore, Gold et al. (2022) recommends incorporating the influence of technological factors on CEP for future research.

The majority of the studies that investigate the influence of factors on CEP apply a quantitative methodology using regression models (Abedin et al., 2023; Braam et al., 2016; Gold et al., 2022; Hong et al., 2021; Liu, 2024). Although quantitative studies usually provide greater generalizability, objective measurement, statistical rigour, and validity, they often tend to simplify and overlook social, cultural, and contextual factors that influence CEP. This limits the ability to understand the nuanced relationship between factors, as there is usually a lack of understanding of the "why" and "how" these factors influence CEP. The study by Liu (2024) specifically highlights the need for further exploring the nuanced relationships between specific corporate characteristics and environmental performance, which is usually missing in quantitative studies.

Furthermore, there are limited studies that focus on the interplay of factors that influence CEP. For instance, the study by Jaffar et al. (2018) finds that the effectiveness of corporate governance in enhancing environmental performance is contingent on the firm's commitment to compliance with environmental regulations. This study is limited to the interaction between corporate governance factors and environmental regulations. Furthermore, the study by (Karassin & Bar-Haim, 2019) presents a model of factors predicting CEP, which is based on the corporate social performance theory; however, the study limits itself to certain factors and does not explain the underlying mechanisms through which these factors influence CEP. Moreover, no study has investigated the nexus of technological factors, organizational culture, corporate governance, and external stakeholder pressures influencing CEP.

While extensive research has been conducted on CEP, there remains a significant gap in understanding the holistic and interactive effects of diverse factors on CEP. Moreover, while the literature identifies a range of factors associated with CEP, including financial performance, organizational culture, governance structures, stakeholder pressures and technological factors, there is an insufficient exploration of the mechanisms and the interplay through which these factors exert their influence. This presents a critical gap, as understanding the key factors influencing CEP and the complex relationships between them is crucial for implementing effective strategies to enhance CEP. Without this knowledge, it is challenging for companies or policymakers to prioritize actions or predict the outcomes of various measures, leading to a mismatch between action and performance towards environmental sustainability.

1.4 Research Objective

The primary objective of this study is to support large companies in the Netherlands in improving their CEP by analyzing and identifying the interplay of the most critical factors within technological factors, organizational culture, corporate governance, and external stakeholder pressures that significantly impact CEP.

The study chooses to focus on technological factors, organizational culture, corporate governance, and external stakeholder pressures, as the existing literature highlights the individual effects of these factors on CEP. Various technological solutions play a pivotal role in contributing towards environmental sustainability (Laborie, 2021). Furthermore, organizational culture has a strong impact on environmental performance (Adebayo et al., 2020). Additionally, different corporate governance mechanisms are also known to influence CEP (Bosun-Fakunle et al., 2023). Lastly, different stakeholder groups, like regulators, consumers and shareholders, are pressurizing the company to act on corporate sustainability (Deloitte Global, 2022). It is evident that these factors play an important role in influencing CEP; however, it is necessary to take into account the synergistic effects of these factors to derive effective, evidence-based and predictable measures for companies to enhance their CEP.

This study chooses to exclude the financial factors as the relationship between financial performance has already been extensively studied, as highlighted in subsection 1.3. Furthermore, including financial factors would add complexity to the novel aspect of the research, which aims to investigate the interplay of technological factors, organizational culture, corporate governance, and external stakeholder pressures that influence CEP. By focusing on this broad set of factors, the research can provide deeper insights into how the most critical elements within the broad categories interact to influence CEP.

The study aims to contribute to the existing body of knowledge in the academic field of corporate sustainability and management by filling in the significant knowledge gap concerning the interplay of critical factors influencing CEP. In addition, this research holds significant societal relevance as it addresses the urgent need for businesses to contribute effectively to global sustainability goals. Moreover, the findings can inform policymakers in formulating effective policies towards environmental sustainability initiatives at large companies.

Scope

The scope of this research is limited to large companies within the Netherlands. The focus of this study is on large companies because they tend to have a more significant environmental footprint, making their CEP strategies critically important for achieving broader environmental sustainability goals (Hadda et al., 2023), (CDP, 2019). Furthermore, larger organizations are commonly under higher public scrutiny from external stakeholders (Salt & Shein, 2020). In addition, multinational corporations can set industry benchmarks and influence smaller organizations to adopt sustainability practices.

In addition, the study is carried out with a focus on the Netherlands because it serves as a concentrated market for large companies. There are approximately 8000 enterprises in the Netherlands with 100 or more employees (CBS, 2021). Furthermore, in 2023, 10 Dutch companies were listed in the Fortune Global 500 (the world's biggest companies by annual revenue) (Fortune, 2023). Moreover, 48% of the Fortune 500 companies have one or more limited companies in the Netherlands (DutchNews, 2014).

Secondly, as a member of the European Union, the Netherlands adheres to EU environmental regulations and standards. Hence, it provides a context that is relevant to other EU countries. Consequently, the insights from this study may be applicable to broader contexts.

Overall, this research aims to develop recommendations for large companies in the Netherlands to improve their CEP.

1.5 Research Questions

Building on the identified knowledge gaps and the study's primary objective, the main research question and the sub-research questions were formulated as follows:

Main Research Question:

How can large companies utilize the interplay of technological factors, organisational culture, corporate governance, and external stakeholder pressures to enhance corporate environmental performance?

Sub-Research Questions:

SQ1: How is corporate environmental performance defined and characterized?

SQ2: What are the technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures that are associated with corporate environmental performance?

SQ3: How do technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures interact to influence CEP?

SQ4: Which strategies might enable large companies to enhance their CEP?

1.6 Research Approach

This research adopts an inductive approach using a semi-quantitative research design to achieve the study's primary objective. The inductive approach is chosen because the research objectives align with theory building rather than theory testing. This design offers a bottom-up approach that involves constructing knowledge and conclusions based on observations (Woo et al., 2017). This approach is particularly relevant for studying complex and multifaceted phenomena like CEP, where the interactions between different factors are under-explored. By using a semi-quantitative and inductive approach, this research aims to uncover and understand nuances that are not easily captured through purely quantitative measures. Furthermore, the research design approach incorporates both exploratory and explanatory elements. The exploratory aspect focuses on identifying the critical factors, interactions, and insights related to CEP. Concurrently, the explanatory dimension aims to explain how these factors interact and exert their influence on CEP.

The study begins with a literature and desk review to address the first sub-research question, which aims to highlight the conceptualization of CEP. This review was conducted to gather definitions, characterizations, and measurements of CEP from existing scholarly articles and reports. The first sub-research question is addressed in section 2.

To address the second sub-research question, another literature and desk review was carried out to identify the technological factors, organizational culture factors, corporate governance factors, and external stakeholder pressures associated with CEP. The findings from this review were synthesized to develop a conceptual framework highlighting the factors influencing CEP. In addition, semi-structured interviews with experts were carried out to identify additional factors and validate the factors found in the literature review. The second sub-research question is addressed in section 3 and subsection 5.1.

The literature and desk research for the first two sub-research questions involved scoping the review and employing specific search terms. The review incorporated both academic and grey literature, such as policy documents and corporate reports. To ensure robust and reliable findings, a minimum of two electronic databases were utilized: Scopus and Google Scholar.

To address sub-questions 3 and 4, the study followed the fuzzy cognitive mapping (FCM) approach. FCM is particularly useful for modelling and analyzing complex causal systems, making it valuable for socio-ecological research, environmental sciences, and management (Keeton & Reckien, 2023; Mourhir, 2021). FCM allows for determining the most critical factors that affect CEP and simulating their impact Papageorgiou et al. (2013). The FCM approach is further elaborated in subsection 4.1.

To address the third sub-question, the FCM was developed based on semi-structured interviews conducted with experts from various stakeholder groups. Initially, individual FCMs were realised by performing qualitative content analysis on the interview transcripts. These individual FCMs were then combined to

form an aggregated FCM, which illustrates the interactions between the identified factors and their influence on CEP. The findings related to the third sub-question are discussed in section 5.

Then, to address the fourth sub-question, a structural analysis of the FCM and a path analysis of the factors involved were conducted to systematically develop strategies that might enable large companies to enhance their CEP. The fourth sub-question is addressed in section 5.

Finally, it is necessary to address the validation of the results. The developed FCM and the recommendations for improving CEP should be validated in future research. This could involve integrating quantitative methods using real data or organizing a workshop with a focus group to gain detailed feedback on the findings. The validation of results is further elaborated in subsection 7.2.

A visual summary of the research approach is provided in Figure 1:

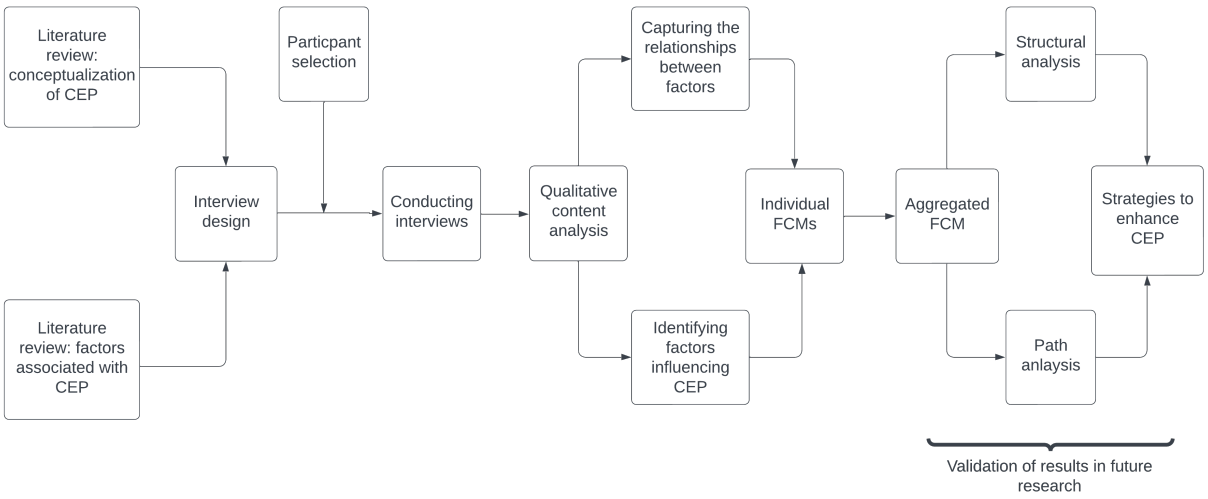

Figure 1: Overview of the research approach

1.7 Management of Technology Relevance

The ability to analyze and adapt to wider societal trends is one of the core aspects of the Management of Technology (MOT) program. Corporate environmental sustainability is a societal trend that is dynamically changing with shifts in the environment, technology, innovation, and regulations. Furthermore, environmental sustainability has become a core aspect embedded within the themes present in the MOT program, which include business strategies, innovation, technology, organization, and commercialization.

Today, many companies use different technologies to report, monitor, and act on environmental sustainability. For example, companies are augmenting their sustainability reporting with technology and data, which subsequently assists with sustainability analysis (Hyöky & Virranta, 2023). Additionally, sensors, the Internet of Things (IoT), and environmental management software are commonly used by large companies for resource optimization, emission reduction, waste management, and reporting. Hence, understanding the interactive effects of different factors and their influence on CEP would assist in realizing how companies can effectively use technological factors to enhance operations and gain a competitive advantage. Furthermore, the study provides a stepping stone toward managing organizational change towards sustainability as it equips corporate managers with a deeper understanding of CEP and its drivers.

Moreover, this research focuses on analysing internal organizational factors (organisational culture and corporate governance) as well as external business environment factors (external stakeholder pressures), which are integral for effective environmental management. This dual focus is essential for developing strategies that are both internally consistent and responsive to external pressures. This approach aligns

with the MOT program's goal of equipping leaders with the skills to understand and navigate both the internal dynamics of their organizations and the external relationships with business partners, ensuring they can respond effectively to the current and future technological, economic, and social challenges faced by technological firms (TU Delft, 2024a).

This study also aligns with various specific courses within the MOT program. For example, it utilizes the learning goals of the course "Leadership and Technology Management" as it aims to recognize different management practices and analyze the success of these practices (in relation to CEP) at large companies (TU Delft, 2024b). Furthermore, as this study involves "organizational culture," it incorporates the role of leadership, organizational behaviour, and values in corporate environmental sustainability. Additionally, this research directly relates to the course "Inter-Organizational Decision-Making" as it aims to provide evidence-based measures to guide managerial decision-making towards enhancing CEP. The study focuses on strategies concerning a complex and wicked problem—environmental sustainability. The research also addresses the decision-making processes in complex, multi-actor settings by employing participatory modelling with input from multiple stakeholder groups.

1.8 Reading Guide

Section 1 highlights the background and context of the study, the problem statement, the extant literature and knowledge gap, the research questions and sub-research questions, the research approach, and the relevance to the Management of Technology program. Then, section 2 delves into the conceptualization of the dependent variable, CEP, by highlighting how CEP is defined and measured. Later, section 3 presents an analytical framework and concept map to demonstrate the technological factors, organizational culture, corporate governance, and external stakeholder pressures that influence CEP. Then, section 4 outlines the research design by detailing the FCM approach, data collection methods, data analysis techniques, and reliability and validity. Subsequently, section 5 presents the final results. Later, section 6 presents a discussion on the findings. Finally, section 7 describes the conclusion of the study.

2 Conceptualizing and Measuring CEP

The primary objective of section 2 is to highlight the conceptualization of CEP based on a literature review to answer the first sub-research question. This section is structured to provide a comprehensive overview of how CEP is defined and assessed within the context of corporate sustainability. The section presents an overview of CEP and highlights the measurement of CEP in the extant literature. Next, it delves into the standards and frameworks that guide and define CEP. Later, it presents the measurement of CEP in practice. Finally, it provides the conceptualization of CEP for this study.

Review approach

The approach to addressing the first sub-research question involved conducting a literature review to gather definitions, characterizations, and measurements of CEP from existing scholarly articles, reports, corporate documents and policy documents. The search terms utilized to source the literature included keywords like "Corporate Environmental Performance", "Corporate sustainability performance", "Environmental Performance Indicators", and "Environmental Performance Measurement". Specifically, the search query that was employed is displayed in the following:

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(TITLE-ABS-KEY("corporate environmental performance" OR "corporate sustainability perform
ance") AND TITLE-ABS-KEY (indicator* OR measure* )) AND ( LIMIT-TO(LANGUAGE, "English"))
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From the literature, key themes regarding the definition and measurement of CEP were identified. Furthermore, the review highlighted commonalities and discrepancies in how CEP is conceptualized and evaluated, offering insights into the multidimensional nature of environmental performance.

2.1 Overview of CEP

The concept of CEP has evolved over time within the broader framework of Corporate Social Responsibility (CSR), which addresses companies' responsibility to society beyond the mere maximisation of profit. It involves considering the social and environmental impacts of business operations and decisions. The initial concepts of corporate social responsibility began to set a foundation between the 1950s and 1960s. Then, the 1970s witnessed the initial regulatory developments and publications around corporate environmental responsibility, conveying businesses' duty to abstain from harming the natural environment (Supriya Pavithran et al., 2020). Subsequently, in the 1980s and early 1990s, there was a growing recognition of the need to measure and manage corporate environmental impacts more systematically (Andrés et al., 2019).

In 1987, the World Commission on Environment and Development published the Brundtland Report, which notably defined sustainable development and addressed global environmental challenges and a call for global action by highlighting the roles of governments, business and civil society (World Commission on Environment, 1987). Later, in 1997, the Global Reporting Initiative was established to address environmental issues. However, it soon expanded its focus to include social and governance aspects after the introduction of the triple bottom line: a sustainability framework that centred on the three p's - people, planet and profit (Elkington, 1998). Then, in 2004, Environmental, Social and Governance (ESG) was officially introduced in a report by the United Nations Global Compact Krantz (2024). The report conveyed the integration of these components in business operations. Today, 'ESG' is almost interchangeably used with corporate sustainability, with ESG data widely utilized by various stakeholders to assess corporate sustainability performance (Krantz, 2024). CEP is a subset of corporate sustainability, as it specifically focuses on the environmental pillar. Nevertheless, It is necessary to understand the broader landscape of corporate sustainability because the increasing focus on CEP could be largely attributed to the growing emphasis on ESG.

The evolution of CEP depicts a broader shift towards recognizing and integrating environmental considerations into business practices. This shift is driven by regulatory developments, stakeholder expectations, and the growing emphasis on sustainable development and ESG factors. As companies continue to enhance their environmental performance, they contribute to a more sustainable future while also gaining competitive advantages such as improved reputation, operational efficiencies, and better risk management.

2.2 CEP Measurement in Literature

The International Organization for Standardization (2013) defines environmental performance as "the measurable results of an organization's management of its environmental aspects" (ISO, 2013). While concise and broad, this definition lacks clear conceptual boundaries, making it somewhat ambiguous. Consequently, researchers in ecology, environmental management, and sustainability studies have faced the challenge of measuring and defining CEP (Dragomir, 2018).

In empirical research, a diverse range of CEP indicators has been employed (Trumpp et al., 2013). The multidimensionality of the CEP construct has led to different researchers using widely different indicators since the 1990s (Dragomir, 2018). Researchers have utilized both process-based measures (e.g., environmental practices) and outcome-based measures (e.g., emissions data) to assess CEP (Brouwers et al., 2014). The choice of selecting CEP indicators is often driven by the practical feasibility, as there is minimal data availability and accessibility within the context of corporate sustainability. This is because CEP is a sensitive issue for large corporates, as it could affect the company's reputation, investor expectations, competitive position, and stakeholder liability. The implementation of the Toxic Release Inventory (TRI) in the United States in 1986 brought about a consequential milestone. The TRI mandated companies to report their emissions of specific toxic chemicals, providing one of the first standardized measures of corporate environmental performance. Since TRI data was publicly available, it provided a standardized measure for CEP (Brouwers et al., 2014). However, the use of TRI data as an indicator was soon criticised for being mono-dimensional and too narrow-sighted. Overall, the multidimensional nature of CEP, the measurement challenges, comparability improvement and dynamically evolving standards make it necessary to appropriately define and conceptualize CEP based on a review of extant research and practices.

One of the first practice-oriented systematic attempts to conceptualize and measure 'good' corporate environmental performance was made in 1989 by the Coalition for Environmentally Responsible Economics (CERES). The framework involved the following considerations: minimize pollutants, conserve resources, reduce wastes, conserve energy, reduce risk, market safe products, compensate for damage, disclose potential hazards, obtain management commitment, and evaluate progress. However, Ilinitch et al. (1998) argued that this approach does not address the bottom-line CEP in a theoretical and systematic way. Ilinitch et al. (1998) also suggested that the existing methods for measuring CEP could lead to excessive complexity and confusion and that standardized and defined measurement systems would benefit the stakeholders involved. Even though significant efforts have been made since then towards characterizing CEP, the corporate environmental sustainability landscape has become an increasingly complex system. Hence, over the years, different indicators for CEP have emerged.

In the extant literature, CEP is measured based on quantitative environmental data collected by the authors (e.g. corporate environmental reports), data from external sources which are not collected by the researchers (e.g. Bloomberg and CDP), survey data collected by the authors (e.g. scoring by the author based on surveys with executives), and based on data from external scores and ratings (ESG databases) (Dragomir, 2018). For example, Lucato et al. (2017) uses eco-efficiency measures for calculating CEP; the eco-efficiency level was calculated by dividing net revenue by the environmental influence (monthly energy, wood, water and gas consumption. Furthermore, Braam et al. (2016) employed the logarithm of different quantities (company's GHG scope 1, 2 and 3 emissions, production of waste (in kg.), total water consumption) to measure CEP. Broadstock et al. (2018) uses emissions data divided by the number of employees as a proxy for CEP by utilizing the Bloomberg database. Similarly, Giannarakis et al. (2017) uses the ratio of emissions data to sales revenue for a five-year period. Moreover, Gotschol et al. (2014), uses a combination of reduction of air emissions, reduction of solid/liquid wastes, and reduction of the amount of energy used, decrease of consumption for hazardous/harmful/toxic materials, and decrease of frequency for environmental accidents as an indicator of CEP. Furthermore, Youn et al. (2011) uses a questionnaire survey with a seven-point Likert scale for pollution reduction and energy consumption reduction. In addition, Baboukardos (2018) uses the aggregate score of environmental scores on % scale from Thomson Reuters ASSET4 ESG Database. This variability in assessing environmental performance has led researchers to evaluate it using a latent variable. This approach aims to encompass several facets of the same concept, that is, the reduction of environmental impact (Gotschol et al., 2014). To address the heterogeneity in defining CEP, Dragomir (2018) conducted an extensive critical literature review to group 140 different indicators of

CEP based on a content analysis of 172 empirical papers published in the last three decades. Based on the review, Dragomir (2018) highlights that external databases from available external rating companies can provide presumed high reliability and high construct validity. Furthermore,Trumpp et al. (2013) also conducted a systematic literature review to find publications providing definitions, conceptualizations, or measures of CEP. The findings suggested that the suitable definition of CEP focuses on both the management activities concerning environmental aspects and the outcomes of these activities and processes (Trumpp et al., 2013).

2.3 Standards and Frameworks

While conceptualizing CEP, it is necessary to take into account established international standards and frameworks around corporate sustainability. Aligning the characterization of CEP with these standards ensures consistency and comparability across different studies.

Over the years, corporations have adopted different frameworks and standards to improve their environmental performance. Some of these include ISO 14001 for environmental management systems, ISO14064 to quantify, monitor and report GHG emissions, the Carbon Disclosure Project (CDP) for carbon emissions reporting, and the Science-Based Targets Initiative (SBTi) for setting emissions reduction targets in line with climate science. By binding to these frameworks, businesses can better manage their environmental impacts and demonstrate their commitment to sustainability to stakeholders. Although these frameworks highlight significant issues, they also create a complex array of standards, often leaving stakeholders struggling with inconsistency and ambiguity. The landscape of several ESG frameworks has been highlighted in Figure 2.

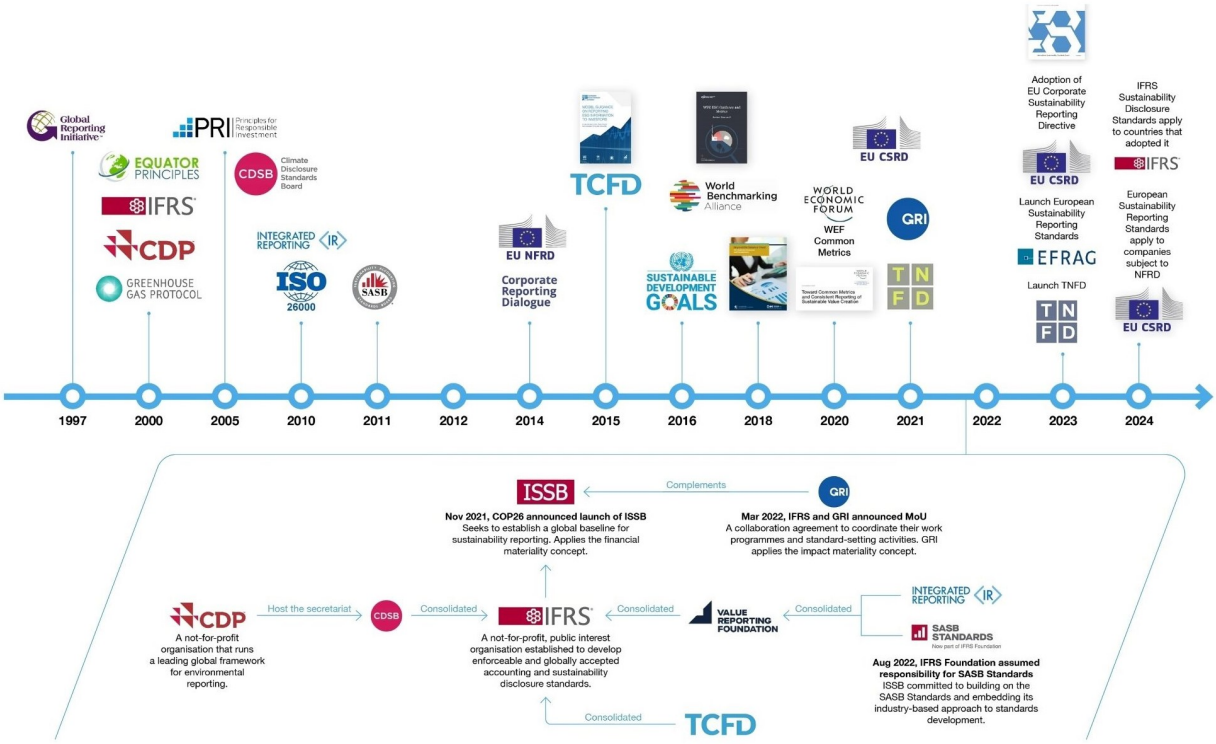


Figure 2: The landscape of ESG frameworks (IFC, 2024)

While it is outside the scope of the study to discuss all the existing frameworks and standards, the study focuses on some broad standards and frameworks to define and conceptualize CEP. Among the various standards and frameworks, ISO standards, CDP, the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS) give a suitable overview for defining CEP.

In addition, apart from the ESG frameworks highlighted in Figure 2, there are several other significant standards and frameworks that focus on corporate environmental sustainability. For example, ISO 14031 defines environmental performance evaluation as a "process to facilitate management decisions regarding an organization's environmental performance by selecting indicators, collecting and analyzing data, assessing information about environmental performance, reporting and communicating, and periodically reviewing and improving this process" (ISO, 2013). The ISO 14031 categorizes two different types of environmental performance indicators (EPIs): management performance indicators and operational performance indicators (ISO, 2013).

Furthermore, CDP provides one of the most comprehensive collection of self-reported, TCFD (Task Force on Climate-Related Disclosures) aligned environmental data (CDP, 2024). More than 23,000 companies report climate, water and forest data to CDP (CDP, 2024). They provide corporates with internationally recognized sustainability scores on the impact on climate change, water and forests. However, reporting to CDP is voluntary. On the contrary, the CSRD mandates all large companies and listed companies in the European Union (EU) to report on their sustainability requirements. The CSRD requires the companies to disclose the following environmental factors (CSRD) (European Parliment, 2022):

1. Climate change mitigation, including as regards scope 1, scope 2 and, where relevant, scope 3 greenhouse gas emissions;
2. Climate change adaptation;
3. Water and marine resources;
4. Resource use and circular economy;
5. Pollution;
6. Biodiversity and ecosystems;

The CSRD establishes broad standards for reporting by specifying these environmental sustainability factors. It pushes the companies to disclose structured, reliable and comparable sustainability information to various stakeholders. On the whole, it aims to provide clarity, aiding investors, analysts, consumers, and other stakeholders in better evaluating EU companies' sustainability performance and the associated business impacts and risks (IBM, 2024). Furthermore, the ESRS provides a set of detailed guidelines and requirements to comply with the CSRD.

2.4 CEP Measurement in Practice

Considering the measurement of CEP in practice provides insights into how theoretical frameworks and standards are applied in real-world scenarios. Analysing CEP measurement in practice highlights best practices and the sub-categories that capture all relevant aspects of environmental performance. CEP measurement in practice can be analysed by looking at external ESG rating providers and global consulting firms. For example, the environmental scores from the ESG ratings provided by MSCI or Morningstar Sustainalytics can be extracted to study CEP. However, the datasets by external ESG rating firms are usually private and expensive.

Accenture, a multinational professional services company, also has several datasets to evaluate the ESG performance of different companies. One of the datasets at Accenture evaluates CEP by considering the sub-categories highlighted in Table 1. It is evident that the sub-categories align with the categories defined by the CSRD highlighted in subsection 2.3.

Table 1: Sub-categories of CEP sourced from Accenture (Accenture, 2024)

CEP sub-categories	**Description**
GHG Emissions	Contribution of business activities to the emission of GHG and other air pollutants based on quantitative and qualitative insights
Air Quality	Impact on air quality from stationary, mobile and industrial sources
Energy Management	Environmental impact associated with energy consumption
Waste and Wastewater Management	Impact of Company's water consumption, wastewater generation and strategies around recycling and wastewater management
Waste and Hazardous Material Management	Environmental issues associated with hazardous and non-hazardous waste generated by companies
Ecological Impact	Impact of company activities on the ecosystem and biodiversity
Product Design and Lifecycle Management	Incorporation of ESG considerations in the characteristics of products and services sold
Material Sourcing and Efficiency	Impact of resilience of materials sourced through the supply chain and company's ability to manage the risk by maximizing resource efficiency

2.5 Conceptualization of CEP

For this study, the conceptualization of CEP is based on the broad categories defined by the CSRD (subsection 2.3). The CSRD categories incorporate significant dimensions of environmental performance that are present in the literature and in practice. Specifically, the conceptualization of CEP involves evaluating corporates on the following sub-categories: climate change mitigation, climate change adaptation, water and marine resources, resource use and circular economy, pollution, and biodiversity and ecosystems.

Aligning CEP with the CSRD categories ensures that the evaluation framework is consistent with current regulatory standards. Moreover, the use of CSRD categories promotes comparability and standardization in CEP measurement. Additionally, the CSRD is widely recognized and well-understood by different stakeholders, ensuring that the assessment of CEP aligns with stakeholder expectations. Overall, the adoption of the CSRD broad categories for the conceptualization of CEP in this study is motivated by the need for comprehensive coverage, regulatory alignment, comparability, stakeholder relevance, and a holistic approach to corporate environmental sustainability.

3 Conceptual Framework for Factors Influencing CEP

The aim of this section is to highlight the technological factors, organizational culture factors, corporate governance factors, and external stakeholder pressures that are associated with CEP based on a literature review and desk research. This section describes the definitions of each of the broad categories and their association with CEP. It illustrates the specific factors within the broad categories that are associated with CEP. Later, based on a synthesis of the findings, the conceptual framework for factors influencing CEP is presented using a concept map. The concept map depicts the specific factors (concepts) and their relationships with CEP.

Review Approach

The review approach for developing the conceptual framework for factors influencing CEP involved the following steps. Initially, the search terms employed consisted of the factor categories itself. Then, the findings were used to refine the search terms and keywords. The keywords and search terms employed for each broad domain are presented in Table 2. The search terms "environmental performance", "sustainability performance", "relationship", "influence", and "affect" were kept constant throughout the review process. Then, the definitions of the key concepts and the findings from the articles were extracted. Later, the patterns in the findings were identified to develop the conceptual framework.

Table 2: Keywords employed for the literature review

Broad concept	**Keywords**
Technological factors	"technological", "technology", "technologies", "innovation"
Organisational culture	"culture", "values", "behaviour", "attitude", "leadership"
Corporate governance	"corporate governance", "governance", "practices", "reporting"
External stakeholder pressures	"stakeholder pressures", "stakeholder", "regulations"

3.1 Technological Factors

Technological factors refer to the ways new practices, innovations, and equipment can affect businesses and their operations. These factors are variables related to the presence, accessibility, and development of technology (Mullakhmetov, 2018). In businesses, technological factors include the various tools, innovations, and digital advancements utilized to streamline operations, improve products, and enhance customer engagement.

Ren et al. (2023) found that integrating digital technologies significantly enhances CEP. Hence, Ren et al. (2023) recommended that companies should incorporate digital tools thoroughly in productions and operations. Furthermore, Yang et al. (2022) found that corporate digital transformation is significantly correlated with enhanced environmental performance by using reduced pollution emissions as a proxy for CEP. The same study also highlighted that digital transformation positively influences green technology innovation, which in turn enhances environmental performance. In addition, it established that improved corporate governance through digital transformation leads to better environmental performance (Yang et al., 2022). Moreover, Trevlopoulos, Tsalis, & Nikolaou (2021) also found that there is a statistically significant relationship between corporate environmental innovation and environmental performance, indicating that environmental innovations have positive effects on CEP. In addition, El-Kassar & Singh (2019) highlighted that significant effects are observed for green product and process innovation on environmental performance.

Green technology innovation is defined as technological innovations that are related to energy conservation, pollution prevention, waste recycling, green product design, and environmental management (Huang et al., 2019). Furthermore, green technologies are also referred to as environmental technologies or sustainable technologies and include applications like renewable energy technologies, energy-efficiency improving technologies, waste management technologies and more.

3.2 Organisational Culture

Organisational culture refers to the collective values, beliefs, and norms that influence the behaviour and actions of members within an organization (Linstead, 2001). The concept of organisational culture is characterized by the values, ethics, and beliefs that shape the day-to-day operations and overall atmosphere within an organization (Huff, 2014). The elements of organisational culture may also include leadership styles, vision, mission, empowerment, coordination, and organisational learning,

Several studies have explored the relationship between organizational culture and environmental performance. For instance, Adebayo et al. (2020) utilized six organizational practices (core values, reporting system, task performance, clarity of roles, careful deliberations, and distinctive identity) and provided empirical evidence of a significant influence of organizational culture on environmental performance. Similarly, C. H. Wang (2019) found that organisational green culture (OGC) positively influences sustainability performance. This indicates that companies that cultivate a culture emphasizing environmental values tend to perform better in terms of sustainability. Furthermore, C. H. Wang (2019) also highlights that green innovation completely mediates the relationship between OGC and green performance. Moreover, the study found that integrating environmental culture within an organization's culture leads to improved environmental performance. Furthermore, Su et al. (2020) established that environmental leadership positively influences CEP. The study also found that green innovation mediates the relationship between these two variables. In addition, Sun et al. (2022) found a significant positive relationship between green transformational leadership and environmental performance. The study also highlighted the mediating role of green innovation and the moderating role of environmental values in this relationship. Moreover, the study by Cantor et al. (2012) highlighted that effectively engaging employees to support the implementation of environmental practices is crucial for achieving improved environmental performance.

Environmental culture, or green culture, can be referred to as a set of shared beliefs, values and attitudes within an organization that focus on environmental sustainability (C. H. Wang, 2019). Similarly, green values or environmental values are principles that prioritize environmental sustainability. Furthermore, environmental leadership involves motivating and guiding employees and organizations towards achieving sustainable environmental goals, often through transformational leadership behaviours that encourage proactive environmental actions and practices (Su et al., 2020).

This study employs the Denison model to understand and identify the dimensions and elements of organisational culture. The Denison model is an organisational culture framework involving four key dimensions: mission, consistency, involvement and adaptability (Denison, 1990). The dimensions also incorporate several characteristics seen in Figure 3.

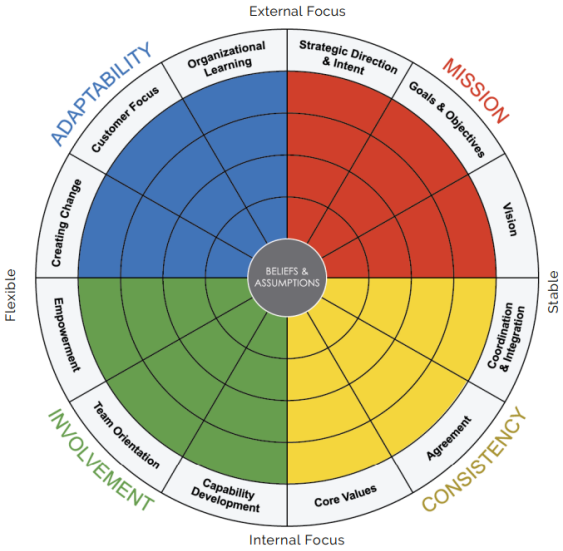


Figure 3: The Denison model of organisational culture (Denison, 2019)

The Denison model highlighted in Figure 3 has previously been used to study the relationship between organisational culture and environmental performance. For instance, the study by Bakhsh Magsi et al. (2018) found that the three traits of organizational culture (adaptability, consistency, and mission) have a significant and positive association with environmental performance.

3.3 Corporate Governance

Corporate governance refers to the systems, processes, rules, policies, laws, and institutions that guide organizations and businesses in their activities, administration, and operational control (Khan, 2015). Corporate governance incorporates elements of the decision-making structure (power and accountability), oversight and control, transparency and accountability, legal and regulatory compliance, risk management and stakeholder management (Conmy, 2024).

There are several studies that highlight the impact of corporate governance factors on environmental performance. For example, the study conducted by Jaffar et al. (2018) presented that corporates with effective corporate governance have fewer violations of environmental laws and, thus, better CEP. Furthermore, the study by Vachon & Klassen (2008) highlighted that stakeholder engagement, specifically collaboration with supply chain members (both suppliers and customers), leads to improved environmental performance. Akin et al. (2009) also found that collaborating with suppliers fosters the adoption of proactive environmental strategies, which in turn leads to higher environmental investments and improved environmental performance. Moreover, Prajogo et al. (2016) found that improvement-oriented auditing leads to enhanced environmental performance, whereas compliance-oriented auditing does not significantly drive substantial improvements in environmental management practices. In addition, Commer et al. (2020) outlined that firms adopting external environmental audits along with internal environmental management practices exhibit better environmental performance. External audits offer third-party validation, ensuring adherence to environmental standards and reinforcing the credibility of the company's environmental initiatives.

There is also a substantial amount of literature that focuses on the relationship between environmental reporting and environmental performance. Reporting is also a fundamental corporate governance factor. However, this relationship is again complex and multifaceted; therefore, the existing findings are contradictory. For instance, the study by Omran et al. (2021) presented a positive and significant association between integrated reporting (IR) quality and CEP. Integrated reporting involves combining financial and non-financial reporting. Moreover, Bednárová et al. (2019) also found that environmental reporting positively correlates with environmental performance. The study also highlighted that this relationship is influenced by region, and companies headquartered in Europe tend to achieve higher CEP, which is likely due to more robust regulations. On the other hand, the study by Doan & Sassen (2020) found a weak and negative association between CEP and corporate environmental reporting.

Some studies also highlight the influence of specific board attributes or CEO characteristics on CEP, like board diversity, size and age (Abedin et al., 2023; Hong et al., 2021). However, these factors are not included directly in the conceptual framework, as the inclusion of multiple specific factors over-complicates the framework and the FCM. Furthermore, specific factors, such as CEO characteristics or demographics, are expected to have an indirect influence through their leadership style or decision-making process. Hence, specific board attributes and demographic characteristics are neglected in the conceptual framework.

3.4 External Stakeholder Pressures

External stakeholders have been known to play a crucial role in influencing corporate sustainability and management. Some studies have focused on external factors like stakeholder pressure and organizational legitimacy. For instance, L. Wang et al. (2020) finds that stakeholder pressures significantly positively impact corporate environmental strategies. Furthermore, Sari et al. (2022) found that stakeholder pressure indicated by consumer pressure, environmental pressure, shareholder pressure, and employee pressure significantly and positively impact the environmental performance of manufacturing companies.

The role of regulatory pressures in influencing CEP has been studied in the existing literature. For example, M. Wang et al. (2022) found that different types of environmental regulations positively influence green technology innovation, which consequently improves the sustainability performance of corporates. Moreover, the study by Fallan (2016) found that corporates subject to environmental reporting regulations disclose

more types of information relative to those not subject to such regulations. The research by Trevlopoulos, Tsalis, Evangelinos, et al. (2021) also highlighted a positive correlation between environmental regulations and CEP. Furthermore, Zhou et al. (2022) highlighted that community pressures are positively associated with CEP and also lead to stronger regulatory enforcement. Zhou et al. (2022) further added that environmental regulations could push the adoption of environmental audits by corporations. In addition, the study by Yen (2018) found that consumer and supplier pressures drive firms to improve environmental pressure. However, Jiang & Fu (2019) found that suppliers and consumers can sometimes have negative roles if their primary focus is on cost reduction rather than sustainability.

3.5 Conceptual Framework

Based on the literature review and the desk research carried out to determine the factors influencing CEP within technological factors, organizational culture, corporate governance, and external stakeholder pressures, the conceptual framework was developed. The conceptual framework is presented using a concept map, which highlights the key concepts and the relationships between them that influence CEP. It consists of nodes (boxes) depicting concepts and arrows depicting the direction of the relationship between the concepts. All the black arrows represent positive relationships, whereas the purple arrows represent undefined relationships. Some relationships are undefined because of the presence of contradictory results in the literature. The conceptual framework is visualised using the concept map presented in Figure 4.

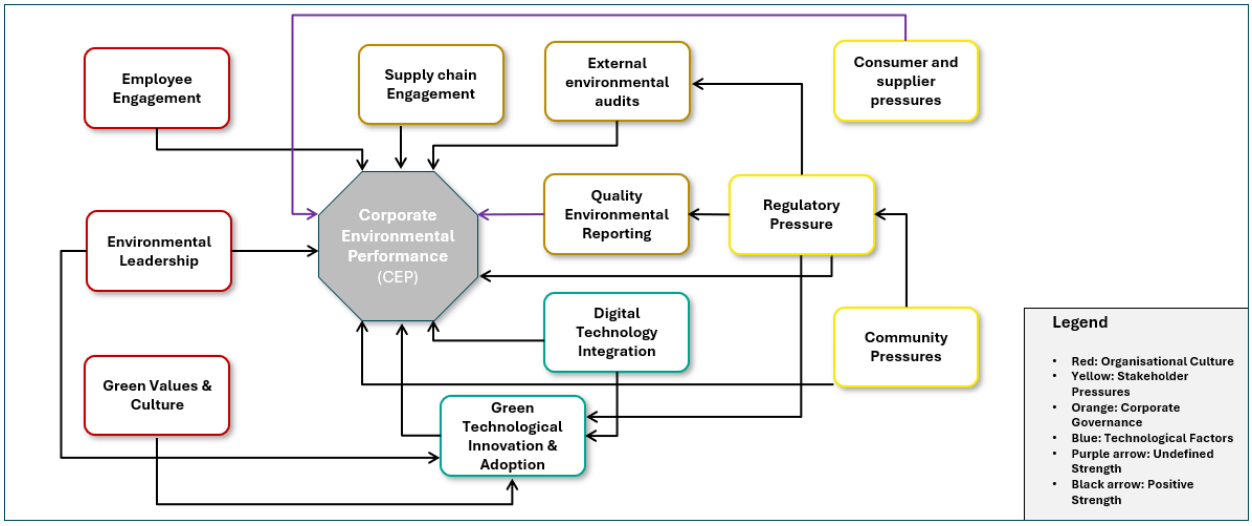


Figure 4: Conceptual framework for factors influencing CEP depicted using a concept map

4 Research Design

The research design for this empirical study follows a semi-quantitative and inductive research design with both exploratory and explanatory elements involved. The exploratory aspect aims to identify the key factors, interactions, and insights related to CEP, while the explanatory dimension focuses on explaining how these factors interact and influence CEP. The empirical and inductive research design provides a bottom-up approach to derive knowledge and conclusions based on observations (Woo et al., 2017).

Specifically, the research design employs the fuzzy cognitive mapping (FCM) approach, which combines conceptual mapping with fuzzy logic to represent and formalize complex systems. Fuzzy logic, an approach to computing based on "degrees of truth" rather than the traditional binary "true or false" (1 or 0) logic, is particularly useful for representing uncertain or imprecise information (Zadeh, 1988). FCMs have been widely used to model, analyze, and understand complex, dynamic, and causal systems. The FCM approach is further detailed in subsection 4.1.

The research design involves data collection through semi-structured interviews with experts. Furthermore, the data analysis methods involve qualitative content analysis of the interview transcripts and a structural and path analysis of the FCM.

This chapter begins by describing and explaining the FCM methodology. Then, it highlights the data collection method by elaborating on the sampling strategy, participant recruitment and selection and the interview design. Later, the section covers the data analysis process, including the qualitative content analysis approach, the structural analysis of the FCM and the analysis approach for formulating strategies to enhance CEP. Lastly, the chapter concludes with a discussion on the reliability and validity of the methodology.

4.1 Fuzzy Cognitive Mapping Approach

Overview

The FCM methodology was first introduced by Kosko (1986) as a modified approach to cognitive maps. While cognitive maps involved graphical representations of causal relationships between concepts, FCMs combined the graphical representation of systems with fuzzy logic to model the causal reasoning and behaviour of complex systems (Malek, 2017). The fuzzy logic allows for the representation of the strength and the direction of the relationship with fuzzy values instead of binary values. The fuzzy logic helps in understanding uncertain, complex and dynamic systems, which is common in real-world scenarios. Fundamentally, FCM provides an understanding of how and why complex systems change in relation to their components. FCMs are increasingly recognized as a valuable tool for modelling and understanding complex environmental systems (Özesmi & Özesmi, 2004). The FCM approach has proven useful in environmental management applications and in incorporating rich knowledge from different stakeholders (Mourhir, 2021). It is particularly useful in research areas where the systems in question are influenced by human perception, behaviour and knowledge, such as in corporate environmental sustainability. In addition, the approach allows the involvement of both exploratory and explanatory aspects.

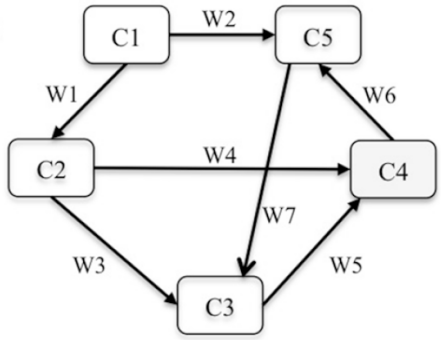
Several alternative research design methodologies could have been considered for this study. For example, system dynamics modelling is a robust technique often used to understand the behaviour of complex systems over time (Benedetto & Pulvirenti, 2009). Furthermore, structured equation modelling (SEM) is another alternative that could have been utilized, especially given its usefulness in testing complex models that involve multiple dependent and independent variables (Y. Fan et al., 2016). However, system dynamics models are heavily quantitative and equation-based, which usually requires precise data. Similarly, SEM models also depend on precise data. On the other hand, FCMs are useful and effective in data-scarce environments (Reckien et al., 2014). In addition, the use of fuzzy logic allows FCMs to represent uncertainty and ambiguity in the relationships between factors.

The FCM approach aligns with the research objectives, as it allows for the exploration of the underlying mechanisms and interactions that influence CEP based on the perspectives and expertise of different stakeholders involved with the topic of corporate environmental sustainability. By employing FCM, the study aims to capture a diverse range of viewpoints, reflecting the complexity of the corporate environmental

sustainability landscape. Furthermore, corporate sustainability is a sensitive topic for large companies, making access to specific data on environmental performance, technological factors, organizational culture, corporate governance, and stakeholder pressures challenging. Hence, the study employs the FCM methodology.

FCMs consist of concepts (factors) expressed by nodes and directed arrows with weights that explain the relationship between the factors (Nair, 2020). The applied weights can be both quantitative and qualitative. FCMs can be represented through a graphical representation as well as through an adjacency matrix. The adjacency matrix is a square vector matrix that represents the relationships between nodes. The two forms of representations can be seen in Figure 5. The nodes (C_i) depict the factors/concepts, and the weights (W_i) represent the direction and strength of the relationship between the nodes. Furthermore, the fuzzy element is present in the weights, which, when quantified, have a value between -1 and +1 (Barbrook-Johnson & Penn, 2022). A positive weight depicts an excitatory relationship, meaning that an increase in C_i results in an increase in C_j or a decrease in C_i leads to a decrease in C_j. Conversely, a negative weight indicates an inhibitory relationship, where an increase in C_i leads to a decrease in C_j or a decrease in C_i results in an increase in C_j (Kolk & Pinkse, 2008). Furthermore, if the weight is equal to 0, then there is no causal relation.

a



b

	C1	C2	C3	C4	C5
C1	0	W1	0	0	W2
C2	0	0	W3	W4	0
C3	0	0	0	W5	0
C4	0	0	0	0	W6
C5	0	0	W7	0	0

Figure 5: An example of an FCM: **(a)** Graphical representation **(b)** Adjacency matrix (Malek, 2017)

Although FCMs quite often use numerical weights, they are considered "semi-quantitative" as they produce indicative rather than predictive numerical values. This allows for analysis of system dynamics without requiring precise quantitative data (Barbrook-Johnson & Penn, 2022).

FCM Development Process

FCMs can be devised using various methods, such as interviews, group discussions, and document analysis (Kocaoglu et al., 2017). This study adopted the individual interviewing approach, as it assists in acquiring wider and deeper knowledge about how a specific system works (Olazabal et al., 2018). Furthermore, in the individual interview approach, the experts have more time and space to demonstrate knowledge and are free from social pressures that might exist in focus group workshops (Knox et al., 2024). Additionally, the sensitivity of the topic of CEP acts as a barrier to adopting the focus group approach. It would be difficult to address a group of experts from different stakeholder groups and companies due to their availability and positions.

FCMs can be constructed by both the researcher and the participant. In this study, the researcher-led mapping is employed. This approach puts a lesser cognitive load on the participant. Furthermore, the

researcher could offer a holistic view and a comprehensive analysis using different data sources, expert interviews and data analysis techniques.

The construction of FCM can be done using various software tools like general-purpose diagramming software, FCMapper, Mental Modeller, Spreadsheet software and R packages. This study primarily uses MS Excel to create the FCMs. Furthermore, it utilizes the Mental Modeller software to create a graphical representation of the aggregated FCM.

Moreover, the FCM protocol can consist of a pre-defined concept approach, an open-ended concept approach, or a hybrid approach combining the two (Knox et al., 2024). In the pre-defined approach, participants are introduced to a specific set of concepts at the beginning. On the other hand, in an open-ended approach, interviewees add their concepts based on their values and perspectives. Given the exploratory nature of the study and the research objectives, the use of a hybrid approach is the most suitable. This approach would present interviewees with some concepts related to CEP identified from the literature while also encouraging them to contribute additional factors that influence CEP.

The basic steps to develop the FCM include developing a list of factors and then specifying the connections between factors to create the map. Furthermore, an example of the detailed process and the intermediate to developing an FCM through interviews can be seen in Figure 6. However, the actual practice of FCM development has variety in the extant literature; therefore, it is necessary to elaborate on the FCM process (Barbrook-Johnson & Penn, 2022).

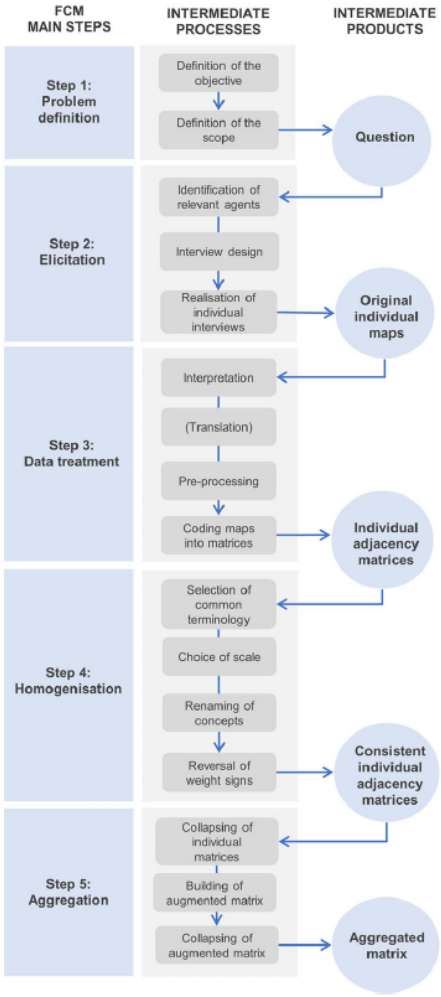


Figure 6: An example of a detailed FCM development process (Olazabal et al., 2018)

The FCM development process in this study closely aligns with the step-by-step process visualized in Figure 6. However, there are differences in the ordering and the inclusion of certain steps. In the highlighted example, the individual FCMs were developed during the interviews. In contrast, in this study, the individual FCMs were constructed after the interviews. This approach allowed for a more thorough analysis and interpretation of the interview data before constructing the maps. Additionally, it reduced the cognitive load on both the interviewee and the researcher during the interviews. However, one potential drawback of not involving participants directly in the mapping process during the interviews is the risk that certain subtle connections may not be fully captured by the researcher.

The process begins with problem definition, where the scope and objective of the study are outlined. The scope and objective of this study are discussed in subsection 1.4. Next, in the elicitation phase, relevant agents are identified through a simple stakeholder analysis, followed by the design and execution of individual semi-structured interviews with experts. These steps are further elaborated in subsection 4.2.

After the interviews, the homogenisation step was undertaken (step 4). This was done to ensure consistency and comparability across the individual maps. This step involved selecting the common terminology for factors influencing CEP by open-coding the interview transcripts. This step is elaborated in subsubsection 4.3.1. Following the homogenisation, the interview transcripts were coded to categorize the relationships between the identified factors. This included categorizing the strength and direction of the relationships. The coding process and the criteria for relationship categorization are detailed in subsubsection 4.3.2.

Based on the factor identification and relationship categorization, individual FCMs (adjacency matrices) were constructed. These individual FCMs were then combined to develop the aggregated FCM. These steps are highlighted in subsubsection 4.3.3 and subsubsection 4.3.4.

Each of these steps is elaborated in the following subsections, providing a detailed understanding of how the FCM was developed and analyzed in this study.

FCM Analysis Techniques

After the FCM has been constructed, different analysis approaches can be employed. The analysis techniques that are often employed use structural/static analysis and dynamic analysis of the map. The structural analysis incorporates metrics like indegrees, outdegrees and centrality, which has been elaborated in subsubsection 4.3.5. In the dynamic analysis, the focus is on analysing how changes in a few factors propagate throughout the system. In order to carry out the dynamic analysis, a state/initiation/activation vector is created where the initial values of all concepts are defined. Then, the activation matrix is multiplied with the adjacency matrix (weight matrix) to produce the next state of the concepts (Malek, 2017). The calculation of the new state vector can have multiple iterations. This iterative process updates the values of factors based on changes in other factors and edge values until a stable pattern emerges, either when the values stop changing or enter a repeating cycle (Barbrook-Johnson & Penn, 2022). The dynamic analysis can support scenario analysis and sensitivity analysis with different initiation vectors. The study is mainly limited to the structural analysis of the FCM output due to the time constraint of the research. However, structural analysis does not assist in understanding the paths and the specific interactions through which the concepts influence CEP. Hence, this study also employs path analysis. Path analysis allows for a detailed investigation of the causal sequences that connect different factors, offering insights into the direct and indirect effects within the system.

4.2 Data Collection

The data collection for this study involves gathering primary data through semi-structured interviews with a diverse range of stakeholders who have expertise in or knowledge of corporate environmental sustainability or who are involved with the factors that influence CEP. Semi-structured interviews are chosen for their flexibility, which aids in providing a thorough understanding of the factors identified in the literature while also allowing for the identification of new factors. This method aligns with the hybrid approach of fuzzy cognitive mapping, allowing an in-depth understanding of the nuanced relationships and mechanisms influencing CEP.

4.2.1 Stakeholder Analysis

A stakeholder analysis was carried out to identify the relevant agents and stakeholder groups for this study. The objective of the analysis was to identify relevant stakeholder groups whose insights and inputs would be valuable for developing the FCM and for ensuring the robustness of the findings. Specifically, stakeholder groups that are relevant to shaping the corporate environmental sustainability landscape and the study are identified and summarized in Table 3.

Table 3: Stakeholder identification and relevance

Stakeholder Group	**Relevance**	**Examples**
Large Companies	Large companies are directly responsible for implementing strategies to enhance their CEP. Their perspectives highlight the practical challenges and opportunities associated with utilizing several factors to improve CEP. Their experiences with both successful and unsuccessful sustainability initiatives can provide valuable insights.	Philips, Heineken, ASML
Consulting & Professional Services	They work closely with large companies and guide them within the corporate environmental sustainability landscape. They have practical experience with helping companies implement sustainability initiatives and improve CEP. They can provide insights into practices that have successfully enhanced CEP.	McKinsey, Deloitte, KPMG
Researchers	They have expertise in working with evidence-based, analytical, and theoretical perspectives around corporate environmental sustainability. They also have expertise with vast literature and findings. They can provide grounded and empirical insight into how different factors influence CEP.	Professors
Regulatory Bodies	These bodies influence corporate behaviour through various mechanisms such as incentives and fines. They also often collaborate with industry stakeholders to develop policies that promote CEP.	European Commission, Dutch Ministry of Economic Affairs and Climate Policy
ESG Rating Companies	These companies provide specific standardized metrics to evaluate CEP. They closely monitor the performance of companies on different sub-indicators of CEP. These ratings also assist different stakeholders in evaluating companies' progress and standing on CEP. Understanding their expectations and requirements ensures that the recommendations of this study are practical and robust.	Sustainalytics, MSCI, Bloomberg
International Environmental Organizations	These organizations enable setting global standards and benchmarks for CEP. They also influence how companies measure, report, and manage their environmental impact. Their frameworks/guidelines are widely adopted by leading companies.	European Environment Agency, CDP, SBTi
Non-Governmental Organizations (NGOs)	NGOs advocate for environmental protection and accountability. They are known to influence public opinion, government policies, and corporate actions. They bring attention to environmental issues that might be overlooked by other stakeholders like corporates or regulatory bodies.	Natuur en Milieu, Greenpeace
Research Organizations	They provide the necessary institutional support, resources, and expertise for comprehensive corporate sustainability research. They conduct large-scale studies and provide thorough analysis of aspects of CEP. They develop practical solutions and theoretical frameworks on corporate sustainability.	Profundo, SOMO, TNO

4.2.2 Sampling Strategy

The research employs purposive sampling to select participants for the semi-structured interviews. This sampling strategy is chosen because it is widely used in inductive, exploratory, qualitative and FCM studies (Arrogante, 2022) and allows for the selection of interviewees who have direct experience with or are particularly knowledgeable about the technological factors, organisational culture factors, corporate governance factors and external stakeholder pressures influencing CEP. The sampling process involved recruiting participants within each of the stakeholder groups highlighted in Table 3.

The selection criteria also included that all participants must work in organizations or bodies that are located in the Netherlands to ensure that the scope of the study is followed. This geographic focus ensures that the findings are relevant and applicable to the specific regulatory, cultural, and market conditions of the Dutch context.

The first step in the sampling process involved identifying large companies within the Netherlands. An organisation in the Netherlands is considered large if it meets two out of the three criteria for two consecutive years: having assets in excess of €20 million, more than 250 employees and having a turnover in excess of €40 million (Tax Administration of the Netherlands, 2023). Furthermore, the sampling strategy involved selecting large companies based on their CEP scores. This was done by sourcing the CEP scores from Accenture (Accenture, 2023). These scores were based on the sub-categories highlighted in Table 1. Furthermore, these scores were computed as percentile scores (performance relative to peer group) and were categorized into quartiles, with Q1 representing the top performers and Q4 representing the lowest performers. By systematically including companies from each of the quartiles and varying levels of CEP, the research design aims to capture the opportunities as well as challenges faced by the representative sample of large companies.

Once several companies are identified within each quartile, the sampling process includes selecting employees from different organizational levels and positions. Different organizational levels generally include senior management and executives, middle management, front-line management and operational staff. Examples of these levels and positions include head of corporate sustainability, vice president, senior manager, consultant and business analyst. The same approach was followed for recruiting participants from consulting and professional services companies as well. Following this approach provides a holistic view of the organisation and allows the study to gather diverse perspectives on the factors influencing CEP as different organisational levels have different experiences with technological factors, corporate culture, corporate governance and external stakeholder pressures.

In addition, the sampling process involved selecting experts in the field of corporate sustainability and management belonging to the remaining stakeholder groups identified in Table 3. Overall, by capturing a broad range of views, expertise, and experiences, the study's findings become more robust, representative, and applicable to different types of organizations.

The advantage of FCMs is that they require fewer individual interviews than traditional methods, as saturation (new concepts identified per additional interviewee) is usually reached earlier (Keeton & Reckien, 2023). Özesmi & Özesmi (2004) highlights that this can be established through an accumulation curve of the total number of variables versus the number of maps or by the number of new variables per interview versus the number of maps. Hence, the accumulation curve is utilized to determine the appropriate sample size.

4.2.3 Recruiting Participants

Based on the identification of the relevant stakeholder groups, sampling strategy and companies, a participant recruitment list was created. The possible participants were mainly identified using LinkedIn, such as an environmental sustainability consultant at company Y. Furthermore, some participants, such as university professors and researchers, were identified from the respective organizations' websites. The participant recruitment list can be found in subsection A.1.

The participants were mainly contacted through LinkedIn. Furthermore, whenever possible, the participants were contacted via email. However, email addresses for the participants were rarely publicly

available, with the exception of university professors and researchers. The following LinkedIn message was sent, considering the 300 characters limit on the platform:

> *Dear *participant*, as I progress with my master's thesis at TU Delft, which focuses on the interplay of factors influencing corporate environmental performance, I am seeking to gain insights from experts. I would be grateful if you could share your knowledge and perspectives through an interview.*

Initially, the response rate was significantly low due to three possible reasons: the sensitivity of the topic, the busy schedules of the participants, and the low visibility of LinkedIn message requests. A few candidates responded by stating that they were not allowed to participate in such interviews, highlighting the sensitivity of the topic for large companies.

As a result, the approach was modified to include the use of LinkedIn Premium and InMail messages. Additionally, some participants were re-approached using these methods. Overall, 80 potential participants were invited, out of which 10 participants responded positively. The breakdown of participant recruitment per stakeholder group can be found in Table 4

Table 4: Participant recruitment per stakeholder group

Stakeholder group	Invites sent	Invite Accepted
Large companies	25	1
Consulting & professional services	12	4
Researchers	9	1
ESG rating companies	7	1
Regulatory bodies	9	0
International environmental organizations	8	1
NGOs	4	0
Research organizations	7	2

After participants accepted the invitation and provided their contact information, an email with the title and objective of the study, along with a Microsoft Teams meeting link, was sent to them. All interviews were conducted online via video calls on MS Teams. Furthermore, the interviews were recorded and transcribed to guide the data analysis.

Ethics Approval

A data management plan and the informed consent form were created before conducting the research. The data management plan was validated by the data steward. Furthermore, the data management plan and the informed consent form were approved by the Human Research and Ethics Committee (HREC) at TU Delft before conducting the interviews. The informed consent form sent to the participants before the interview can be found in subsection A.2.

4.2.4 Overview of participants

Table 5 presents the overview of the participants (interviewees) by highlighting the stakeholder group they belong to, their role and their experience and expertise. Each interview was conducted for approximately 45 minutes, except for the interview with P7, which was limited to 25 minutes due to the participant's availability.

Table 5: Participant list

Participant	Stakeholder Group	Role	Experience
P1	Research Organization	Senior Consultant at Research Organization B	Has 4 years of experience in this role. Has worked in the chemical industry for almost 19 years. Previously worked in the corporate sustainability department of a large chemical company. Has experience with life cycle assessment for different products, sustainability strategies from a top-down view, and product portfolio management of the company in terms of corporate sustainability performance. In addition, has been involved with corporate sustainability reporting and scope 1, 2 and 3 emissions.
P2	Consulting and professional services	Senior Sustainability Analyst at Company A (a global professional services company)	3+ years of experience working as a sustainability consultant. During their work, they have come into contact with the CEP sub-categories (defined in this study). Mainly focuses on sustainability, strategy creation and implementation plans, covering ES&G across all of those elements.
P3	Consulting and professional services	Strategy analyst at Company A (a global professional services company)	2 years of experience in this role, focusing mostly on sustainability projects for large clients in the Netherlands and on the pillars of ESG. Their focus is also on ESG MAP (measurement, analytics and performance). Furthermore, they help clients navigate through the major regulations like EU CSRD and the EU taxonomy. Also helps clients understand how these regulations impact their corporate governance and reporting.
P4	Research Organization	Head of Corporate Sustainability at Research Organization B	Almost 1 year of experience in the current role. Nearly 7 years of experience in sustainability-focused roles. Their responsibilities have included developing a comprehensive roadmap to achieve net zero emissions for scope 1 and 2. Additionally, they closely collaborated on initiatives related to the company's social impact and governance issues.

P5	International Environmental Organisation	Manager at SBTi (Science Based Target Initiative)	Manager at SBTi (a global partnership that helps companies align their climate actions with science) for 1.5 years. They lead the development of energy sector standards, guidance, tools, and technical resources to support science-based target-setting methods for the energy industry.
P6	ESG rating and analytics firm	ESG research Analyst at company C	Almost 2 years of experience at the mentioned role. Experience with evaluating and opining client sustainability strategies, ESG materiality assessments, carbon footprints and benchmarking against industry standards. Evaluating if the sustainability performance can be linked to the company's financial structure, including bonds and loans.
P7	Consulting and professional services	Sustainability and Innovation lead at company A	Has been a part of company A for more than 9 years. Their main focus is on driving sustainability for clients. Specifically, their focus is on creating sustainability in IT technology as well as creating sustainability through IT technology and then contributing to a broader scheme of corporate environmental sustainability.
P8	Large company	ESG Business Analyst at Company D (Financial Services) (CEP score → Q1)	Holds a master's in global business and sustainability consultant. Almost 1 year of experience in the current role and has worked within sustainability in previous roles as well. 2 years of experience as a Sustainability Consultant at company Y (a global professional services company where they advised different large companies on how to integrate ESG legislations such as CSRD within their business. Their current focus and expertise also lie with CSRD itself and how it needs to be implemented or translated into a business context.

P9	Consulting and professional services	Digital Integration Senior Manager at company A	Working at company A for 9 years. They are responsible for driving the transformation agenda of large corporate clients in sustainability by integrating technology and digital solutions. Has expertise in managing and guiding sustainability initiatives for large corporate clients. Some of their responsibilities include strategic leadership, performance monitoring and reporting, technology and sustainability integration and change management.
P10	Academia	Professor of corporate sustainability at University N	More than 1 year of experience as a full professor and 6 years of experience as an associate professor at University N. They are a professor of corporate sustainability reporting, and they have 16 years of experience in conducting research in this field.

4.2.5 Interview Design

In developing the interview design, a brief review of studies focusing on the fuzzy cognitive mapping approach was conducted, specifically those focusing on the individual interview method for data collection (Carley & Palmquist, 1992; Edwards & Kok, 2021; Keeton & Reckien, 2023; Olazabal et al., 2018; Özesmi & Özesmi, 2004).

The interview design began with background information about the study, providing the interviewee with the research's objective and scope. The interviewee was also given a breakdown of the CEP indicators as conceptualized in the section 2. An introductory question was then posed to capture the participant's role, experience, and expertise related to corporate environmental sustainability and management.

The interview was divided into two phases. The objective of the first phase was to understand the specific factors associated with CEP within the broad domains of technological factors, organizational culture, corporate governance, and external stakeholder pressures. Initially, the interviewee was asked to mention these factors based on their understanding and experience. Later, they were queried about the factors identified in the conceptual framework. During this phase, the identified factors were simultaneously noted on a PowerPoint slide. An example of the output from phase 1 for one of the interviews can be seen in Figure 16.

In the second phase, the screen was shared with the participant. The aim of this phase was to understand the interactions between the identified factors and how they influence CEP. The participants were encouraged to discuss the strength and the direction of the relationship between factors. The specifications and guiding questions for the interview design can be found in Table 6. The guiding statements and questions in the interview design have been italicised.

Table 6: Interview design

Section	Time	Content
Background	7 mins	- Introduction: Name, affiliation, purpose of recording, and data processing. - Describing the scope and objective of the study. - Explaining the structure of the interview: phase 1 (factors influencing CEP), phase 2 (interplay of factors). - Indicators of CEP: Climate change mitigation, Climate change adaptation, Water and marine resources, Resource use and circular economy, Pollution, Biodiversity, and ecosystems.
Introduction	3 mins	- Q1: Briefly describe your role and experience with corporate environmental sustainability and management.
Phase 1: Identifying the factors associated with CEP	15 mins	- Q2: What are the technological factors associated with CEP? *These factors are variables related to the presence, accessibility, and development of technology.* - Q3: Is digitalization or green technological innovation and adoption associated with CEP? (conceptual framework) - Q4: What are the organizational culture factors associated with CEP? *Refers to values, beliefs, and attitudes that influence the action and behaviour within an organization.* - Q5: Are green values and culture, environmental leadership, or employee engagement associated with CEP? (conceptual framework) - Q6: What are the corporate governance factors associated with CEP? *Rules, practices, processes directing and controlling the company.* - Q7: Is engagement with supply chain members, due diligence, or reporting associated with CEP? (conceptual framework). - Q8: What are the external stakeholder pressures affecting CEP? - Q9: Do regulators, NGOs/activists, or consumers and suppliers influence CEP?
Phase 2: Interplay of factors	20 mins	- Aim: To explore the interactions and influence of discussed factors on CEP. - Participant encouraged to identify the direction and strength of the relationship *Strength of relationships – strong, medium, weak.* - Q10: Can you identify relations where a change in one factor leads to changes in others, affecting CEP? - Guiding Questions: *Q: Influence of technological factors on other factors.* *Q: Interaction of organizational culture with other factors.* *Q: Influence of corporate governance on other factors.* *Q: Effect of external stakeholder pressures on internal factors.*

4.3 Data Analysis

The data analysis method consists of two phases. The first phase employs qualitative content analysis using an inductive coding approach to develop a list of factors associated with CEP, identify the relationships between these concepts, and create individual FCMs. The second phase entails combining the individual FCMs into an aggregated FCM and conducting a structural analysis. This phase also includes simplifying the aggregated FCM through condensation, followed by a path analysis of the condensed map. Finally, strategies are formulated by integrating insights from both the structural and path analyses.

Qualitative content analysis involves the subjective interpretation of textual content, systematically categorized by coding and identifying recurring themes or patterns (Hsieh & Shannon, 2005). The inductive approach is an iterative process that involves analyzing textual data using a bottom-up method, reading through the textual data to identify codes, categories, and patterns as they emerge (Bingham, 2023). The inductive coding approach begins with open coding, which refers to the process of identifying and labelling key concepts and patterns in the textual data (Charmaz, 2014). This is followed by axial coding to determine the relationships between the open codes (Allen, 2017).

The data analysis for this study began with transcribing and anonymizing the interviews. The transcribed interviews were then corrected by listening to the interview recordings to address any inaccuracies in the automated transcripts. Subsequently, the corrected transcripts were imported into Atlas.ti (a qualitative research software) (ATLAS.ti, 2024a). The open coding process was applied by reading through the transcripts and labelling concepts associated with CEP. The unit of analysis for the coding process consisted of words, phrases, and sentences, which served as the basis for the development of codes (Roller & Lavrakas, 2015).

Initially, all interviews were open-coded to identify the factors associated with CEP. The identification of all concepts aided in creating an empty $n \times n$ matrix, where n is the number of concepts identified. Next, the axial coding process was employed to categorize the relationships between the concepts. During this process, the interviews were reread to label the relationships between concepts. Additionally, the strength and direction of the relationships were categorized and quantified based on the relationship categorization criteria described in subsubsection 4.3.2. This information was used to fill in the empty $n \times n$ matrix, thereby developing individual FCMs.

Finally, the individual FCMs were collapsed into an aggregated FCM using the process described in subsubsection 4.3.4. The structural analysis of the aggregated FCM was then performed as detailed in subsubsection 4.3.5. Later, the aggregated FCM was condensed (simplified) for further analysis using the process highlighted in subsubsection 4.3.7. Then, the insights from the structural analysis were combined with path analysis to formulate strategies for enhancing CEP (subsubsection 4.3.8).

4.3.1 Open Coding

While open-coding the transcripts, specific factors associated with CEP were labelled. Then, similar codes were grouped together to form concepts associated with CEP. Furthermore, these concepts were categorized within the broad domains defined in the research question: technological factors, organizational culture, corporate governance, and external stakeholder pressures. The concepts (code groups) are also the factors realized in the FCMs; hence, definitions for the concepts were provided. This process aids in the homogenization and selection of common terminology for concepts, ensuring consistency and clarity in the final analysis. An example of the output of this process can be seen in Table 7.

Through this process, 26 factors were identified to be associated with CEP. Hence, in total, 27 concepts (including CEP) were used to create an empty matrix template for the realisation of individual FCMs. The list of 27 concepts, along with their definitions, codes and broad factor category, can be seen in Table 15.

In addition, 5 other factors were also identified as being associated with CEP; however, these factors were excluded because they were either outside the scope of the study or no relationships with other concepts in the system were identified for these factors. These factors and the reasons for their exclusion are highlighted in Table 16.

Table 7: Example of the open coding process highlighting how concepts are categorized

Factor group	Concepts/code groups	Definition	Codes
Technological	Implementing sustainable technologies	Technologies that directly assist in improving the environmental impact	sustainable energy technologies, adopting renewable energy, tech directly associated with decarbonization, carbon capture & storage, waste-management technologies, energy-management systems

Furthermore, to determine if the sample size is sufficient, an accumulation curve with the number of new variables per interview is plotted in Figure 7. The accumulation curve shows that the saturation point has been reached, indicating that most of the variables have been captured and that additional sampling would not significantly add new concepts to the FCM. Ideally, more interviews should be conducted to ensure that the saturation point has been definitively reached. However, this was not possible due to the time constraints of this research.

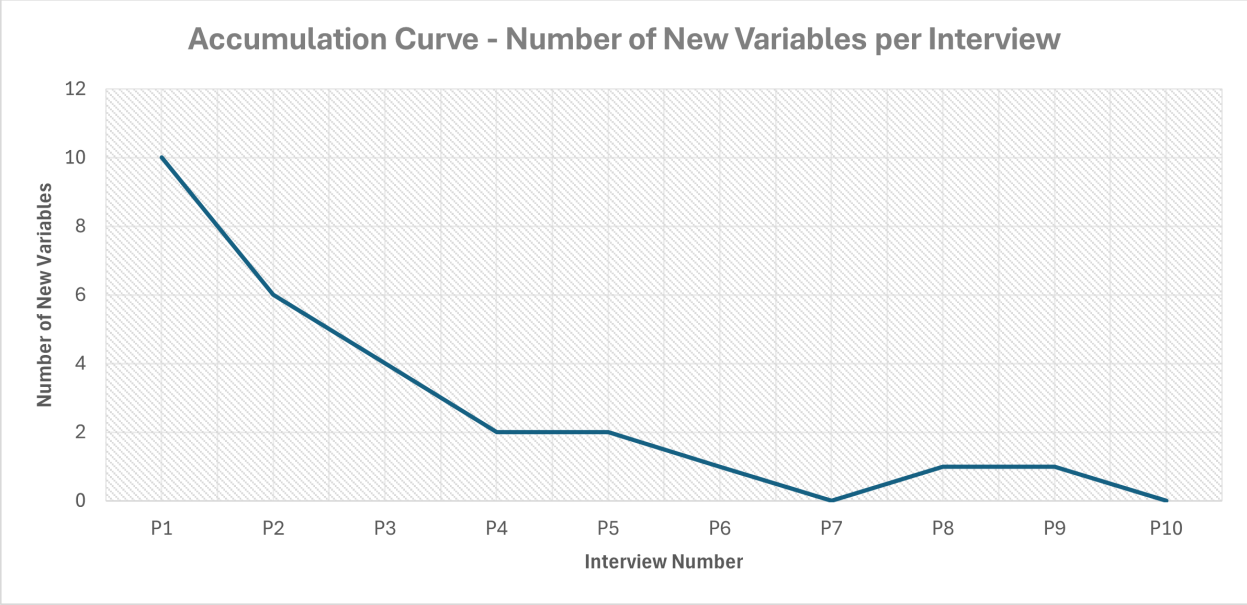


Figure 7: Accumulation curve - number of new variables per interview

4.3.2 Relationship categorization

Once the concepts in the FCM were decided, the next step involved interpreting the relationship between variables by coding and extracting relationship statements. The relationships are described in linguistic terms (strong, medium, weak) and are then transformed to values between -1 and 1 (Malek, 2017). This can be referred back to phase 2 of Table 6, where the interviewees were asked to define the strength and relationship between factors. In this study, the strong, medium and weak relationships are quantified using 0.9, 0.5 and 0.1, respectively.

Even though participants were encouraged to define the strength of the relationship in terms of strong, medium and weak, it was not always possible. Hence, two different approaches were adopted to categorize the relationship. Carley & Palmquist (1992) highlighted that there are many ways of using relationship characteristics; hence, it is necessary to define the criteria for relationship categorization. An example for quantifying relationship strength is as follows: a value of 1 refers to an implied relationship, a value of 2

refers to a stated relationship, and a value of 3 refers to a repeated relationship. On the other hand, a value of -1 refers to an implied negative relationship, a value of -2 refers to a stated negative relationship, and a value of -3 refers to a repeated negative relationship (Carley & Palmquist, 1992).

The first approach involved direct categorization, which relies on the interviewee directly stating a positive or negative relationship with a strong, medium or weak strength. The second approach involved using emphasis, justification or repetition to determine the strength of the relationship. It is important to note that the second approach was utilized only when the first approach was not applicable. Furthermore, the direction is determined by labelling words and phrases that indicate a positive or negative. The specific criteria that were followed for assigning a weight to the direction and strength of the relationship can be seen in Table 8 and Table 9, respectively.

Table 8: Criteria to categorize the direction of the relationship between factors

Direction	Criteria
Positive (+)	Phrases that indicate that an increase in the source concept leads to an increase in the target concept or a decrease in the source concept leads to a decrease in the target concept. Examples include phrases like " an increase in concept A improves/enhances/supports/increases concept B" or "a decrease in concept A hinders/reduces conflicts/decreases concept B"
Negative (-)	Phrases that indicate that an increase in the source concept leads to a decrease in the target concept or a decrease in the source concept leads to an increase in the target concept. Examples include phrases like "rise of concept A could lead to hindrance/decrease/decline in concept B" or " A decline in concept A could cause concept B to increase/improve"

Table 9: Criteria to categorize the strength of the relationship between factors

Strength	**Criteria**
Strong (0.9)	• Relationship indicated with strong emphasis and concrete examples or justification, OR • Relationship indicated with strong emphasis and repetition. *(Strong emphasis includes terms like "crucial," "vital," "significant," "major," "critical," "definitely," "100%," "for sure," and "important").*
Medium (0.5)	• Relationship indicated with strong or moderate emphasis but without justification or examples, OR • Relationship indicated with minimal emphasis, but justification and examples provided, or the indication is repeated. *(Moderate emphasis includes terms like "notable," "considerable," "reasonably significant," and "moderate impact").*
Weak (0.1)	• Relationship is indicated or purely implied with minimal emphasis and without justification or examples.

Examples of assigning weights based on the interpretation and coding of the quotations from the interview transcripts can be seen in Table 10.

Table 10: Examples of relationship categorization

Link	Strength and Direction	Quote	Comment
Regulatory pressure → Environmental reporting	0.9	*"So reporting is linked to regulations for reporting. And that's a very **strong link**. And so if regulations increase, reporting would increase as well."*	Direct categorization
Employee engagement → CEP	0.5	*"So increasing employee engagement as well, if you do that well, then you can significantly improve your CEP."*	Strong emphasis without examples or justification
Regulatory pressure → Investor pressure	0.1	*Investors, too, are considering regulations and incorporating them into their models*	Relationship indicated with minimal emphasis

4.3.3 Individual Adjacency Matrix

Based on the identification of the variables in the FCM and the quantified relationships between the variables for every interview, the individual FCMs were developed. An example of the FCM can be seen in Figure 8. In addition, all the individual FCMs can be found in subsection B.3.

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																0.9	0.9										
Implementing sustainable technologies																											0.9
Implementing digital technologies		0.5																									
Implementing tech to influence behaviour																											
Environmental leadership																	0.1	0.1			0.5						
Effective change management																											
Employee engagement																											
Green values																											
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																	-0.5							0.5	0.5		-0.9
Integrated sustainability champions																	0.1	0.1			0.5						
Recruitment of sustainability experts																0.5		0.5									
Workforce training																											
Environmental reporting																	0.5										
Continuous performance assessment																											0.9
SMART target-setting & KPI prioritization																	0.1										
Internal control policies																											
Peer Pressure																					0.1						
External due diligence & validation																											
Value chain engagement																											
Regulatory pressure																0.1					0.1						
Investor pressure																0.1											
Community pressure																											
Customer/client pressure																											
CEP																								-0.5	-0.5		

Figure 8: Example of individual FCM - participant P5

4.3.4 Aggregation of Individual FCMs

The individual FCMs were combined into one matrix to generate the aggregated FCM. The relationships only mentioned by one participant were defined as weak and received a value of 0.1, even if the participant defined the relationship as strong or medium. Furthermore, the relationships that were defined by multiple

participants were averaged in the final adjacency matrix (Olazabal et al., 2018).

The average was calculated by summing up the weights in individual FCMs and dividing by the number of participants who defined the relationship:

$$\text{Averaged weight in aggregated map} = \frac{\sum_{i=1}^{n} w_i}{n_p}$$

where w_i represents the weight given by participant i to the relationship, and n_p is the number of participants who defined the relationship.

The aggregated FCM matrix (27 × 27) can be seen in Figure 10. The aggregated FCM matrix (27 × 27) is shown in Figure 27. In this matrix, the relationships with weights between 0.7 and 0.9 are considered strong relationships, weights between 0.4 and 0.6 are considered moderate relationships, and weights between 0.1 and 0.3 are categorized as weak relationships.

4.3.5 Structural Analysis of FCM

The structural analysis of FCMs provides several insights into understanding complex systems, particularly in understanding the nature and importance of concepts within these systems. Identifying crucial concepts and their nature within an FCM can highlight potential leverage points for guiding the complex system in a desired direction through targeted interventions (Schuerkamp & Giabbanelli, 2024). Hence, structural analysis can be useful in deriving the most crucial measures for improving CEP at large companies.

The three types of variables in FCMs are transmitter variables (drivers), receiver variables and ordinary variables (means). A pure transmitter is a concept that has only outgoing arrows and no incoming arrows. On the other hand, pure receivers are concepts that only have incoming arrows and no outgoing arrows. Furthermore, ordinary variables have both incoming arrows and outgoing arrows. However, the ordinary variables can also be characterized as transmitters or receivers based on the ratio of incoming arrows to outgoing arrows.

These variables are characterized by computing their outdegrees, indegrees and degree centrality Özesmi & Özesmi (2004). The outdegrees of a concept is the row sum of the absolute weights for that particular concept. Furthermore, the indegrees for a variable is the column sum of their absolute weights. Furthermore, the centrality of a variable is the sum of its indegrees and outdegrees (Özesmi & Özesmi, 2004). In this study, a concept was characterized as a transmitter if its indegree-outdegree ratio was less than 0.5. On the contrary, a concept was characterized as a receiver if its indegree-outdegree ratio was more than 2.

Overall, outdegrees express the influence of the concepts on other concepts in the map. The indegree represents the dependency of the variable on other concepts. Furthermore, degree centrality reflects the importance of a concept within the system, as concepts exhibit a high degree of centrality when they are directly involved in several strong relationships. In contrast, they have a low degree of centrality when they participate in only a few weak relationships (Schuerkamp & Giabbanelli, 2024).

4.3.6 Bubble Chart Analysis

Once the structural metrics were computed for the concepts, a bubble chart analysis of the concepts was employed to visualise the nature of the concepts. Furthermore, it was utilized to determine whether the factor categories (technological factors, organisational culture, corporate governance, and external stakeholder pressures) cluster around specific quadrants, thereby indicating the nature of their influence and interdependencies on CEP.

The bubble chart was created by plotting the indegree of the concepts versus the outdegree of the concepts, where the size of each bubble represented the centrality of the concept. Hence, a bigger bubble size represented a more important concept. Furthermore, different colours were employed to represent each of the factor categories. The Python programming language was utilized to visualise the bubble chart. The code for generating the plot can be seen in subsection B.4.

The analysis of the bubble chart involved identifying the quadrant location of different concepts. Additionally, it involved identifying the clustering of the broad category factors across the four quadrants. Each

quadrant signals the nature of the concepts. The top right quadrant, with high indegree and high outdegree, indicates the most important factors as they have high degree centrality. The factors in the top left quadrant, with high indegree but low outdegree, are likely to behave as receiver factors. Furthermore, the concepts in the bottom right quadrant, with low indegree and high outdegree, are likely to behave as transmitting factors. Lastly, concepts in the bottom left quadrant, with both low indegree and low outdegree, play minimal roles in the network. Overall, the chart helps identify leverage points within the FCM. The bubble chart can be found in Figure 14.

4.3.7 FCM Condensation

Özesmi & Özesmi (2004) argued that analyzing complex cognitive maps with more than 20-30 variables can be challenging and counterproductive. Therefore, it is useful to simplify the map without losing important information. To simplify the aggregated FCM, this study chose to exclude relationships that were identified only once. This simplification allowed for further analysis of the FCM, focusing on the most relevant factors and thereby ensuring the credibility of the findings.

The condensed FCM was then utilized to identify feedback loops within the system. Feedback loops play a crucial role in understanding and simulating complex systems. Analyzing these loops aids in predicting the behaviour of systems, indicating whether the system will stabilize, oscillate, or enter into chaotic behaviour. The feedback loops were identified by visually analyzing the pathways in the condensed FCM. Specifically, the loops were identified by starting with the 'CEP' node and tracing the pathways that lead back to the starting point. These loops were also identified and validated using the Python code presented in subsection B.5.

4.3.8 Formulating Strategies to Enhance CEP

Formulating strategies to enhance CEP was based on the insights generated from the structural analysis. However, structural analysis does not assist in understanding the paths and the specific interactions through which the concepts influence CEP. Hence, it was necessary to incorporate the analysis of paths and interactions to derive measures to increase CEP.

To derive the most effective and robust strategies, the formulation of strategies was based on the condensed (simplified) FCM. In addition, the strategies were formulated by focusing on strong (weight: 0.7-0.9) or moderate (weight: 0.4-0.6) relationships.

The first set of strategies was formulated by considering the most crucial concepts in the system, which were identified based on the degree of centrality of the concepts. The concepts with a degree centrality higher than the average degree centrality in the system were considered in this step. The concepts with a high degree centrality could either have a direct or indirect influence on CEP. Hence, to understand the interaction and the paths through which CEP is influenced, it was necessary to navigate the paths that these concepts took to reach the target node (CEP). The Python code in subsection B.6 was employed to extract the paths through which CEP is influenced. Later, for concepts with high degree centrality, their nature and interactions were investigated to formulate strategies.

The first set of strategies only considered the high degree centrality concepts, however, there might be concepts in the system that have a direct impact on CEP but do not have a high centrality. Hence, the second set of strategies was formulated based on investigating the concepts that directly influence CEP; this could be analysed by inspecting the 'CEP' column in the FCM adjacency matrix or by pinpointing the paths that only have two variables. Then, the strategies were formulated by starting with the concept that has the strongest direct impact on CEP.

Furthermore, the first two sets of strategies do not take into account the driving factors (pure transmitters) that have a lower-than-average degree centrality but might moderately or strongly influence other variables in the system. Hence, to take these factors into account, a third set of strategies were formulated. In this set, the pure transmitters that strongly or moderately influence were extracted, and then their paths to CEP were analysed to formulate strategies.

The formulation of strategies in all steps involved understanding the paths on the right side of the concepts (outgoing arrows) to ensure a systematic approach and avoid repeatability. Furthermore, by formulating

the strategies while considering three different angles (high centrality, direct impact and pure transmitters, the analysis approach ensures that all important interactions and paths are taken into account.

In addition, this approach also indicated the strategies' prioritisation. The first and second sets of strategies provide priority strategies, as they are based on the crucial concepts in the system as well as concepts that have a high direct impact on CEP. Furthermore, the third set of strategies are additional measures that assist in improving the factors that are identified in the first or the second set of strategies, which consequently enhances CEP.

4.4 Reliability and Reproducibility

To increase the reliability and reproducibility of the FCM approach and the research design, several recommendations and practices were adopted from (Olazabal et al., 2018). The research by Olazabal et al. (2018) highlighted a series of good practices to enhance the transparency and reproducibility of the FCM-building processes. The following practices were adopted from this study:

1. Ensuring consistent terminology by homogenizing terminology across all individual maps. Furthermore, using a standardized list of concepts (subsubsection 4.3.1).
2. Developing and following a consistent interview protocol for all participants (Table 6).
3. Applying consistent criteria for pre-processing of maps and documenting the criteria for assigning weights and connections (subsubsection 4.3.2).
4. Documenting aggregation process, including how weights and connections are averaged (subsubsection 4.3.4).
5. Sharing intermediate products such as individual FCMs (subsection B.3).

Furthermore, additional steps were taken to improve the reliability of the research design, which included consulting with researchers who have expertise in FCM. Four researchers were consulted to understand and improve the application of FCM in this study. In addition, a test interview was conducted with the company supervisor to improve the interview protocol.

4.5 Validity

Olazabal et al. (2018) also provided measures to enhance the validity and credibility of the FCM approach. The following steps were incorporated in this study:

1. Clearly defining the research objectives, scope and system boundaries.
2. Identifying and selecting relevant stakeholders and experts from diverse sectors and knowledge areas (Table 3).
3. Creating accumulation curve for new concepts per interview to validate the sample size (Figure 7).
4. The relationships identified by only one participant were directly assigned a weight of 0.1, even if the relationship was defined as strong or medium by the participant (subsubsection 4.3.4).

5 Results

This chapter presents the results of the study. Initially, the factors influencing CEP, the categories to which they belong, and their definitions are described in subsection 5.1. subsection 5.2. Following this, the results of the structural analysis of the FCM are highlighted. Then, the graphical representation of the condensed FCM is highlighted in subsection 5.4, along with the analysis of the feedback loops. Lastly, the formulated strategies for enhancing CEP in large companies are presented in subsection 5.5.

5.1 Factors Influencing CEP

In total, 26 factors influencing CEP were identified. Among these factors, 5 were technological factors, 5 were organizational culture factors, 11 were corporate governance factors, and 5 were external stakeholder pressures. These factors are highlighted along with their definitions in Table 11.

The conceptual framework developed in Figure 4 identified 2 technological factors influencing CEP: implementing digital technologies and green technological innovation and adoption. Both of these factors were identified as influential through the interviews. However, contrary to the framework, the focus was on the implementation and adoption of these technologies rather than on internal 'green innovation' at firms. Apart from these factors, data management and analysis, incremental innovation, and implementing technology to influence behaviour were captured through the interviews.

Furthermore, the conceptual framework highlighted environmental leadership, green values and culture, and employee engagement as organizational culture factors. All three of these factors were identified as influential through the expert interviews. Moreover, entrepreneurial culture and greenwashing culture were additional organizational culture factors that were identified.

For corporate governance factors, the conceptual framework recognized supply chain engagement, external environmental audits, and environmental reporting. All three of these factors were determined to be influential through the interviews in the form of value chain engagement, external due diligence and validation, and environmental reporting. In addition, 8 other corporate governance factors were identified. These factors can be seen in Table 11.

Regulatory pressure, consumer and supplier pressure, and community pressure were highlighted as external stakeholder pressures influencing CEP in the concept map. These factors were also identified through the interviews. Furthermore, investor pressure and peer pressure were additional factors that were recognized.

Table 11: Factors influencing CEP

Factor group	**Factors**	**Definition**
Corporate governance	Effective change management	Involves steering organizational change from its initial planning stages, through its execution, and ultimately to resolution (Stobierski, 2020)
	Inter-department coordination	Collaboration and communication between organizations
	Integrated sustainability champions	Individuals within an organization who actively advocate for sustainable behaviour and implementation of sustainable practices across all departments
	Recruitment of sustainability experts	Hiring professionals with specialized knowledge and skills in sustainable practices
	Workforce training	Providing employees with the necessary skills and knowledge
	Environmental Reporting	Practice of documenting and disclosing detailed information about an organization's environmental impact

Factor group	Concepts	Definition
	Continuous performance assessment	Continuous process of evaluating and monitoring performance against specific key performance indicators and also deriving insights
	SMART target-setting & KPI prioritization	Involves defining specific measurable, achievable and time-bound objectives and selecting and focusing on key-performance indicators
	Internal control policies	Involves introducing internal protocols for environmental management
	External due diligence & validation	Having an independent third party (specialized in environmental sustainability) assess, verify, evaluate and validate the environmental practices, targets and performance
	Value chain engagement	Active collaboration and communication with all stakeholders involved in the value chain
External stakeholder pressure	Peer pressure	Influence exerted by the organization's peer group
	Regulatory pressure	Influence exerted by laws, regulations, and government policies
	Investor pressure	Influence exerted by shareholders and potential investors
	Community pressure	Influence exerted by non-governmental organizations, activist groups, and local communities and general public
	Customer/client pressures	Pressure from customers, clients and suppliers
Organisational culture	Environmental leadership	Attitude, motivation, focus and behaviour of leadership towards sustainability
	Employee engagement	Degree of enthusiasm, commitment and involvement of employees towards their organizations and goals (Smith, 2024)
	Green values	Values and principles within an organization that focus on sustainability
	Entrepreneurial culture	Culture that promotes entrepreneurship, innovation, creativity and risk-taking
	Greenwashing culture	Involves promoting norms that misleadingly present the organizations as environmentally friendly
Technological	Data management & analysis	Process of systematically handling data (collecting, storing and organizing) as well as analyzing data to guide decision-making
	Implementing sustainable technologies	Technologies that directly assist in improving the environmental impact (across the indicators of CEP)
	Implementing digital technologies	Integrating digital tools and systems
	Implementing tech to influence behaviour	Using technologies to guide and influence people's behaviour

Factor group	Concepts	Definition
	Incremental innovation	Refers to the process of making gradual improvements to existing products, services, or technologies over time

Furthermore, the distribution of the identified factors influencing CEP by stakeholder group was visualized using a stacked bar chart presented in Figure 9. The graph assists in understanding the relevance of factors, stakeholder priorities and perspectives, as well as areas of consensus and divergence.

From Figure 9, it is evident that certain factors are widely acknowledged across multiple stakeholder groups, suggesting their importance in improving CEP. Specifically, environmental reporting, regulatory pressure, and investor pressure were identified by all stakeholder groups and participants. Furthermore, smart target-setting and KPI prioritization, environmental leadership and data management and analysis were identified by a significant number of participants and by all stakeholder groups. These six factors indicate key areas where high consensus exists, suggesting that they are highly relevant in the context of CEP.

In contrast, Figure 9 highlights that some factors were only mentioned by 1-2 participants, suggesting that they might be relevant only in specific contexts or are less widely recognized. Specifically, internal control policies, implementing technologies to influence behaviour, incremental innovation, inter-department coordination, and entrepreneurial culture were identified by only one participant. In addition, only two participants identified workforce training and integrated sustainability champions.

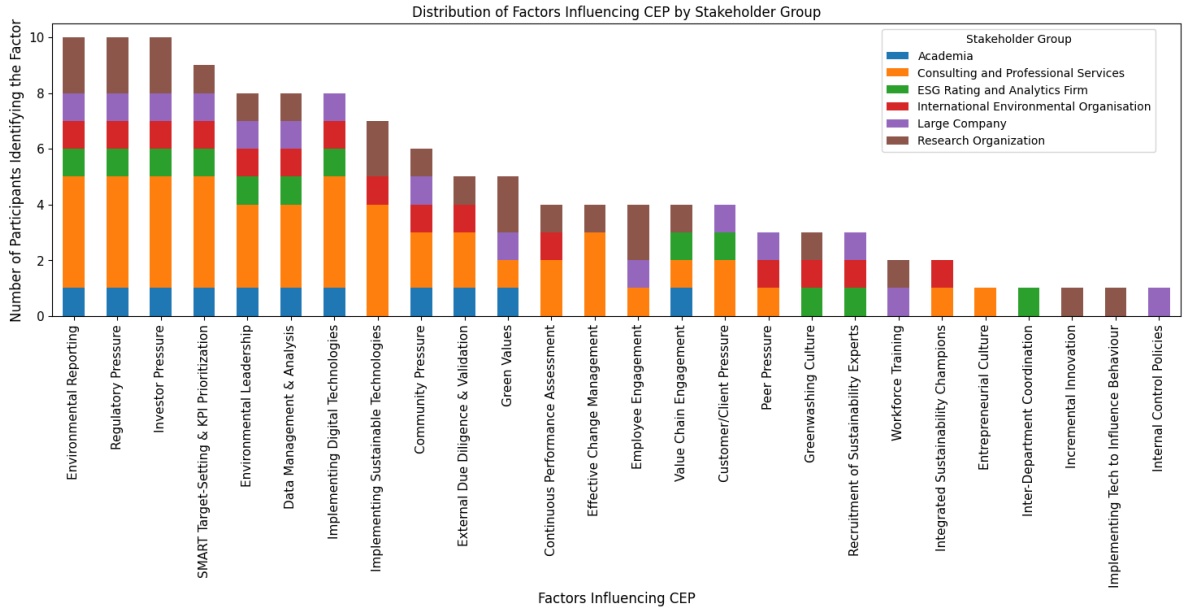


Figure 9: Stacked bar chart representing the frequency with which each factor influencing CEP was identified by different stakeholder groups

The analysis demonstrates that different stakeholder groups are not limited to a specific factor category but rather engage broadly across technological factors, corporate governance factors, organisational culture factors and external stakeholder pressures. This highlights that the relevant stakeholders and experts recognize the importance of multiple dimensions of corporate environmental sustainability. This further suggests that improving CEP might require a holistic and integrated approach as different stakeholder groups recognize the relevance of a wide range of factors. The lack of clear patterns in terms of how different stakeholder groups prioritize certain types of factors suggests that experts from various roles and stakeholder groups consider multiple factors together, further indicating interconnectedness within the system.

Figure 9 also highlights the unique priorities of different stakeholder groups. For example, participants from consulting and professional services distinctively identified effective change management and entrepreneurial culture, likely due to their role in guiding companies through changes and transitions. Additionally, research organizations uniquely emphasized technological factors, such as incremental innovation and technologies, to influence behaviour, reflecting their common focus on innovation, R&D, and new technologies. Furthermore, the participant from a large company uniquely identified internal control policies, likely due to their experience with internal organizational systems and processes. Lastly, the expert from the ESG rating and analytics company highlighted the role of inter-department coordination.

5.2 Aggregated FCM - Matrix Representation

The aggregated adjacency matrix can be seen in Figure 10. The red cells represent relationships that were identified by only one participant, and the yellow cells represent the averaged weights. In total, 76 connections were identified, out of which 38 connections were averaged weights, and the other 38 connections were only mentioned once. The graphical representation of the aggregated FCM can be seen in Figure 27.

The density of the aggregated FCM is 0.108, which is computed by the number of connections identified in the FCM (76) divided by the maximum number of possible connections (27×26) (Özesmi & Özesmi, 2004). The density of the map indicates the extent to which the concepts in the FCM are interconnected.

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											0.1
Data management & analysis			0.3													0.6	0.1	0.3									0.1
Implementing sustainable technologies																											0.7
Implementing digital technologies		0.7																									
Implementing tech to influence behaviour							0.1	0.1																			
Environmental leadership							0.7	0.5	0.1						0.1	0.1	0.1	0.2	0.1		0.5						0.7
Effective change management																											0.7
Employee engagement																											0.5
Green values																0.5		0.1									0.6
Inter-department coordination		0.1														0.1											
Entrepreneurial culture			0.1	0.1			0.1																				
Greenwashing culture																-0.1	-0.1							0.1	0.1		-0.6
Integrated sustainability champions							0.1									0.1	0.1	0.1			0.1						
Recruitment of sustainability experts																0.4		0.1									
Workforce training																											0.1
Environmental reporting																	0.6	0.5		0.5							0.6
Continuous performance assessment																0.1											0.8
SMART target-setting & KPI prioritization																	0.1										0.7
Internal control policies																											0.1
Peer Pressure																					0.1						0.5
External due diligence & validation																											0.9
Value chain engagement		0.7																									
Regulatory pressure		0.6	0.5	0.1		0.6										0.7		0.5			0.4			0.4			
Investor pressure			0.1	0.1												0.3	0.1	0.1			0.1						
Community pressure																0.1							0.5				
Customer/client pressure																0.1											
CEP																								-0.6	-0.7	-0.5	

Figure 10: Aggregated adjacency matrix

Several relationships were consistently identified by multiple participants and stakeholder groups. The relationships that were identified by five or more participants have been highlighted in the following:

1. **Regulatory pressure → environmental reporting**

   The influence of regulatory pressure on environmental reporting practices was the most frequently recognized relationship, identified by eight participants across all stakeholder groups. Furthermore, the strength and direction of the relationship was quantified as +0.7, indicating that regulatory pressure has a strong and positive impact on environmental reporting. This suggests that compliance with regulatory requirements is a key motivator for large companies to improve their environmental reporting.

2. **Implementing digital technologies → data management and analysis**

This relationship was identified by seven participants across different stakeholder groups, including consulting firms, ESG rating and analytics firms, large companies, academia and international environmental organisations. Furthermore, the relationship has an average weight of +0.7, indicating that digital technologies play a significant role in improving environmental data management and analysis.

3. **Data management and analysis → environmental reporting**

   Six participants from consulting firms, ESG rating and analytics firms, large companies, and academia highlighted this relationship. This relationship has an average weight of +0.6, indicating a moderate and positive relationship. Moreover, the consensus among different stakeholder groups demonstrates the significant role of data management and analysis in enhancing environmental reporting.

4. **Investor pressure → environmental reporting**

   Investor pressure was also identified as a driver of environmental reporting by six experts across research organizations, consulting firms, large companies, and academia. It was found to have a weak and positive influence on environmental reporting, with an average weight of +0.3. This suggests that while investor pressure is a widely acknowledged factor, other influences may serve as more significant drivers of environmental reporting. In addition, as evident from Figure 10, investor pressure is moderately and positively influenced by regulatory pressure. This indicates that the effectiveness of investor pressure could be contingent upon the strength of regulatory pressure.

5. **Implementing sustainable technologies → CEP**

   Six participants recognized the implementation of sustainable technologies as a direct driver of CEP. This relationship was identified by experts from research organizations, consulting firms and international environmental organizations. These groups are directly involved in guiding companies towards decarbonization and net-zero targets. As a result, these stakeholders are likely to prioritize the application of sustainable technologies in their strategies. Furthermore, this relationship has an average weight of +0.7, indicating a strong and positive impact of implementing sustainable technologies on enhancing CEP.

6. **Regulatory pressure → smart target-setting & KPI prioritization**

   Five experts identified the link between regulatory pressure and smart target-setting & KPI prioritization. This link was identified by experts from research organizations, consulting firms and international environmental organizations. Furthermore, the link is associated with an average weight of +0.5, indicating a moderate and positive influence of regulatory pressure on smart target-setting and KPI prioritization. This suggests that regulatory pressure moderately and positively influences how large companies set their targets and prioritize certain KPIs.

7. **Environmental leadership → CEP**

   Environmental leadership was identified as a strong driver of CEP, with an average relationship weight of +0.7. This relationship was recognized by five experts across consulting firms, research organizations, large companies, and academia. The widespread acceptance and strong impact of this relationship highlight the critical role of environmental leadership in improving CEP.

The consensus among participants across diverse stakeholder groups indicates a strong agreement on the relationships, which validates their relevance and wide applicability. Furthermore, these relationships involve technological factors, organisational cultural factors, corporate governance factors, and external stakeholder pressures, which further highlight the interconnectedness in the system. On the contrary, there were 15 relationships that only two participants identified. However, only one of these relationships was solely identified by one stakeholder group:

- **Data management and analysis → implementing sustainable technologies**

This relationship was identified by participants P2 and P3 from consulting firms. Their roles focus on sustainability strategy and implementation at large companies in the Netherlands. Furthermore, consulting

firms emphasize data-driven decision making, which could have possibly led to the unique identification. Furthermore, the average weight for the link was quantified as +0.3, which indicates a weak and positive relationship.

Comparison with conceptual framework

The conceptual framework developed in Figure 4 identified links between several factors and CEP. The aggregated matrix in Figure 10 can also be compared to the conceptual framework to highlight the relationships between factors.

Technological factors

The concept map highlights that green technological innovation and adoption and the implementation of digital technologies are directly and positively linked to CEP. It also shows that several factors, such as green values, environmental leadership, and implementation of digital technologies, influence green technological innovation and adoption.

In contrast, the FCM emphasizes the direct and strong impact of implementing sustainable technologies on CEP. However, it notes that the implementation of sustainable technologies is moderately influenced by regulatory pressure and weakly influenced by data management and analysis. The FCM further reveals that the implementation of digital technologies has a strong influence on data management and analysis, which in turn positively affects the implementation of sustainable technologies, environmental reporting, and the setting of SMART targets and KPI prioritization. These concepts directly and positively contribute to CEP.

While the conceptual framework identifies green innovation and adoption, the FCM identifies the implementation of sustainable technologies. The difference likely arises because the conceptual framework is based on theoretical perspectives and existing literature, while the FCM is mainly constructed using expert-driven insights. Furthermore, practitioners are likely to concentrate on the actions with practical outcomes like the implementation process rather than predicting the broader, long-term impacts of innovation.

Organisational culture factors

The conceptual framework identifies that, among organizational culture factors, employee engagement and environmental leadership directly and positively influence CEP. Similarly, the FCM highlights a strong direct relationship between environmental leadership and CEP and a moderate direct relationship between employee engagement and CEP. Moreover, the FCM identifies that environmental leadership also positively influences CEP through an increase in effective change management, employee engagement and external due diligence and validation. In addition, the FCM highlights that environmental leadership is positively influenced by regulatory pressure. The concept map also highlights that green values indirectly influence CEP through green technological innovation and adoption. On the other hand, the FCM identifies that green values both directly and indirectly increase CEP through an increase in environmental reporting.

Corporate governance factors

For corporate governance factors, the conceptual framework identifies the direct links between supply chain engagement, external environmental audits, environmental reporting, and CEP. Similarly, the FCM also highlights the strong direct relationship between external due diligence and validation and CEP and a moderately strong relationship between environmental reporting and CEP. However, the FCM finds that the value chain engagement indirectly influences CEP through an increase in data management and analysis. It should be noted that while the conceptual framework identifies the link between environmental reporting and CEP, the FCM goes further by defining the strength and direction of this relationship.

The conceptual framework also pointed out that external environmental audits and environmental reporting are influenced by regulatory pressure. These relationships are also validated by the FCM. However, the FCM finds that environmental reporting is positively influenced by several other factors like green values, sustainability experts, and investor pressure. In addition, it finds that external due diligence and validation is positively affected by the presence of environmental leadership. In contrast to the conceptual framework, the FCM also highlights the positive influence of other corporate governance factors, such as effective change management, recruitment of sustainability experts, continuous performance assessment, and SMART target-setting & KPI prioritization.

External stakeholder pressures

The concept map highlights direct links between regulatory pressure, consumer pressure, and CEP. It also highlights connections between community pressure and regulatory pressure, as well as the relationship between regulatory pressure and environmental reporting. In contrast, the FCM reveals that the positive effects of regulatory pressure propagate through different factors like data management and analysis, implementing sustainable technologies, environmental leadership, environmental reporting, smart target setting and KPI prioritization, and investor pressure to influence CEP. The FCM also validates the influence of community pressure on regulatory pressure.

In addition, unlike the conceptual framework, the FCM identifies a negative relationship between CEP and community pressure as well as investor pressure. It can be noted that for these relationships the direction for the relationship is reversed in the FCM.

Furthermore, in contrast to the concept map, the FCM also identifies investor pressure and peer pressure as important factors in the system. The FCM elaborates that peer pressure has a moderate and positive influence on CEP. Moreover, it highlights that community pressure indirectly influences CEP by increasing regulatory pressure.

5.3 Structural Analysis

The indegrees, outdegrees and the degree centrality for the concepts are plotted in Figure 11, Figure 12 and Figure 13, respectively. It should be noted that the 'CEP' concept is analysed but not plotted in these graphs because the purpose of the structural analysis is to understand the nature of concepts that are influencing CEP.

Indegree

The average indegree in the FCM is 0.65, which serves as a baseline for comparing the indegree of individual concepts in the FCM. From Figure 11, it is evident that environmental reporting shows the highest indegree. Furthermore, data management and analysis, SMART target-setting and KPI prioritization, and external due diligence and validation are other variables that have high indegrees. These variables are strongly influenced by other variables in the system, indicating that they have a high dependency on other variables.

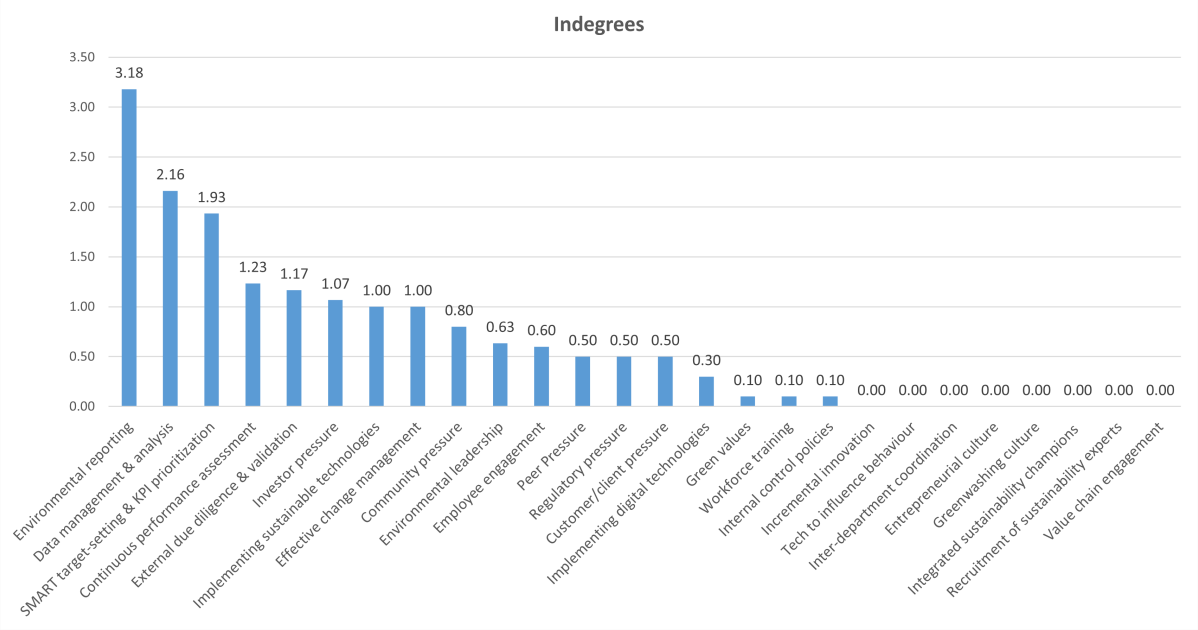


Figure 11: Indegree of concepts

From Figure 11, it can also be seen that 8 concepts have no indegrees; hence, these concepts are pure

transmitters. Namely, incremental innovation, implementing tech to influence behaviour, inter-department coordination, entrepreneurial culture, greenwashing culture, integrated sustainability champions, recruitment of sustainability experts and value chain engagement are not influenced by other factors in the system.

Outdegree

The average outdegree in the FCM is 0.88, which provides a baseline for comparing the outdegree of individual concepts in the FCM. The average outdegree is higher than the average indegree in the FCM, indicating that, on average, concepts in the system tend to exert more influence on other concepts than they receive. Figure 12 highlights the outdegree of the concepts. It is evident that regulatory pressure has the highest outdegree, indicating that it has the strongest influence on other factors in the system. Furthermore, environmental leadership, environmental reporting, data management and analysis and green values have a strong influence on the other factors in the system. It can also be seen that there are no concepts with zero outdegrees, indicating that there are no pure receivers in the system, which means that all factors influence at least one other factor. Furthermore, the outdegree of CEP is 1.80, which indicates that there might be possible feedback loops in the system which influence CEP.

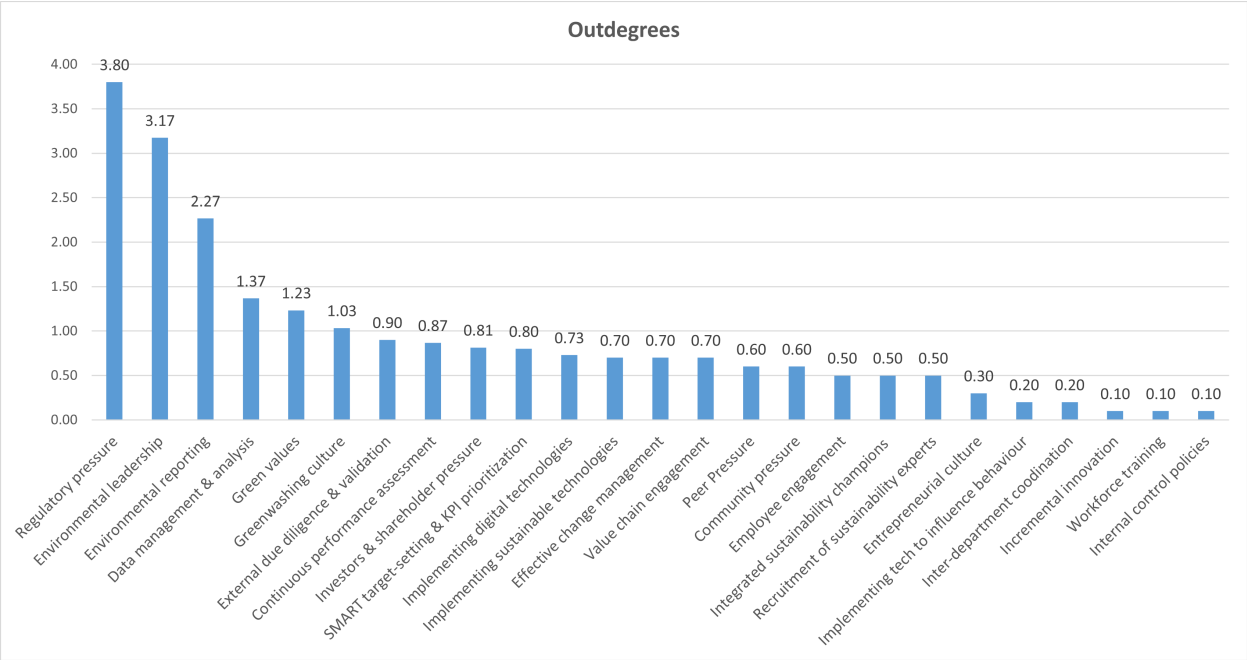


Figure 12: Outdegree of concepts

Degree Centrality

The average degree centrality in the FCM is 1.53, which provides a baseline for evaluating the relative importance of individual concepts in the FCM. From Figure 13, it is evident that environmental reporting has the highest degree centrality. Moreover, regulatory pressure, environmental leadership, data management and analysis, and SMART target-setting and KPI prioritization have a high degree centrality, which indicates their high importance in the system. It can also be recognized that these top 5 important variables consist of corporate governance factors, organisational culture factors, technological factors, and external stakeholder pressure. This indicates that specific factors within different broad domains are influential in the system. In addition, incremental innovation, workforce training, internal control policies and customer/client pressures have the lowest centrality, indicating that they are relatively less important in the system.

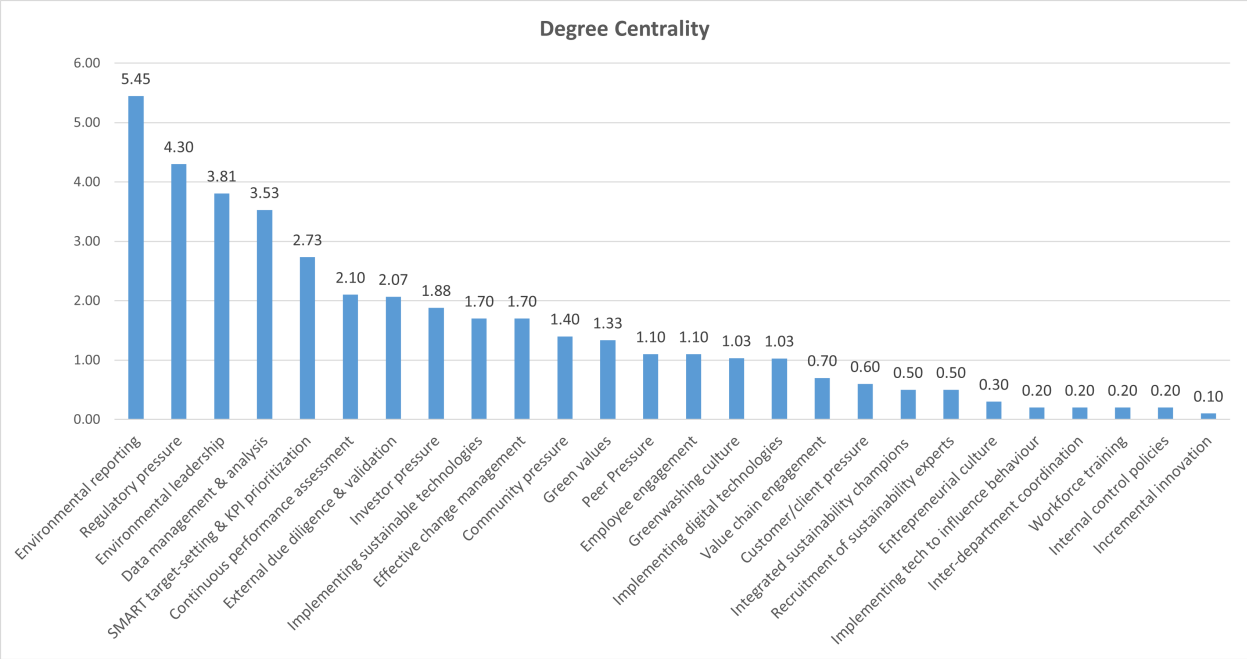


Figure 13: Degree centrality of concepts

Based on the indegrees, outdegrees and centrality, the nature of these concepts is categorized and summarized in Table 12. The concepts in Table 12 are also arranged in the order of importance, starting with the concept that has the highest degree centrality. The transmitters and receivers were categorized based on the criteria in subsubsection 4.3.5. In total, the FCM consists of 8 pure transmitters, 12 ordinary variables, 2 receivers and five transmitters.

Environmental reporting behaves as a strong ordinary variable because it is strongly influenced by other variables in the system and also has a heavy influence on other factors in the system. Furthermore, regulatory pressure and environmental leadership play the role of important transmitters within the system. In addition, SMART target-setting and KPI prioritization are important receivers in the FCM.

Table 12: Nature of concepts

Concepts	**Nature of Concept**
Environmental reporting	Ordinary
Regulatory pressure	Transmitter
Environmental leadership	Transmitter
Data management & analysis	Ordinary
SMART target-setting & KPI prioritization	Receiver
Continuous performance assessment	Ordinary
External due diligence & validation	Ordinary
Investor pressure	Ordinary
Implementing sustainable technologies	Ordinary
Effective change management	Ordinary
Community pressure	Ordinary
Green values	Transmitter
Peer pressure	Ordinary
Employee engagement	Ordinary
Greenwashing culture	Pure Transmitter

Concepts	Nature of Concept
Implementing digital technologies	Transmitter
Value chain engagement	Pure Transmitter
Customer/client pressure	Receiver
Integrated sustainability champions	Pure Transmitter
Recruitment of sustainability experts	Pure Transmitter
Entrepreneurial culture	Pure Transmitter
Implementing tech to influence behaviour	Pure Transmitter
Inter-department coordination	Pure Transmitter
Workforce training	Ordinary
Internal control policies	Ordinary
Incremental innovation	Pure Transmitter

Bubble Chart

The visualization of the bubble chart (Figure 14) for the concepts indicates that factors within the broad domains of technological factors, organizational culture, corporate governance, and external stakeholder pressures do not cluster around specific quadrants. This non-clustering pattern signifies that the influence and interdependencies of these factors are diverse and distributed across various levels of influence and being influenced. Such a distribution highlights the complex and multifaceted nature of interactions affecting CEP, as improvements in one domain can have varied impacts depending on the interplay with other domains. Additionally, the visualization helps in understanding the quadrants to which each factor belongs, indicating the nature and importance of the concept within the map.

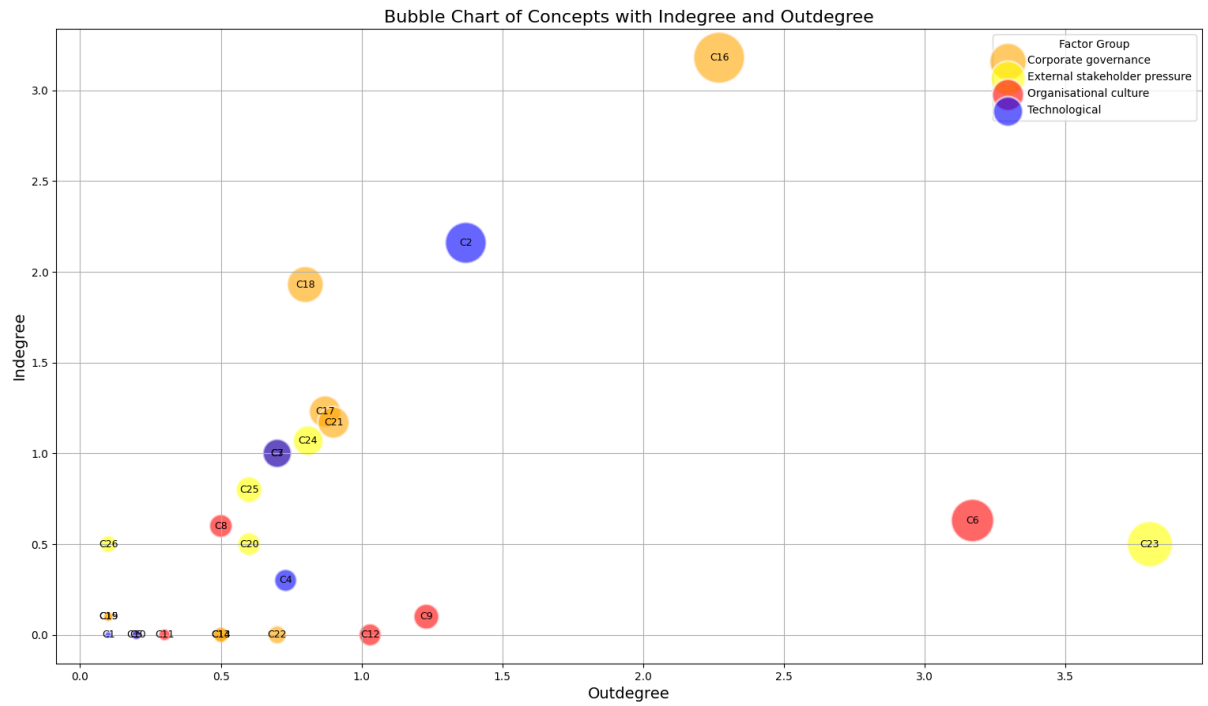


Figure 14: Bubble chart - indegrees versus outdegrees, for each of the concepts in the FCM (bubbles represent concepts and bubble size represents centrality)

From Figure 14, it is evident that environmental reporting (C16) is located in the top right quadrant, indicating its high importance within the system. Furthermore, regulatory pressure (C23) and environmental

leadership (C6) are positioned in the bottom right quadrant, suggesting that they are key transmitter concepts with high outdegree and low indegree. Moreover, data management and analysis (C2) and SMART target-setting and KPI prioritization are situated in the top left quadrant with high outdegree and low indegree where SMART target-setting and KPI prioritization behaves as a receiver variable and data management and analysis is characterized as an ordinary variable due to its relatively higher indegree. Furthermore, concepts in the bottom left quadrant, such as incremental innovation (C1) and workforce training (C15), have relatively smaller bubble sizes, indicating their minimal relevance in the system.

5.4 Condensed FCM

The simplified (condensed) FCM was created by excluding the relationships that were only identified once (red cells in Figure 10). The exclusion of these relationships led to the exclusion of seven concepts: incremental innovation, implementing tech to influence, inter-department coordination, entrepreneurial culture, integrated sustainability champions, workforce training and internal control policies. Subsequently, the condensed FCM in Figure 15 consists of 20 concepts and 38 relationships. This provides a clearer understanding of the system, allowing for more effective further analysis. The matrix representation of the condensed FCM can be found in subsection C.2.

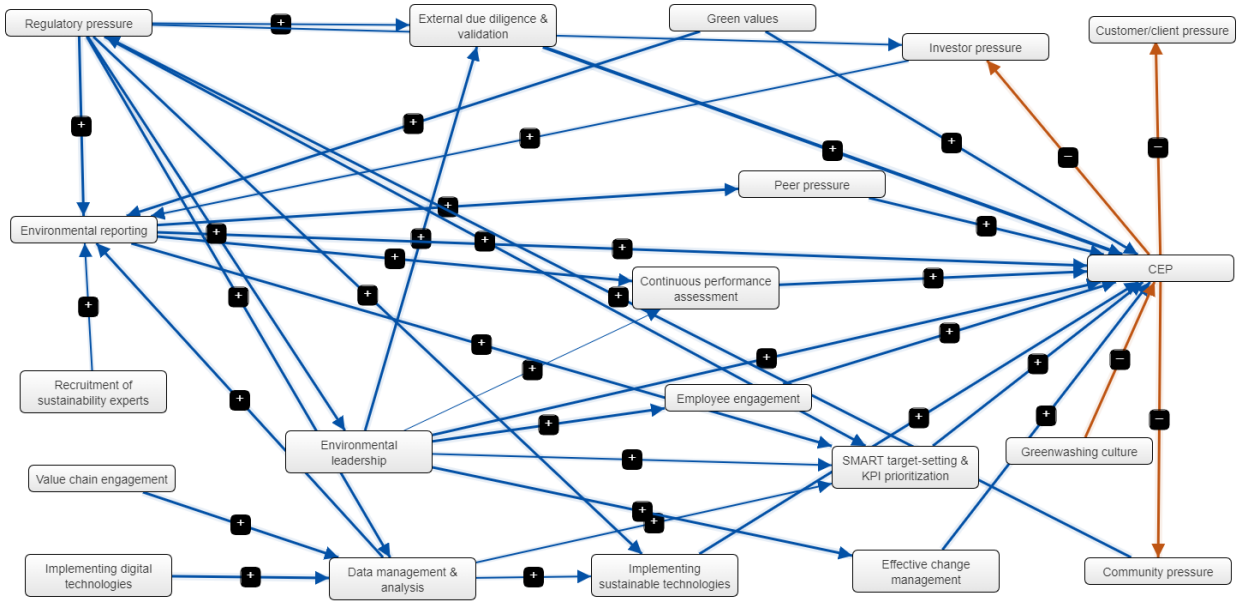


Figure 15: Condensed FCM - graphical representation, where blue arrows represent a positive relationship and orange arrows indicate a negative relationship (created using Mental Modeler (Gray & Cox, 2015))

Feedback Loops

Several feedback loops were identified in the condensed FCM presented in Figure 15. It is evident that CEP has outgoing arrows going towards investor, community, and customer/client pressure. These interactions serve as the primary interactions through which various feedback loops are initiated within the system.

The underlying feedback loops are highlighted in the following, with red arrows indicating a negative relationship:

- CEP → Investor pressure → Environmental reporting → CEP
- CEP → Community pressure → Regulatory pressure → Data management & analysis → Implementing sustainable technologies → CEP
- CEP → Community pressure → Regulatory pressure → Data management & analysis → Environmental reporting → CEP

- CEP → Community pressure → Regulatory pressure → Environmental leadership → CEP
- CEP → Community pressure → Regulatory pressure → Investor pressure → Environmental reporting → CEP

These underlying feedback loops also have additional feedback loops associated with them. Specifically, these additional loops are present through the following interactions:

- **Environmental reporting** positively affects CEP through continuous performance assessment, SMART target-setting & KPI prioritization, and peer pressure.
- **Data management & analysis** positively impacts CEP by driving the implementation of sustainable technologies and also influencing environmental reporting.
- **Environmental leadership** positively influences CEP through effective change management, employee engagement, external due diligence and validation, continuous performance assessment, and SMART target-setting & KPI prioritization.

The highlighted underlying feedback loops represent balancing feedback loops. This indicates that as CEP improves, community and investor pressures decrease; however, these external stakeholder pressures also contribute to increasing CEP through their positive relationships with regulatory pressure and environmental reporting. This implies that the balancing feedback loops may lead to CEP stabilizing at a certain performance level. However, the CEP will only stabilize once the external stakeholders are satisfied with the company's CEP. This suggests that companies with low CEP will remain under scrutiny from external stakeholders until they reach the desired CEP level. Furthermore, companies that have achieved the desired CEP score might be able to avoid over-committing to certain resources.

5.5 Formulating Strategies to Enhance CEP

Following the analysis approach outlined in subsubsection 4.3.8, 14 strategies were developed. The first set of strategies is based on the concepts with the highest centrality, while the second set is derived from concepts with a strong or moderate direct impact. Therefore, the first two sets of strategies are priority strategies. Furthermore, the third set of strategies provides additional measures that companies can adopt to enhance the concepts addressed in the first or second set. The strategies were formulated by integrating insights from both structural analysis and path analysis. Moreover, implementation considerations for each strategy are discussed in this subsection.

It should be noted that two factors, community pressure and peer pressure, were identified during the analysis process but were neglected during the formulation of strategies. Peer pressure has a direct, moderate and positive influence on CEP, however, peer pressure is influenced by the peer group's CEP which cannot be internally controlled by the company. Furthermore, community pressure was excluded as it has a broader effect on regulatory pressure, which then propagates through the system.

5.5.1 First Set of Strategies: High Centrality Concepts

Environmental Reporting

Environmental reporting is an ordinary variable with the highest centrality in the FCM. It directly and indirectly enhances CEP through various pathways:

- Environmental reporting → Continuous performance assessment → CEP
- Environmental reporting → SMART target-setting & KPI prioritization → CEP
- Environmental reporting → Peer pressure → CEP
- Environmental reporting → CEP

These pathways highlight that environmental reporting, directly and indirectly, improves CEP by enhancing continuous performance assessment and SMART target-setting & KPI prioritization. Hence, the following strategy was formulated:

- **Strategy:** companies should enhance their environmental reporting to better inform continuous performance assessment, as well as SMART target-setting and KPI prioritization.

While environmental reporting is essential for tracking and communicating environmental performance, there is a risk that companies might focus excessively on documentation and disclosure without taking further actions to improve their environmental performance. Therefore, companies that already perform well in environmental reporting should concentrate on utilizing these reports to better inform continuous performance assessment and SMART target-setting & KPI prioritization. These companies might also consider prioritizing other strategies discussed in the following sections.

The suggested strategy will be more impactful for companies that currently do not prioritize environmental reporting. For these companies, enhancing environmental reporting could provide a clearer understanding of their current environmental landscape, which can then guide more effective SMART target-setting and KPI prioritization. However, enhancing these practices could require significant resources, such as time, financial investment, and human capital.

It is also evident that an increase in environmental reporting also increases peer pressure, which improves CEP. However, the influence of peer pressure on CEP may be less effective if the peer group has a low environmental performance. Hence, other pathways are prioritized in the formulation of this strategy.

Regulatory Pressure

Regulatory pressure is a driving variable with a high centrality and the highest outdegree. Consequently, regulatory pressure influences CEP through the most number of pathways. The underlying pathways with strong or moderate relationships have been highlighted in the following:

- Regulatory pressure → Data management & analysis → Environmental reporting → CEP
- Regulatory pressure → Implementing sustainable technologies → CEP
- Regulatory pressure → Environmental leadership → CEP
- Regulatory pressure → Environmental reporting → CEP
- Regulatory pressure → SMART target-setting & KPI prioritization → CEP
- Regulatory pressure → External due diligence & validation → CEP

These pathways also guide additional pathways, as factors like environmental leadership, environmental reporting, and data management and analysis influence CEP through multiple paths.

These underlying pathways demonstrate that regulatory pressure indirectly influences CEP by positively impacting multiple factors. Hence, the following strategy is formulated:

- **Strategy:** companies should prioritize regulatory compliance while proactively leveraging regulatory pressures to enhance data management and analysis, implement sustainable technologies, strengthen environmental leadership, increase SMART target-setting and KPI prioritization, and adopt external due diligence and validation.

While regulatory compliance is necessary, companies might become too reactive or dependent on regulations, which could limit other important aspects of their environmental strategy, such as fostering a green culture or proactively setting industry standards.

The effectiveness and complexity of implementing this strategy can also vary depending on the industry. For example, companies in highly regulated industries such as energy and manufacturing are often subject to more complex regulatory environments. Hence, this strategy might lead to more substantial improvements in highly regulated industries; however, compliance could also be more resource-intensive.

Environmental Leadership

Environmental leadership is a key transmitter variable with high centrality and high outdegree. Consequently, environmental leadership influences CEP through multiple pathways. The pathways with strong or moderate relationships are highlighted below:

- Environmental leadership → Effective change management → CEP
- Environmental leadership → Employee engagement → CEP
- Environmental leadership → External due diligence & validation → CEP
- Environmental leadership → CEP

These pathways indicate that environmental leadership not only directly enhances CEP but also indirectly improves CEP through a positive effect on effective change management, employee engagement and external due diligence and validation. Based on this, the following strategy was formulated:

- **Strategy:** companies should strengthen environmental leadership by ensuring the presence of environmental leaders in top management. These leaders should be committed to sustainability, focusing on driving CEP by supporting effective change management, employee engagement, and the adoption of external due diligence and validation

While strengthening environmental leadership can be effective, there is a risk that companies may over-rely on top management, focusing solely on a top-down approach to drive environmental performance. The efforts of top management might not be effective without the involvement and alignment of employees at different organizational levels. Therefore, for this strategy to be effective, companies should prioritize employee engagement and effective change management throughout the organization.

Data Management and Analysis

Data management and analysis is an ordinary variable with a high centrality. It indirectly influences CEP through different pathways:

- Data management & analysis → Environmental reporting → CEP
- Data management & analysis → Implementing sustainable technologies → CEP
- Data management & analysis → SMART target-setting & KPI prioritization → CEP

From Figure 10 and these pathways, it is evident that data management and analysis primarily increases CEP through its impact on environmental reporting. However, it also has a weaker influence on SMART target-setting & KPI prioritization, as well as the implementation of sustainable technologies, which then further enhances CEP. Based on this, the following strategy was formulated:

- **Strategy:** companies should enhance data management and analytics capabilities to support environmental reporting, SMART target-setting & KPI prioritization and the implementation of sustainable technologies.

However, enhancing data management and analytics capabilities might require significant investment in technology and infrastructure. While technological firms with established IT infrastructure can immediately utilize their existing capabilities, the impact of this strategy is likely to be more significant for traditional companies that have not yet fully developed their data management and analytics capabilities. For these traditional firms, the adoption of enhanced data management and analytics could drive substantial improvements in CEP through better environmental reporting, SMART target-setting & KPI prioritization, and the implementation of sustainable technologies. However, these companies may also face higher resistance to change.

SMART target-setting and KPI prioritization

SMART target-setting and KPI prioritization is a receiver concept with high centrality. It is strongly influenced by other variables, and it directly impacts CEP. From Figure 10, it is evident that the relationship between SMART target-setting and KPI prioritization and CEP has an average weight of +0.7, indicating a strong and positive relationship. Due to its short and direct path to CEP, this concept can lead to immediate improvements in CEP. Based on this, the following strategy was formulated:

- **Strategy:** corporates should define specific, measurable, achievable, realistic, and time-bound (SMART) targets and should select and prioritize key performance indicators

To enhance SMART target-setting and KPI prioritization, companies should focus on improving regulatory compliance and environmental reporting. Furthermore, companies in highly regulated environments are likely to align KPIs with regulatory requirements, as regulatory pressure has a moderate and positive influence on this variable. In contrast, companies in less regulated environments can effectively use this strategy to establish industry standards and adapt to future regulatory trends.

Continuous performance assessment

Continuous performance assessment is an ordinary variable that has high centrality. From the aggregated matrix, it is evident that the relationship between continuous performance assessment and CEP has an average weight of +0.8, indicating that it has a direct and strong impact on CEP. In addition, Due to its short and direct path to CEP, this concept can lead to immediate improvements in CEP. Hence, the following strategy was formulated:

- **Strategy:** companies should enhance their continuous performance assessment processes by regularly evaluating and monitoring environmental performance against specific key performance indicators to derive actionable insights.

Continuous performance assessment is also moderately and positively influenced by environmental reporting. Therefore, companies with reputable environmental reporting might be able to quickly adapt their continuous performance assessment processes. Conversely, companies that lack strong environmental reporting may need to focus on improving environmental reporting to enhance their continuous performance assessment.

External due diligence and validation

External due diligence and validation is another variable with high centrality that only directly influences CEP. It was found that the relationship between external due diligence and validation and CEP has an average weight of +0.9, indicating a stong and positive relationships. Furthermore, it has a short and direct path to CEP which suggests that it might lead to immediate improvements in CEP. Therefore, the following strategy was formulated:

- **Strategy:** companies should adopt an independent third party environmental organization to assess, verify, evaluate and validate the existing environmental practices, targets and performance.

While the adoption of external due diligence and validation can be beneficial, it can also be expensive. Furthermore, there is a risk that companies might neglect the actions recommended by the external auditor, leading to no significant improvements in CEP. Therefore, companies must ensure that these recommended actions are implemented.

External due diligence and validation is also moderately and positively influenced by environmental leadership and regulatory pressure, hence, companies in highly regulated environments with environmental leaders in top management are more likely to adopt external due diligence and validation.

5.5.2 Second Set of Strategies: Direct Impact Concepts

Effective change management

Effective change management is an ordinary variable with a direct, strong and positive influence on CEP. Hence, the following strategy was formulated:

- **Strategy:** companies should incorporate effective change management practices

It is evident that achieving better CEP requires organizational changes; hence, incorporating effective change management practices is essential. Effective change management is also positively and strongly influenced by environmental leadership; hence, companies with strong environmental leaders in their top management are likely to incorporate effective change management. On the other hand, implementation might be more challenging in companies without strong environmental leadership. These companies could strengthen their environmental leadership or engage external consultants specializing in change management.

Implementing sustainable technologies

Implementing sustainable technologies is another ordinary variable that directly and strongly improves CEP. Therefore, the following strategy was formulated:

- **Strategy:** companies should increase the adoption and implementation of sustainable technologies.

Implementing sustainable technologies is essential for reducing environmental impact. However, the aggregated FCM shows that implementing sustainable technologies is moderately influenced by regulatory pressure. However, if companies rely heavily on regulatory pressure as the primary driver for implementing sustainable technologies, they may adopt a reactive rather than proactive approach to sustainability. Hence, companies must proactively integrate sustainable technologies into their operations to have a greater impact on their CEP.

Furthermore, companies performing well on the climate change mitigation dimension of CEP could benefit from other strategies formulated in this section. On the other hand, companies underperforming in this dimension will benefit more from this strategy.

Green values

Green values acts as a transmitter variable and, thus, is less likely to be affected by other variables. However, it moderately and directly increases CEP with an average weight of +0.6. Therefore, the following strategy was formulated:

- **Strategy:** companies should integrate sustainability-focused values and principles into their organisational culture.

Green values is not affected by other variables in the FCM, which suggests that green values can be a consistent driver of CEP, regardless of changes in other areas, such as external stakeholder pressures or technological factors.

However, there is a risk that companies might superficially adopt green values without deeply embedding them into their culture and all organizational levels.

Employee engagement

Employee engagement is an ordinary variable that directly, moderately and positively influences CEP. Consequently, the following strategy was formulated:

- **Strategy:** companies should enhance employee engagement by fostering their employees' enthusiasm, commitment, and involvement in the organization's sustainability goals

Employee engagement is also moderately and positively influenced by environmental leadership; hence, companies with strong environmental leadership are more likely to enhance employee engagement. Therefore, companies could strengthen environmental leadership to support this strategy.

Greenwashing culture

Greenwashing culture is a pure transmitter variable that has a direct, moderate and negative influence on CEP. Therefore, the following strategy was formulated:

- **Strategy:** corporates should actively work to eliminate greenwashing culture and practices

Greenwashing culture can undermine genuine sustainability efforts, which could lead to a decline in CEP. Companies with existing greenwashing practices might face greater challenges in implementing this strategy as they might have to revise and rebuild practices.

5.5.3 Third Set of Strategies: Low Centrality Transmitter Concepts

Recruitment of sustainability experts

Recruitment of sustainability experts is a pure transmitter variable that moderately and positively influences environmental reporting, which, in turn, enhances CEP. Therefore, the following strategy was formulated:

- **Strategy:** companies should recruit sustainability experts to enhance environmental reporting.

Sustainability experts bring specialized knowledge and skills that are crucial for accurate and comprehensive environmental reporting. However, recruiting experts can be expensive. This strategy is most effective for companies with less or limited sustainability experts.

Value chain engagement and implementing digital technologies

Value chain engagement is a pure transmitter variable that strongly and positively influences data management and analysis. Similarly, implementing digital technologies is another pure transmitter variable that also strongly and positively influences data management and analysis. Both of these relationships have an average weight of +0.7 in the aggregated FCM. Based on this, the following strategy was formulated:

- **Strategy:** companies should increase communication and collaboration with its value chain members and implement digital technologies to enhance environmental data management and analysis

Effective communication and collaboration within the value chain are essential for gathering accurate and comprehensive environmental data. By actively engaging with their suppliers, distributors, and other value chain partners, companies can ensure that data collection is consistent and complete. This strategy is particularly beneficial for companies with complex supply chains.

Moreover, the implementation of digital technologies will directly improve data management and analysis. However, it may require significant investment, and integrating digital technologies with existing operations can be complex. Additionally, the implementation of digital technologies will have a greater impact on traditional firms with a low level of digitalization.

6 Discussion

This chapter presents a detailed discussion of the findings of this study. Firstly, the chapter provides the interpretation of findings by highlighting the findings and comparing them with the existing literature in subsection 6.1. Then, subsection 6.2 describes the key contributions of this study. Finally, subsection 6.3 discusses the limitations and generalizability of the study.

6.1 Interpretation of Findings

6.1.1 Identification of Factors

The study identified 26 critical factors influencing CEP within the broad categories of technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures. These factors are highlighted in Table 11. Furthermore, to provide further insights, the study compared the identified factors from the interviews with those in the conceptual framework (Figure 4). The comparison highlighted that most of the factors from the conceptual framework were also identified as influencing factors through the interviews, with the exception of green technological innovation. Moreover, the study highlighted which factors were identified by different stakeholder groups to understand consensus and unique identification among these groups.

Several studies in the existing literature have focused on identifying various factors influencing CEP. For example, some studies have identified the role of organisational culture in influencing influencing environmental performance (Adebayo et al., 2020; Bakhsh Magsi et al., 2018; Ong et al., 2019). Moreover, Abedin et al. (2023) and Hong et al. (2021) have highlighted the impact of corporate governance on CEP. Some studies have also identified the influence of external stakeholder pressures on environmental performance (Jiang & Fu, 2019; L. Wang et al., 2020). Furthermore, some studies have highlighted the technological factors influencing CEP (Ren et al., 2023; Vachon, 2012). In addition, some studies have also considered a wide range of factors; for example, the study by Gold et al. (2022) identified firm-level attributes, industry-specific factors, stakeholder pressure, and country-level attributes that influence corporate sustainability practices. However, Gold et al. (2022) recommended the consideration of technological factors in future research.

This study identified the role of technological factors, organisational culture, corporate governance, and external stakeholder pressures in alignment with the extant literature. In addition, it provides specific factors within these broad factor groups. While several studies in the existing literature have focused on identifying various factors influencing CEP, this study uniquely and holistically identifies, prioritises, and consolidates 26 critical factors within these broad categories.

The study highlighted that several factors like environmental reporting, regulatory pressure, investor pressure, smart target-setting and KPI prioritisation, environmental leadership and data management and analysis were widely acknowledged by a greater number of participants and stakeholder groups, indicating their high relevance in the context of corporate environmental sustainability. In contrast, some concepts, such as entrepreneurial culture and implementing technologies to influence behaviour, were uniquely identified by one participant and are not observed in the existing literature. The identification of these unique factors highlights the need for further investigation to validate their influence and significance within the context of corporate environmental sustainability.

6.1.2 Interactions Among Factors

The study further analysed the interactions and relationships between the identified factors to understand how they collectively influence CEP. The relationships between factors and their influence on CEP were modelled using the aggregated FCM highlighted in Figure 10. Specifically, the aggregated FCM demonstrates how technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures interact to influence CEP. The aggregated FCM was also compared to the conceptual framework developed in Figure 4 to relate the findings. Moreover, the study highlighted which relationships were identified frequently or uniquely by different stakeholder groups to gain further insights. The crucial interactions are discussed in this subsection.

The literature review in section 3 highlighted contradictory results on the relationship between environmental reporting and CEP in the extant literature (Doan & Sassen, 2020). However, this study found that an

increase in environmental reporting does lead to an increase in environmental performance through both direct and indirect effects. Specifically, the study identifies that environmental reporting increases CEP via an increase in continuous performance assessment, smart target-setting & KPI prioritisation, and peer pressure. These relationships also align with some existing findings. For example, the study by Tam et al. (2006) highlights that reporting facilitates identifying and using environmental performance indicators, which can lead to significant improvements in environmental performance. Furthermore, Gomes da Silva & Gouveia (2020) suggests that tracking and monitoring environmental performance minimises environmental impact. Moreover, environmental reporting demands establishing specific, measurable indicators to track progress (Defra, 2011).

Furthermore, environmental reporting is also affected by green values, data management and analysis, recruitment of sustainability experts, and regulatory pressure. This indicates that environmental reporting is influenced by factors from different categories (culture, technology, governance and external stakeholder pressures). Hence, companies and researchers must adopt an integrated approach while studying the factors influencing CEP.

The results also highlighted that regulatory pressure is the most influential external stakeholder pressure in the FCM as it influences specific technological, organisational culture, and corporate governance factors. Specifically, it influences data management and analysis, implementation of sustainable technologies, environmental leadership, environmental reporting, smart target-setting & KPI prioritisation, and external due diligence and validation. In addition, it also influences investor pressure. The study by Manikas & Godfrey (2010) found that environmental regulations push firms to implement technologies to improve their sustainability practices. Moreover, the study by Fallan (2016) found that corporates subject to environmental reporting regulations disclose more types of information relative to those not subject to such regulations. The increase in environmental reporting also requires firms to prioritise KPIs and collect and analyse environmental data. This possibly explains the increase in data management and analysis and smart target-setting and KPI prioritisation due to environmental regulations (Su et al., 2020). Furthermore, the corporate sustainability due diligence directive (CSDDD) that came into force in May 2024 (during this study) also justifies the increase in external due diligence and validation due to regulatory pressures (European Commission, 2024). The interactions through which regulatory pressures influence CEP provide another example to demonstrate that it is necessary to consider the interactions between different factors while investigating their impact on CEP.

The study further finds that environmental leadership increases CEP directly and through various pathways, such as an increase in effective change management, employee engagement, and external due diligence and validation. The study by Xu et al. (2022) suggests that environmental leaders communicate and support an organisation's environmental goals and practices to promote higher engagement levels. Moreover, the study by Cantor et al. (2012) highlighted that effectively engaging employees to support the implementation of environmental practices is crucial for achieving improved environmental performance. One of the ways to increase employee engagement is through workforce training programs. Further, Eileen Graham et al. (2000) suggests that implementing change management techniques can improve the perceived environmental performance, which is influenced by the backing of top management.

In addition, Commer et al. (2020) outlined that firms adopting external environmental audits along with internal environmental management practices exhibit better environmental performance. External audits offer third-party validation, ensuring adherence to environmental standards and reinforcing the credibility of the company's environmental initiatives. This study also finds a strong direct relationship between external due diligence and validation and CEP. The study by L.-P. Fan & Chung (2023) suggests that environmental leadership significantly impacts various aspects of environmental behaviour and management, possibly implying that environmental leaders drive the focus on external due diligence. The extant literature supports that environmental leadership influences CEP through governance practices and organisational culture changes. This further supports the need to take into account the interactions between factors influencing CEP.

Furthermore, the results highlighted that data management and analysis could drive CEP through a strong increase in environmental reporting and a weak increase in implementing sustainable technologies and

SMART target-setting & KPI prioritisation. Moreover, it found that data management and analysis strongly increase with value chain engagement and implementation of digital technologies. The study Xu et al. (2022) found that corporate digital transformation improves CEP by enhancing green technological innovation and corporate governance. The study discusses that digital transformation enhances CEP by improving information sharing, big data applications, and optimising business models. This possibly explains the relationship between data management and analysis and implementing sustainable technologies Xu et al. (2022). Moreover, World Economic Forum (2023) highlighted that addressing and disclosing scope three emissions is challenging because of data availability and quality, which can be tackled by improving value chain collaboration. The pathways through which data management and analysis influence CEP further emphasise the need to consider the interactions among factors influencing CEP.

Apart from the key interactions discussed, it is also necessary to highlight other relationships that can enhance CEP or other influencing factors in the FCM. The results highlight that green values moderately and directly increase CEP while also indirectly influencing CEP through an improvement in environmental reporting. Furthermore, green values are not affected by other variables in the FCM, indicating that green values can consistently increase CEP regardless of changes in other factors. The study by González-Ordóñez (2024) highlighted that corporate environmental values are essential for successful sustainability initiatives within an organisation. Furthermore, it discusses that companies with environmental values and culture are more likely to achieve sustainability goals. One of the ways through which companies can promote environmental values and develop environmental culture is by fostering awareness and responsibility towards environmental issues (González-Ordóñez, 2024). Hence, companies can benefit from fostering a green culture with sustainability-focused values.

Furthermore, the results indicate that recruiting sustainability experts can moderately enhance environmental reporting, which consequently improves CEP. In addition, the recruitment of sustainability experts is also not influenced by other variables in the FCM. This is supported by the findings of (Poolen, 2022), which highlights that most companies struggle with sustainability reporting due to a lack of sustainability expertise and data availability.

In conclusion, the interactions among technological factors, organisational culture, corporate governance, and external stakeholder pressures create a complex network, highlighting the multifaceted nature of enhancing CEP. The FCM approach provides a nuanced understanding of these interactions, revealing that a comprehensive investigation into the combined effects of these factors is crucial for effectively improving CEP. By discussing the interactions through which environmental reporting, environmental leadership, regulatory pressure and data management and analysis influence CEP, the study emphasises the need for an integrated and holistic approach when investigating the impact of factors influencing CEP. In summary, recognising and addressing these interactions among factors is essential for developing effective strategies that drive improvements in CEP.

Feedback Loops

The various interactions in the FCM also lead to different balancing feedback loops in the system. The underlying feedback loops have been highlighted in Figure 15. The balancing feedback loops in the FCM arise because CEP negatively influences investor, community, and customer pressure; however, these external stakeholder pressures also contribute to increasing CEP through their positive relationships with regulatory pressure and environmental reporting. This implies that the balancing feedback loops may lead to CEP stabilizing at a certain performance level. However, the CEP will only stabilize once the external stakeholders are satisfied with the company's CEP. This suggests that companies with low CEP will remain under scrutiny from external stakeholders until they reach the desired CEP level. Furthermore, companies that have achieved the desired CEP score might be able to avoid over-committing to certain resources.

These interactions can be explained through the lens of organisational legitimacy theory. Organisational legitimacy is the alignment between an organisation's activities and the norms of acceptable behaviour within the larger social system Dowling & Pfeffer (1975). When a company demonstrates strong CEP, it aligns itself with societal environmental norms and expectations. This alignment can reduce the pressure from external stakeholders (such as customers, community groups, and investors) because the organisation is perceived as legitimate and responsible. Furthermore, firms with weak CEP will face increased pressure

from these external stakeholder groups.

6.1.3 Strategies to Enhance CEP

This study also formulated strategies that might enable companies to enhance their CEP based on the interactions and relationships between factors. The strategies presented in subsection 5.5 were formulated based on structural and path analysis insights.

The first set of strategies was based on high centrality concepts that focused on the most crucial elements in the system. These concepts directly or indirectly affected CEP through different pathways. The second set of strategies focused on concepts that have a direct high impact on CEP but have a relatively lower degree of centrality. These concepts influence CEP through a direct pathway only. The third set of strategies was based on low-centrality concepts that do not directly influence CEP but impact the concepts in the first two sets of strategies.

Many existing studies and strategies focus on individual factors to enhance environmental performance. For example, Latan et al. (2018) highlights strategies such as using green, sustainable resources and implementing environmental management systems. Some studies indicate that companies can improve their environmental performance by building green teams among employees (Dumont et al., 2017). Other studies recommend investments in environmental-friendly technologies and green products (Li et al., 2016). However, The study by Baumgartner & Ebner (2010) highlights the need for holistic and integrated strategies which combine an internal focus on resources, processes and culture with an external focus on stakeholder expectations. Latan et al. (2018) also discusses the gap in understanding the direct and indirect impacts of an environmental strategy on CEP.

Moreover, Dragomir (2020) highlights that a company's environmental strategies involve a blend of goals and approaches, such as meeting regulatory requirements (compliance) and effectively communicating sustainability efforts. Furthermore, companies can adjust the mix of these elements based on their current needs and management objectives. In addition, Dragomir (2018) discusses that simultaneously optimizing and balancing multiple elements is considered a comprehensive approach.

While a majority of the studies focus on recommending measures based on individual factors, this study demonstrates that strategies can include the interactive effects of different factors to create a more holistic approach to enhancing CEP. This integrated approach enables companies to develop strategies that are adaptive to the complex and dynamic nature of CEP. It should be noted that strategies incorporating the interactive effects of different factors are mainly visible in the first set of formulated strategies. For example, one of the formulated strategies suggests that companies should strengthen environmental leadership by ensuring the presence of environmental leaders in top management. These leaders should be committed to sustainability, focusing on driving CEP by supporting effective change management, employee engagement, and the adoption of external due diligence and validation. This strategy considers the interaction between organizational culture and corporate governance factors.

On the other hand, the second set of formulated strategies is based on direct impact factors, which are also useful and necessary for immediate and focused interventions. However, as discussed, these types of strategies are already prominent in the existing literature.

A decision support tool based on FCM

FCMs have previously been utilised to realise decision support tools for different applications. For example, Oukhay & Romdhane (2022) proposed a decision support framework using FCM for selecting and prioritizing KPIs in line with a company's strategic objectives. Furthermore, Kyriakarakos et al. (2014) presented an FCM decision support system for renewable energy sources (RES) planning at a local or regional level. In addition, Malek (2017) discusses that FCM has demonstrated its effectiveness as a tool for system modelling and decision-making support, opening up possibilities for its use in addressing environmental challenges.

This study provides an FCM template that can be utilized as a decision-support tool by large companies in the Netherlands. The results in subsection 5.5 suggest that different strategies may be suited for different companies. For instance, technological companies might already have advanced data management and analytics capabilities; therefore, further enhancing these areas might not be an impactful strategy. Moreover,

the current state of factors may vary across industries. Therefore, companies can use the FCM template to devise specific strategies based on their current state and confidential information. They can conduct a dynamic analysis of their current state (initial values for concepts in the system) to understand how changes propagate through the system.

The existing literature also highlights some decision-support tools in the context of corporate sustainability. For example, Subramanian et al. (2010) proposed a nonlinear mathematical programming model aimed at assisting manufacturing firms with product design and lifecycle management by considering environmental factors. Furthermore, the literature also discusses environmental system management tools such as monitoring and reporting tools and carbon footprint assessment tools Grecu et al. (2020).

It is evident that the existing decision-support tools focus on specific factors that might assist in improving environmental performance, such as carbon footprint assessment or product lifecycle management. On the other hand, this study provides a customizable and comprehensive framework for enhancing corporate environmental performance in large companies by holistically capturing the interactions between a wide range of technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures.

6.2 Contributions

This research makes several important contributions to the academic field of corporate sustainability and management. Primarily, it fills a significant knowledge gap concerning the interactive effects of the critical factors within technological factors, organisational culture factors, corporate governance factors and external stakeholder pressures influencing CEP. Previous research has often focused on individual factors in isolation, but this study provides a comprehensive understanding of the dynamics at play in corporate environmental sustainability and management by exploring these interactions.

The study uniquely and holistically identifies, prioritises, and consolidates 26 critical factors influencing CEP within technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures. Furthermore, this study establishes that interactions among factors do influence CEP. Hence, future research should take an integrated and holistic approach when investigating the impact of factors influencing CEP.

Moreover, the study provides an FCM template that visualizes and explains the complex causal interrelationships between the identified factors. The modelled FCM can be utilized as a decision-support tool by large companies in the Netherlands to devise specific strategies that could enable them to improve their CEP.

In addition, the study demonstrates that strategies to influence CEP can include the interactive effects of different factors to create a more holistic approach to enhancing CEP. By considering these interrelationships, companies can develop more nuanced and effective strategies that do not merely target individual factors in isolation but rather address the broader system of influences.

6.3 Limitations

The study has some limitations that should be acknowledged, as they influence the interpretation and generalizability of the results and may also suggest potential directions for future research.

The participants for the interview were sampled using purposive sampling. This method significantly relies on the researcher's judgment for participant selection, which can inherently introduce subjectivity and potential bias ATLAS.ti (2024b). Furthermore, as samples are chosen based on specific criteria or characteristics, they may not sufficiently capture the diversity and variability of the broader population. To counter the potential lack of diversity and variability, the study sampled participants from various stakeholder groups, including large companies, consulting and professional services, researchers, ESG rating companies, and international environmental organisations. This broad range ensures a variety of perspectives and experiences are captured. Additionally, the study aimed to select companies based on different CEP scores to incorporate the challenges and opportunities faced by companies with different levels of CEP. Moreover, within the companies, participants were chosen from various organisational levels, including senior management, middle management, and operational staff. However, only one of the

participants belonged to the 'large company' stakeholder group.

Another limitation of this research is the potentially limited sample size, which could impact the generalizability of the results. The study utilised an accumulation curve to determine the appropriate sample size, ensuring that saturation (new concepts identified per additional interviewee) was reached early. While the sample size did reach the saturation point, additional interviews could have been conducted to ensure that the saturation point was definitively reached. Moreover, it should be acknowledged that the study concentrated on experts working in organisations or bodies located in the Netherlands. This geographical focus was aimed at making the findings relevant to the specific regulatory, cultural, and market conditions of the Dutch context, as the scope of the study was focused on large companies in the Netherlands. However, the unique cultural, organisational, and contextual factors of this specific environment might impact the generalizability of the results and may not be applicable to other settings.

Furthermore, the construction of FCMs relies heavily on expert knowledge, which introduces subjectivity. In this study, the FCM is constructed based on individual semi-structured interviews where a key concern is that directing the conversation can unintentionally influence the interviewee's responses. This issue was mitigated by consistently following the interview design with open-ended questions. Furthermore, the participants were first asked to highlight concepts without presenting them with a pre-defined list of concepts, which could possibly introduce bias. In addition, the homogenisation of concepts and the assigning of weights also introduces subjectivity (Malek, 2017). To mitigate the subjectivity in the homogenisation of concepts, the study employed consistent terminology across all individual maps. This was achieved through open coding of interview transcripts and grouping similar codes together into broader concepts. This process ensured consistency and clarity in the final analysis. Furthermore, the assignment of weights relied on the subjective interpretation of the researcher's understanding of the emphasis and examples provided by participants. Participants' varying communication styles and levels of expressiveness might lead to inconsistent emphasis, which can affect weight assignment. To mitigate some of these limitations, the criteria for categorisation of weights were clearly defined. Furthermore, the aggregation of maps involved averaging the weights, which assumes equal validity and comparability of all participants' views. This may not reflect the true variability in expertise among participants.

In addition, the FCM captures the relationships among factors at a specific moment. It represents the current understanding of how these factors interact to influence CEP. Hence, it might be necessary to modify the FCM to include changing conditions or emerging knowledge (Apostolopoulos et al., 2024). However, the developed FCM can be easily adjusted and updated at any time (Malek, 2017).

Moreover, the analysis of results involved assigning a default weight of 0.1 to relationships mentioned by only one participant. Furthermore, the formulation of strategies was based on only strong and moderate relationships. Even though these steps do assist in enhancing the credibility of the findings, they might oversimplify potentially significant but less frequently mentioned relationships.

Even though several steps were taken to counter these limitations, FCMs heavily rely on the subjective nature of data. While this approach allows for a deep understanding of complex systems, it might influence the validity of the findings. Hence, validation of the results is an essential step that should be taken in future research.

7 Conclusion

The primary objective of this study was to support large companies in the Netherlands in improving their CEP by analyzing and identifying the interplay of the most critical factors within technological factors, organizational culture, corporate governance, and external stakeholder pressures that significantly impact CEP. This research was guided by the following main research question:

How can large companies utilize the interplay of technological factors, organisational culture, corporate governance, and external stakeholder pressures to enhance corporate environmental performance?

This research question was answered by addressing the following sub-questions:

SQ1: How is CEP defined and characterized?

To answer SQ1, this study conducted a literature and desk research that provided a comprehensive overview of CEP definitions and measurements from academic and practical perspectives. Based on this review, CEP in this study was conceptualized using the broad categories defined by the CSRD. These categories include climate change mitigation and adaptation, water and marine resources, resource use and circular economy, pollution, and biodiversity. The alignment of CEP with the CSRD broad categories was driven by the need for comprehensive coverage, regulatory alignment, comparability, stakeholder relevance, and a holistic approach to corporate environmental sustainability.

SQ2: What are the technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures that are associated with corporate environmental performance?

Through a combination of literature review and expert interviews, the study identified the key factors within these four domains that are associated with CEP. The study identified a total of 26 factors associated with CEP, including 5 technological factors, 5 organisational culture factors, 11 corporate governance factors, and 5 factors representing external stakeholder pressures.

Among these, the key technological factors identified included data management and analysis, implementation of digital technologies, and implementation of sustainable technologies. Furthermore, the key organisational culture factors identified included environmental leadership, employee engagement, green values, and greenwashing culture. Moreover, the key corporate governance factors included environmental reporting, continuous performance assessment, SMART target-setting and KPI prioritization, external due diligence and validation, and effective change management. Lastly, the key external stakeholder pressures included regulatory, investor, community, and peer pressure.

SQ3: How do technological factors, organisational culture factors, corporate governance factors, and external stakeholder pressures interact to influence CEP?

The study modelled the relationships between the identified factors and their influence on CEP using the aggregated FCM. The findings reveal that the interactions among technological factors, organizational culture, corporate governance, and external stakeholder pressures form a complex network. The key interactions within this network are highlighted below.

The study shows that environmental reporting (a corporate governance factor) positively influences CEP through both direct and indirect interactions. Specifically, it was found that environmental reporting enhances CEP by driving improvements in continuous performance assessment, SMART target-setting & KPI prioritization, and peer pressure. Moreover, environmental reporting itself is influenced by green values, data management and analysis, recruitment of sustainability experts, and regulatory pressure. This indicates that environmental reporting is shaped by factors across different domains — culture, technology, governance, and external stakeholder pressures.

The results also highlight that regulatory pressure is the most influential external stakeholder pressure, as it impacts specific technological, organizational culture, and corporate governance factors. Specifically, it affects data management and analysis, implementation of sustainable technologies, environmental leadership, environmental reporting, SMART target-setting & KPI prioritization, external due diligence and validation, and investor pressure.

The study further finds that environmental leadership increases CEP directly and through various pathways, such as enhancing effective change management, employee engagement, and external due diligence and validation. These interactions highlight the interplay between organisational culture and corporate governance factors.

The findings highlight that the broad factor groups do not behave uniformly; instead, specific factors within each domain exhibit diverse and varied interactions. This highlights the complex and multifaceted nature of the interactions influencing CEP.

SQ4: Which strategies might enable large companies to enhance their CEP?

Based on the insights from the structural analysis and path analysis of the aggregated FCM, the study formulated 14 different strategies that might enable large companies to improve their CEP. The first set of strategies is based on the concepts with the highest centrality, while the second set is derived from concepts with a strong or moderate direct impact. Therefore, the first two sets of strategies are priority strategies. Furthermore, the third set of strategies provides additional measures that companies can adopt to enhance the concepts addressed in the first or second set.

The first set of strategies also demonstrates how companies can formulate strategies that include the interactive effects of different factors to create a more holistic approach to enhancing CEP.

Furthermore, the study discusses that different strategies might be suited to different companies based on their current state. For example, technological companies with strong data management and analytics capabilities might benefit more from strategies other than enhancing data management and analytics capabilities. Hence, the study emphasizes that companies can use the FCM template to devise specific strategies based on their current state and confidential information.

First Set of Strategies: High Centrality Concepts

1. Companies should enhance their environmental reporting to better inform continuous performance assessment, as well as SMART target-setting and KPI prioritization.
2. Companies should prioritize regulatory compliance while proactively leveraging regulatory pressures to enhance data management and analysis, implement sustainable technologies, strengthen environmental leadership, increase SMART target-setting and KPI prioritization, and adopt external due diligence and validation.
3. Companies should strengthen environmental leadership by ensuring the presence of environmental leaders in top management. These leaders should be committed to sustainability, focusing on driving CEP by supporting effective change management, employee engagement, and the adoption of external due diligence and validation.
4. Companies should enhance data management and analytics capabilities to support environmental reporting, SMART target-setting & KPI prioritization, and the implementation of sustainable technologies.
5. Corporates should define specific, measurable, achievable, realistic, and time-bound (SMART) targets and should select and prioritize key performance indicators.
6. Companies should enhance their continuous performance assessment processes by regularly evaluating and monitoring environmental performance against specific key performance indicators to derive actionable insights.
7. Companies should adopt an independent third-party environmental organization to assess, verify, evaluate, and validate the existing environmental practices, targets, and performance.

Second Set of Strategies: Direct Impact Concepts

8. Companies should incorporate effective change management practices.
9. Companies should increase the adoption and implementation of sustainable technologies.

10. Companies should integrate sustainability-focused values and principles into their organizational culture.
11. Companies should enhance employee engagement by fostering their employees' enthusiasm, commitment, and involvement in the organization's sustainability goals.
12. Corporates should actively work to eliminate greenwashing culture and practices.

Third Set of Strategies: Low Centrality Transmitter Concepts

13. Companies should recruit sustainability experts to enhance environmental reporting.
14. Companies should increase communication and collaboration with their value chain members and implement digital technologies to enhance environmental data management and analysis.

In conclusion, this study contributes to the academic field of corporate sustainability and management by filling a significant knowledge gap concerning the interplay of critical factors influencing CEP. Furthermore, the study informs how large companies can utilize the interplay of technological factors, organizational culture factors, corporate governance factors, and external stakeholder pressures to enhance CEP.

7.1 Implications of the Findings

The key theoretical, practical, and policy implications of the findings of this study have been summarized in this subsection.

Theoretical Implications

The study advances the theoretical understanding of corporate environmental sustainability and management by uncovering the interplay of technological factors, organizational culture, corporate governance, and external stakeholder pressures in influencing CEP.

The study holistically identifies and consolidates the critical factors influencing CEP within these four domains. Furthermore, it demonstrates the pathways and interactions through which these factors influence CEP. The developed FCM, which models the interactions among the identified factors, offers a theoretical basis for understanding the causal interrelationships, which can inform future research. Additionally, the study emphasizes that future research on factors influencing CEP should adopt an integrated and holistic approach by considering the interactions among these factors.

The insights gained from this study can guide future research directions and inform theoretical advancements in the fields of corporate environmental and sustainability management, organizational behaviour, and strategic management.

Practical Implications

The study highlights 14 strategies that might enable large companies in the Netherlands to improve their CEP. Furthermore, the study encourages companies to formulate strategies that include the interactive effects of different factors to create a more holistic approach to enhancing CEP. By considering the interplay between the identified factors, companies can develop more nuanced and effective strategies that do not merely target individual factors in isolation but rather address the broader system of influences.

Moreover, the study provides an FCM template that companies can use as a decision-support tool, enabling them to map out the various factors affecting their environmental performance and understand how these factors interact. By using the FCM, companies can identify key leverage points where interventions are likely to have the greatest impact. The model helps decision-makers understand the potential outcomes of different strategic choices and allows them to simulate how changes in one area might affect others. Additionally, companies can devise specific strategies by taking into account their unique circumstances, industry, and external environment.

Policy Implications

This study emphasizes the significant impact of regulatory pressure on CEP. It demonstrates the interactions through which regulatory pressures influence CEP, suggesting that policymakers can focus on leveraging factors not currently influenced by regulatory pressures, such as green values and employee engagement.

Additionally, policymakers could consider the interactions through which CEP is influenced to devise more effective policies.

7.2 Future Research

Based on the findings and limitations of the study, various recommendations are derived for future research.

Firstly, validating the aggregated FCM and the developed strategies is crucial to ensure the real-life applicability of the findings. Hence, researchers can organize workshops with focus groups consisting of experts from the identified stakeholder groups who can provide valuable insights into the practicality and relevance of the aggregated FCM and the formulated strategies. These workshops can be utilized to discuss strategies, gather feedback and make necessary adjustments based on the collective input of the participants (Penn et al., 2013)

Furthermore, researchers can conduct a sensitivity or scenario analysis to validate the developed FCM. A sensitivity analysis can be carried out by varying the values of different factors in the developed FCM and observing the resulting changes in CEP (Kolk & Pinkse, 2008). The sensitivity analysis can help determine how variations in certain factors influence CEP. Furthermore, scenario analysis can simulate different potential future scenarios and their impact on CEP.

Researchers can also integrate quantitative methods using real data such as regression models, structural equation modelling, or simulation techniques to provide a more robust validation of the findings (Huang et al., 2019). Quantitative methods allow for the verification of the relationships identified in the FCM and the quantification of the impact of different factors on CEP.

The study also recommends expanding the sample size and diversity in future studies. These studies can include more companies from different sectors in the sample. Furthermore, they can include experts from regulatory bodies and NGOs. This will provide a more comprehensive understanding of the factors influencing CEP and the effectiveness of the developed strategies.

Additionally, future studies should consider exploring the interactions of the weak relationships identified in this study. Investigating these additional factors and their interactions will provide a more holistic understanding of the influences on CEP and help develop more comprehensive and effective strategies.

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Appendices

A Data Collection

A.1 Participant Recruitment List

Potential participants from large companies

Table 13: Participant recruitment list for the 'large companies' stakeholder group

Company Code	Sector	CEP Score	Participant Role
C1	Banking & Financial Services	NA	Audit Manager - Transition & Sustainability
C2	Material & Equipment Manufacturing	Q1	Corporate Sustainability Strategy Manager
C2	Material & Equipment Manufacturing	Q1	Change Manager ESG Sustainability Strategy
C2	Material & Equipment Manufacturing	Q1	ESG Sustainability Strategy Manager
C3	Food & Beverages Manufacturing	Q1	Senior Circular Economy Manager
C3	Food & Beverages Manufacturing	Q1	Senior Performance & Sustainability Manager
C3	Food & Beverages Manufacturing	Q1	Innovation Realisation Office Manager
C4	Financial Services	Q1	ESG Business Analyst
C5	Retail	Q1	Sustainability Analytics Lead
C6	Energy	Q2	Strategy Consultant
C6	Energy	Q2	ESG Advisor
C6	Energy	Q2	Sustainability Transformation Manager
C7	Food & Beverages Manufacturing	Q2	Carbon Reporting Specialist
C7	Food & Beverages Manufacturing	Q2	Sustainability Manager
C7	Food & Beverages Manufacturing	Q2	Sustainability Manager
C8	Banking & Financial Services	Q3	Lead - Climate Alignment Strategy
C9	Manufacturing	Q3	Director Sustainability Insights
C9	Manufacturing	Q3	ESG Consultant
C9	Manufacturing	Q3	Senior Supplier Sustainability Manager
C10	Banking & Financial Services	Q3	Director Sustainability Advisory
C11	Food & Beverages Manufacturing	Q4	Sustainability Manager
C12	Manufacturing	Q4	Sustainability Lead - Climate Action
C12	Manufacturing	Q4	ESG Transformation Manager
C13	Utilities	NA	Business Analyst - Sustainability
C14	Retail	NA	Sustainability Manager

Potential participants from other stakeholder groups

Table 14: Participant recruitment list per stakeholder group

Group	Organization Code	Participant Role
Consulting	G1	Sustainability/digital integration manager
	G1	Sustainability and Innovation lead
	G1	Senior manager sustainability manager
	G1	Manager net zero transitions
	G1	Sustainability Reporting Analyst
	G1	Consultant
	G1	Sustainability strategy and consultant
	G1	Manager Business strategy
	G1	Strategy Analyst
	G1	Senior analyst - sustainability strategy
	G2	Manager sustainability and strategy
	G3	Senior solution analyst
Researchers	A1	Professor - Corporate responsibility & sustainability
	A2	Associate professor/ IEA member
	A3	Assistant professor - International Business & Sustainability
	A4	Professor - sustainability reporting
	A5	Global business and sustainability RSM
	A6	Full Professor - Business & Sustainability
	A7	Full Professor - Corporate responsibility & sustainability
	A9	Global business and sustainability RSM
ESG rating	E1	ESG research & Sustainability Consultant
	E1	Analyst - ESG insights, corporate solutions
	E1	ESG research senior analyst
	E2	Vice President
	E2	Senior Associate
	E2	Corporate sustainability specialist
	E2	BD manager sustainability
Regulatory	R1	Sr. Policy Advisor
	R1	Policy Officer
	R1	Policy Officer
	R1	Senior Policy officer
	R1	Supervisory board member
	R2	Senior Policy Officer
	R2	Policy Director
	R3	Project Leader
	R3	Team leader
International environmental organization	S1	Target Validation Manager
	S1	Head of Validation
	S1	Energy sector Manager
	S1	Net-zero manager
	S2	Senior Manager
	S2	Manager - ESG data policy and regulation
	S2	Reporter services senior manager
	S2	Technical Manager climate change
NGOs	N1	Senior Substantive Climate Plans
	N1	Sr. policy officer climate justice & mobility
	N2	Manager partners and sectors
	N2	International Team Lead

Group	Organization Code	Participant Role
Research organization	T1	Senior Consultant
	T1	Corporate Strategy Analyst
	T1	Head of corporate sustainability
	T2	Sustainable supply chain & Market Researcher
	T2	Assistant Policy researcher
	T3	Senior Researcher
	T3	Senior Researcher

A.2 Informed Consent Form

1. **Title of Research Study**: Enhancing Corporate Environmental Performance of Large Companies: A Fuzzy Cognitive Mapping Approach
2. **Researcher(s):** Rishi Chalwade (master's student) from TU Delft
3. **Purpose of the Study:** The research study aims to uncover the interplay of different factors influencing corporate environmental performance (CEP). The study will map the findings from the interviews and the results will be used to provide recommendations to the companies. The expected duration of your participation is approximately 45 minutes. The findings from this study will be used for academic publications (thesis repository of TU Delft)
4. **Study Procedures:** You will be asked to participate in a semi-structured interview where you will share your experiences, perspectives, and insights related to corporate environmental performance. The questions will explore areas such as factors influencing CEP, relationships between factors and the strengths of the relationships.
5. **Confidentiality and Privacy:** The study involves collection of interview audio recordings and interview transcripts. The data will be stored securely in the TU Delft institutional storage to which only the student intern and the supervisory committee of the thesis at TU Delft will have access. All personal data except the role and experience will be destroyed one month after the project completion (approximate date - 30th September 2024). The anonymized interview summary will be made publicly available with the MSc thesis report. The responses, views or other input can be quoted anonymously in research outputs.
6. **Voluntary Participation:** Your participation in this study is entirely voluntary. You have the right to withdraw at any time without penalty. You may also choose not to answer any questions you do not feel comfortable with. Please note that the interview will be audio recorded for analysis purposes.
7. **Contact Information:** Should you have any questions or require further information about the research, please contact:
    - Name: Rishi Chalwade
    - Email: -

Declaration on consent:

Consent to Participate: By proceeding to the interview, you acknowledge that you have read and understood this consent form and agree to participate in the research study under the conditions outlined above. Please sign and date this form to indicate your consent to participate in the study. A copy of this consent form will be provided to you for your records.

Signature of Participant:

Date:

A.3 Phase 1 Interview Output (Example)

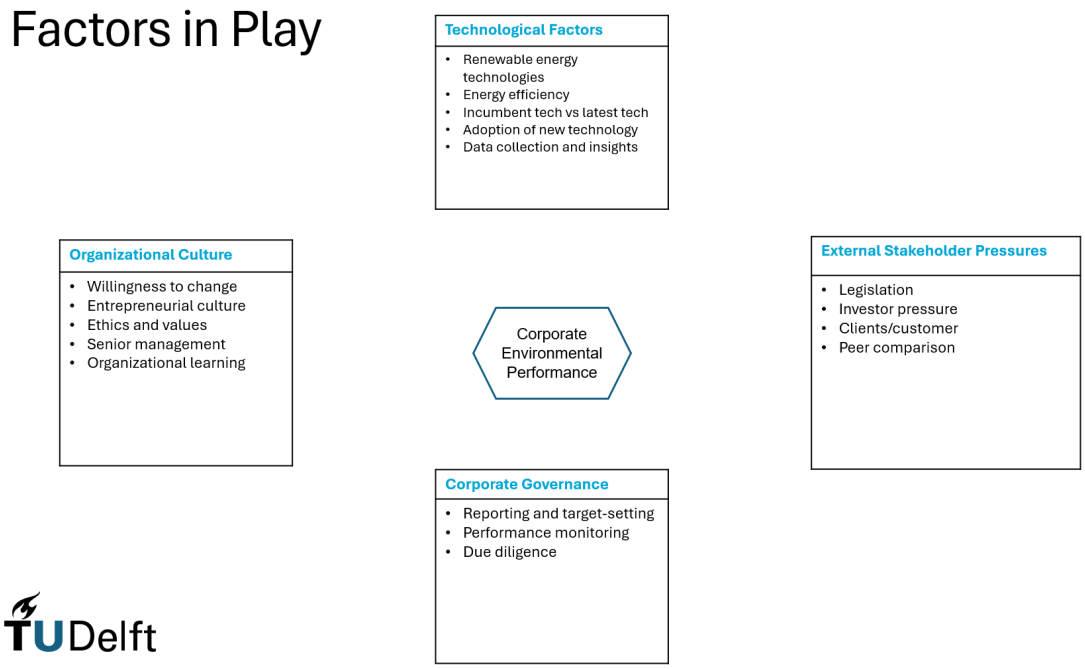

Figure 16: Output from phase 1 of the Interview (Example)

B Data Analysis

B.1 Open Coding - Homogenisation

The concepts, their definitions, their broad factor category and the codes that were grouped to form the concept can be seen in Table 15.

Table 15: List of factors influencing CEP, with their factor group, definition and codes

Factor group	**Concepts\code groups**	**Definition**	**Codes**
-	CEP	Corporate environmental performance as conceptualized in this study	CEP, environmental performance, corporate environmental performance
Corporate governance	Effective change management	Involves steering organizational change from its initial planning stages, through its execution, and ultimately to resolution (Stobierski, 2020)	change management, shift, change, integral change, willingness to change
	Inter-department coordination	Collaboration and communication between organizations	Inter-department coordination, coordination across departments
	Integrated sustainability champions	Individuals within an organization who actively advocate for sustainable behaviour and implementation of sustainable practices across all departments	sustainability champions as part of the teams, sustainability champions, sustainability heroes
	Recruitment of sustainability experts	Hiring professionals with specialized knowledge and skills in sustainable practices	Hiring sustainability specialists, sustainability director, recruiting sustainability experts
	Workforce training	Providing employees with the necessary skills and knowledge	training the staff, trainings, training sessions
	Environmental Reporting	Practice of documenting and disclosing detailed information about an organization's environmental impact	report, reporting

Factor group	Concepts\code groups	Definition	Codes
	Continuous performance assessment	Continuous process of evaluating and monitoring performance against specific key performance indicators and also deriving insights from it	Continuously assessing performance, performance monitoring, performance assessment
	SMART target-setting & KPI prioritization	Involves defining specific measurable, achievable and time-bound objectives and selecting and focusing on key performance indicators	SMART targets, specific and measurable targets, realistic targets, clear KPIs, KPI setting, KPI prioritization
	Internal control policies	Involves introducing internal protocols for environmental management	internal control policies, internal control
	External due diligence & validation	Having an independent third party (specialized in environmental sustainability) assess, verify, evaluate and validate the environmental practices, targets and performance	environmental audits, due diligence, validating targets
	Value chain engagement	Active collaboration and communication with all stakeholders involved in the value chain	having conversations with value chain members, collaborating with value chain, value chain engagement
External stakeholder pressure	Peer pressure	Influence exerted by the organization's peer group	competitors, peers, peer pressure, peer benchmarking
	Regulatory pressure	Influence exerted by laws, regulations, and government policies	regulations, regulatory pressure, policies, CSRD, EU taxonomy, legislations
	Investors pressure	Influence exerted by shareholders and potential investors	investor pressure, investors, shareholder pressure
	Community pressure	Influence exerted by non-governmental organizations, activist groups, and local communities	NGOs, activist groups, public, community pressure
	Customer/client pressures	Pressure from customers, clients and suppliers	customer pressure, clients

Factor group	Concepts\code groups	Definition	Codes
Organizational culture	Environmental leadership	Attitude, motivation, focus and behaviour of leadership towards sustainability	attitude of CEO, board focus, CEO focus, leadership motivation, leadership focus, top management alignment, sustainability at leadership level
	Employee Engagement	Degree of enthusiasm, commitment an involvement of employees towards their organizations and goals (Smith, 2024)	employee engagement, engaging employees
	Green values	Values and principles within an organization that focus on sustainability	"baked into their culture that they nurture all the natural resources", business values, principles, ethics, values, spirit to become more green
	Entrepreneurial culture	Culture that promotes entrepreneurship, innovation, creativity and risk-taking	entrepreneurial culture, more entrepreneurial
	Greenwashing culture	Involves promoting norms that misleadingly present the organizations as environmentally friendly	Greenwashing
Technological	Data management & analysis	Process of systematically handling data (collecting, storing and organizing) as well as analysing data to guide decision-making	data collection, data storage, data insights, real-time data, capture and work with data, data analysis, data availability
	Implementing sustainable technologies	Technologies that directly assist in improving the environmental impact (across the indicators of CEP)	sustainable energy technologies, adopting renewable energy, tech directly associated with decarbonization, carbon capture & storage, waste-management technologies, energy-management systems

Factor group	Concepts\code groups	Definition	Codes
	Implementing digital technologies	Integrating digital tools and systems	digital tools, digital technologies, data platforms, gen AI, technological systems to capture data, AI/data-mining/machine learning for data analysis, IT technology, enterprise resource planning (ERP) systems
	Implementing tech to influence behaviour	Using technologies to guide and influence people's behaviour	technologies to influence behaviour, "using AI to help employees in understanding what they could do to perform better on environmental impact"
	Incremental innovation	Refers to the process of making gradual improvements to existing products, services, or technologies over time	incremental innovations, incremental technologies

B.2 Factors Excluded from Individual FCMs

Table 16: Reasons for exclusion of certain Concepts

Concept	Definition	Reason for Exclusion
External Shocks	Unexpected event or change originating outside an organization (e.g., Geopolitical tensions and climate disasters)	Outside the scope of the study
Material Availability	Accessibility and supply of raw materials or components needed for production and operations	Outside the scope of the study
Financial Mechanisms	Mechanisms to raise, manage and distribute funds. E.g., Loans, bonds and investments	Outside the scope of the study
CSR-linked compensation	Employees pay and bonuses tied to corporate social responsibility	Relationship not identified with any factors in the system
Top talent attraction	Attracting highly skilled individuals	Is not affecting any other factor in the system

B.3 Individual FCMs

Participant P1

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											0.9
Data management & analysis																											
Implementing sustainable technologies																											0.9
Implementing digital technologies																											
Implementing tech to influence behaviour																											
Environmental leadership																											
Effective change management																											
Employee engagement																											
Green values																											
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																											
Integrated sustainability champions																											
Recruitment of sustainability experts																											
Workforce training																											0.5
Environmental reporting																											
Continuous performance assessment																0.5											
SMART target-setting & KPI prioritization																											
Internal control policies																											
Peer pressure																											
External due diligence & validation																											
Value chain engagement																											
Regulatory pressure																0.5		0.1									
Investor pressure																0.5	0.1	0.1									
Community pressure																											
Customer/client pressure																											
CEP																											

Figure 17: Individual FCM - participant P1

Participant P2

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis			0.1													0.9											
Implementing sustainable technologies																											
Implementing digital technologies		0.9																									
Implementing tech to influence behaviour																											
Environmental leadership							0.9	0.5									0.1	0.1									0.9
Effective change management																											0.9
Employee engagement																											0.9
Green values																											
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																											
Integrated sustainability champions																											
Recruitment of sustainability experts																											
Workforce training																											
Environmental reporting																	0.5	0.5									0.5
Continuous performance assessment																											
SMART target-setting & KPI prioritization																											
Internal control policies																											
Peer pressure																											
External due diligence & validation																											
Value chain engagement		0.9																									
Regulatory pressure		0.9				0.1										0.9		0.5						0.5			
Investor pressure																0.1											
Community pressure																											
Customer/client pressure																											
CEP																											

Figure 18: Individual FCM - participant P2

Participant P3

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis			0.5													0.1		0.1									
Implementing sustainable technologies																											0.5
Implementing digital technologies		0.9																									
Implementing tech to influence behaviour																											
Environmental leadership																											
Effective change management																											0.5
Employee engagement																											
Green values																											
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																											
Integrated sustainability champions							0.1									0.1											
Recruitment of sustainability experts																											
Workforce training																											
Environmental reporting																											0.5
Continuous performance assessment																											
SMART target-setting & KPI prioritization																											
Internal control policies																											
Peer pressure																											
External due diligence & validation																											
Value chain engagement																											
Regulatory pressure		0.9														0.9		0.9			0.5			0.1			
Investor pressure																0.1											
Community pressure																0.1											
Customer/client pressure																0.1											
CEP																								-0.9	-0.9	-0.9	

Figure 19: Individual FCM - participant P3

Participant P4

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																											
Implementing sustainable technologies																											0.9
Implementing digital technologies																											
Implementing tech to influence behaviour							0.9	0.9																			
Environmental leadership							0.5														0.5						0.9
Effective change management																											0.5
Employee engagement																											0.1
Green values																											0.5
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																											-0.5
Integrated sustainability champions																											
Recruitment of sustainability experts																											
Workforce training																											
Environmental reporting																											
Continuous performance assessment																											
SMART target-setting & KPI prioritization																											
Internal control policies																											
Peer pressure																											
External due diligence & validation																											0.9
Value chain engagement		0.9																									
Regulatory pressure			0.1			0.9																					
Investor pressure																											
Community pressure																							0.1				
Customer/client pressure																											
CEP																											

Figure 20: Individual FCM - participant P4

Participant P5

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																0.9	0.9										
Implementing sustainable technologies																											0.9
Implementing digital technologies		0.5																									
Implementing tech to influence behaviour																											
Environmental leadership																	0.1	0.1			0.5						
Effective change management																											
Employee engagement																											
Green values																											
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																	-0.5							0.5	0.5		-0.9
Integrated sustainability champions																	0.1	0.1			0.5						
Recruitment of sustainability experts																0.5		0.5									
Workforce training																											
Environmental reporting																	0.5										
Continuous performance assessment																											0.9
SMART target-setting & KPI prioritization																	0.1										
Internal control policies																											
Peer pressure																					0.1						
External due diligence & validation																											
Value chain engagement																											
Regulatory pressure																0.1					0.1						
Investor pressure																0.1											
Community pressure																											
Customer/client pressure																											
CEP																								-0.5	-0.5		

Figure 21: Individual FCM - participant P5

Participant P6

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																0.1		0.5									
Implementing sustainable technologies																											
Implementing digital technologies		0.5																									
Implementing tech to influence behaviour																											
Environmental leadership																											0.5
Effective change management																											
Employee engagement																											
Green values																											
Inter-department coordination		0.5														0.5											
Entrepreneurial culture																											
Greenwashing culture																											-0.1
Integrated sustainability champions																											
Recruitment of sustainability experts																0.5											
Workforce training																											
Environmental reporting																											0.9
Continuous performance assessment																											0.5
SMART target-setting & KPI prioritization																											
Internal control policies																											
Peer pressure																											
External due diligence & validation																											
Value chain engagement		0.1																									
Regulatory pressure																0.5		0.1									
Investor pressure																											
Community pressure																											
Customer/client pressure																											
CEP																								-0.5		-0.1	

Figure 22: Individual FCM - participant P6

Participant P7

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																											
Implementing sustainable technologies																											0.5
Implementing digital technologies																0.5											
Implementing tech to influence behaviour																											
Environmental leadership																		0.5									
Effective change management																											
Employee engagement																											
Green values																											
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																											
Integrated sustainability champions																											
Recruitment of sustainability experts																											
Workforce training																											
Environmental reporting																											
Continuous performance assessment																											
SMART target-setting & KPI prioritization																											
Internal control policies																											
Peer pressure																											
External due diligence & validation																											
Value chain engagement																											
Regulatory pressure																											
Investor pressure																											
Community pressure																											
Customer/client pressure																											
CEP																											

Figure 23: Individual FCM - participant P7

Participant P8

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																0.9											
Implementing sustainable technologies																											
Implementing digital technologies		0.9																									
Implementing tech to influence behaviour																											
Environmental leadership								0.5							0.9				0.5								0.5
Effective change management																											
Employee engagement																											
Green values																0.5											
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																											
Integrated sustainability champions																											
Recruitment of sustainability experts																0.1											
Workforce training																											
Environmental reporting																		0.5		0.5							
Continuous performance assessment																											
SMART target-setting & KPI prioritization																											
Internal control policies																											0.9
Peer pressure																											0.5
External due diligence & validation																											
Value chain engagement																											
Regulatory pressure		0.1				0.9										0.9								0.5			
Investor pressure																0.9											
Community pressure																											
Customer/client pressure																											
CEP																										-0.5	

Figure 24: Individual FCM - participant P8

Participant P9

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																											0.5
Implementing sustainable technologies																											0.5
Implementing digital technologies		0.9																									
Implementing tech to influence behaviour																											
Environmental leadership																											
Effective change management																											0.9
Employee engagement																											
Green values																											0.9
Inter-department coordination																											
Entrepreneurial culture			0.9	0.9			0.5																				
Greenwashing culture																											
Integrated sustainability champions																											
Recruitment of sustainability experts																											
Workforce training																											
Environmental reporting																	0.9			0.5							
Continuous performance assessment																											0.9
SMART target-setting & KPI prioritization																											0.5
Internal control policies																											
Peer pressure																											0.5
External due diligence & validation																											0.9
Value chain engagement																											
Regulatory pressure			0.9	0.9												0.9		0.9									
Investor pressure			0.9	0.9													0.5				0.5						
Community pressure																											
Customer/client pressure																											
CEP																										-0.5	

Figure 25: Individual FCM - participant P9

Participant P10

Concepts	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27
Incremental innovation																											
Data management & analysis																0.5											
Implementing sustainable technologies																											
Implementing digital technologies		0.5																									
Implementing tech to influence behaviour																											
Environmental leadership									0.5							0.5											0.9
Effective change management																											
Employee engagement																											
Green values																0.5		0.5									0.5
Inter-department coordination																											
Entrepreneurial culture																											
Greenwashing culture																-0.1											-0.5
Integrated sustainability champions																											
Recruitment of sustainability experts																											
Workforce training																											
Environmental reporting																											
Continuous performance assessment																											
SMART target-setting & KPI prioritization																											0.9
Internal control policies																											
Peer pressure																											
External due diligence & validation																											
Value chain engagement		0.9																									
Regulatory pressure																0.9					0.5						
Investor pressure																0.5											
Community pressure																							0.9				
Customer/client pressure																											
CEP																								-0.5			

Figure 26: Individual FCM - participant P10

B.4 Bubble Chart Analysis

Python code for visualisation

```
import matplotlib.pyplot as plt
import pandas as pd

#Data
data_final_updated = {
"Concepts": [
"Incremental innovation", "Data management & analysis", "Implementing sustainable technologies",
"Implementing digital technologies", "Implementing tech to influence behaviour", "Environmental leadership",
"Effective change management", "Employee engagement", "Green values", "Inter-department coodination",
"Entrepreneurial culture", "Greenwashing culture", "Integrated sustainability champions",
"Recruitment of sustainability experts", "Workforce training", "Environmental reporting",
"Continuous performance assessment", "SMART target-setting & KPI prioritization", "Internal control policies",
"Peer Pressure", "External due diligence & validation", "Value chain engagement", "Regulatory pressure",
"Investors & shareholder pressure", "Community pressure", "Customer/client pressures"
],
"Outdegree": [
0.10, 1.37, 0.70, 0.73, 0.20, 3.17, 0.70, 0.50, 1.23, 0.20, 0.30, 1.03, 0.50, 0.50, 0.10, 2.27, 0.87, 0.80,
0.10, 0.60, 0.90, 0.70, 3.80, 0.81, 0.60, 0.10
],
"Indegree": [
0.00, 2.16, 1.00, 0.30, 0.00, 0.63, 1.00, 0.60, 0.10, 0.00, 0.00, 0.00, 0.00, 0.00, 0.10, 3.18, 1.23, 1.93,
0.10, 0.50, 1.17, 0.00, 0.50, 1.07, 0.80, 0.50
],
"Centrality": [
0.10, 3.53, 1.70, 1.03, 0.20, 3.81, 1.70, 1.10, 1.33, 0.20, 0.30, 1.03, 0.50, 0.50, 0.20, 5.45, 2.10, 2.73,
0.20, 1.10, 2.07, 0.70, 4.30, 1.88, 1.40, 0.60
],
"Factor Group": [
"Technological", "Technological", "Technological", "Technological", "Technological", "Organisational culture",
"Corporate governance", "Organisational culture", "Organisational culture", "Corporate governance",
"Organisational culture", "Organisational culture", "Corporate governance", "Corporate governance",
"Corporate governance", "Corporate governance", "Corporate governance", "Corporate governance",
"Corporate governance", "External stakeholder pressure", "Corporate governance", "Corporate governance",
"External stakeholder pressure", "External stakeholder pressure", "External stakeholder pressure",
"External stakeholder pressure"
],
"Labels": [
"C1", "C2", "C3", "C4", "C5", "C6", "C7", "C8", "C9", "C10", "C11", "C12", "C13", "C14", "C15", "C16",
"C17", "C18", "C19", "C20", "C21", "C22", "C23", "C24", "C25", "C26"
```

```
]
}

df_final = pd.DataFrame(data_final_updated)

#Color mapping
color_map = {
"Corporate governance": "orange",
"External stakeholder pressure": "yellow",
"Organisational culture": "red",
"Technological": "blue"
}

#Bubble chart
plt.figure(figsize=(14, 10))

for factor_group, group_data in df_final.groupby("Factor Group"):
scatter = plt.scatter(
group_data["Outdegree"], group_data["Indegree"],
s=group_data["Centrality"] * 300, # Scale up bubble sizes for better visibility
c=color_map[factor_group], label=factor_group, alpha=0.6, edgecolors="w", linewidth=2
)

#Add labels to bubbles
for i, row in df_final.iterrows():
plt.text(row["Outdegree"], row["Indegree"], row["Labels"], fontsize=9, ha='center', va
    ='center', color='black')

plt.xlabel("Outdegree", fontsize=14)
plt.ylabel("Indegree", fontsize=14)
plt.title("Bubble Chart of Concepts with Indegree and Outdegree", fontsize=16)
plt.legend(title="Factor Group")
plt.grid(True)
plt.show()
```

Listing 1: Python code to generate bubble chart

B.5 Identifying Feedback Loops

Python code to identify feedback loops

```python
import pandas as pd
import numpy as np

# Load the adjacency matrix from an Excel file
file_path = r'file/path'
fcm_df = pd.read_excel(file_path)

# Extracting concept names
adj_matrix = df.iloc[:, 1:].values

concepts = df.iloc[:, 0].values

# Function to find loops starting and ending with a specific concept
def find_loops(matrix, concepts, target_concept):
    loops = []
    num_concepts = len(concepts)

    # Find the index of the target concept
    try:
        target_index = list(concepts).index(target_concept)
    except ValueError:
        print(f"Concept '{target_concept}' not found in the list of concepts.")
        return loops

    # Function to perform depth-first search (DFS)
    def dfs(current_path, start_index):
        current_index = current_path[-1]
        for next_index in range(num_concepts):
            if not np.isnan(matrix[current_index, next_index]):
                if next_index == start_index:
                    loops.append([concepts[i] for i in current_path + [next_index]])
                elif next_index not in current_path:
                    dfs(current_path + [next_index], start_index)

    # Start DFS from the target concept
    dfs([target_index], target_index)

    return loops

# Find and print the loops starting and ending with 'CEP'
target_concept = "CEP"
loops = find_loops(adj_matrix, concepts, target_concept)
for loop in loops:
    print(" -> ".join(loop))
```

Listing 2: Python code to identify feedback loops

B.6 Formulating Strategies to Enhance CEP

Python code to navigate paths leading to CEP (FCM)

```python
import pandas as pd
import networkx as nx

# Load the adjacency matrix from an Excel file
file_path = r'file/path'
fcm_df = pd.read_excel(file_path)

# Create a directed graph
G = nx.DiGraph()

# Add edges to the graph based on the adjacency matrix
for i, row in fcm_df.iterrows():
    from_node = row['Concepts']
    for to_node in fcm_df.columns[1:]:
        if not pd.isna(row[to_node]):
            G.add_edge(from_node, to_node)

# Function to find all paths from a given start node to the target node
def find_all_paths(graph, start, target, path=[]):
    path = path + [start]
    if start == target:
        return [path]
    if start not in graph:
        return []
    paths = []
    for node in graph[start]:
        if node not in path:
            new_paths = find_all_paths(graph, node, target, path)
            for p in new_paths:
                paths.append(p)
    return paths

# Find all paths to CEP
all_paths_to_cep = []
for node in G.nodes:
    if node != 'CEP':
        paths = find_all_paths(G, node, 'CEP')
        all_paths_to_cep.extend(paths)

# Print all the paths to CEP
for path in all_paths_to_cep:
    print(" -> ".join(path))
```

Listing 3: Python code to navigate paths leading to CEP

C Results

C.1 Aggregated FCM - Graphical Representation

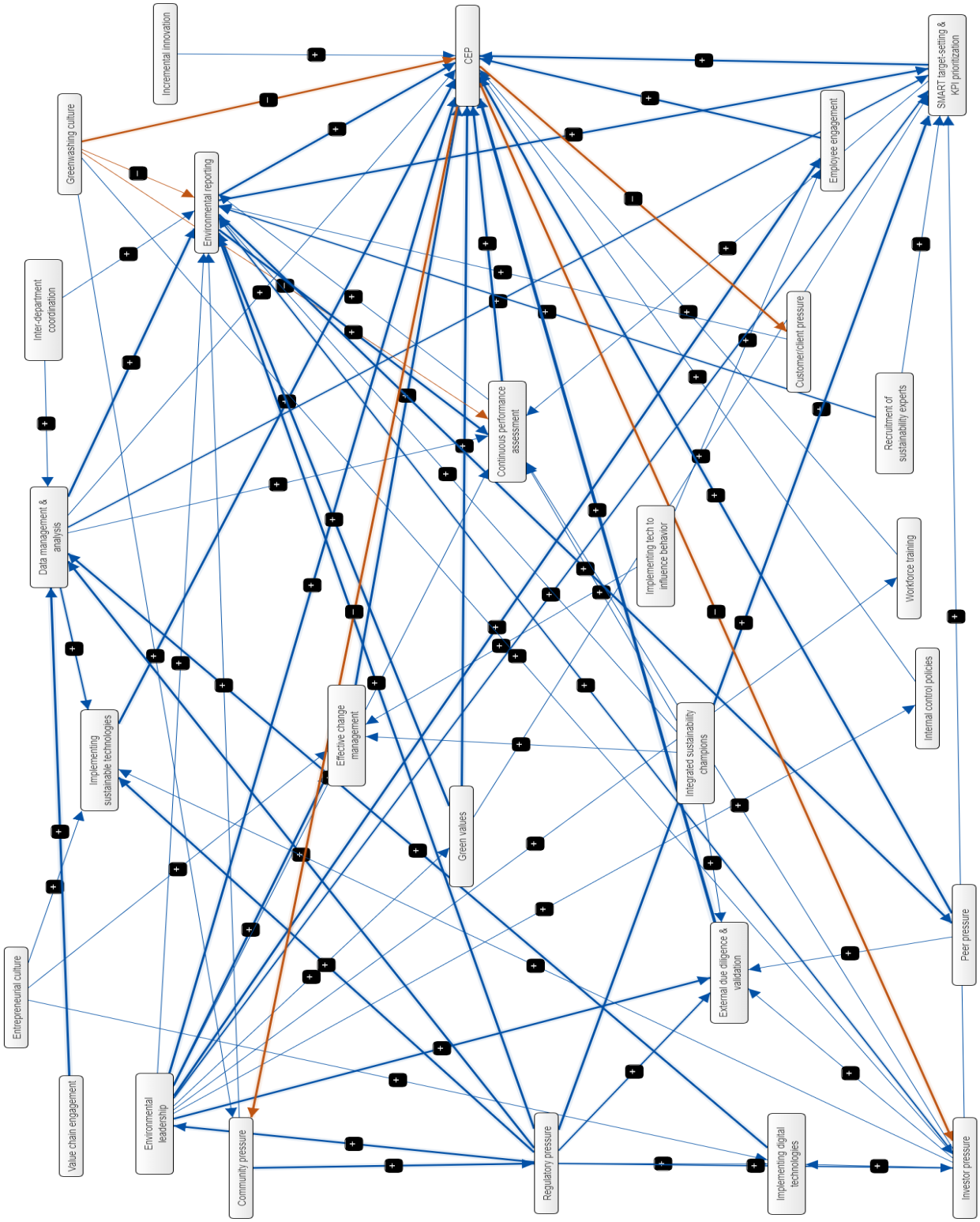

Figure 27: Aggregated FCM - graphical representation (created using Mental Modeler (Gray & Cox, 2015))

C.2 Condensed FCM - Matrix Representation

Concepts	C2	C3	C4	C6	C7	C8	C9	C12	C14	C16	C17	C18	C20	C21	C22	C23	C24	C25	C26	C27
Data management & analysis		0.3								0.6		0.3								
Implementing sustainable technologies																				0.7
Implementing digital technologies	0.7																			
Environmental leadership					0.7	0.5					0.1	0.2		0.5						0.7
Effective change management																				0.7
Employee engagement																				0.5
Green values										0.5										0.6
Greenwashing culture																				-0.6
Recruitment of sustainability experts										0.4										
Environmental reporting											0.6	0.5	0.5							0.6
Continuous performance assessment																				0.8
SMART target-setting & KPI prioritization																				0.7
Peer pressure																				0.5
External due diligence & validation																				0.9
Value chain engagement	0.7																			
Regulatory pressure	0.6	0.5		0.6						0.7		0.5		0.4			0.4			
Investor pressure										0.3										
Community pressure																0.5				
Customer/client pressure																				
CEP																	-0.6	-0.7	-0.5	

Figure 28: Condensed FCM - matrix representation

D Additional Tools and Resources

1. **Reference Management**
    - **Mendeley:** Utilized for managing references and citations throughout the study
2. **Grammar and Language Tools**
    - **OpenAI's ChatGPT:** Employed to assist with grammar checking and proofreading