FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION

Investigating GREAN: The green Enterprise Architecture framework

Juliette Bruyneel
Student number: 02005860

Supervisors: Prof. dr. Geert Poels, Dr. Antonio Baptista (University of Porto)
Counsellors: Dr. Niels Vandevenne (Innocom Institute), Jonas Van Riel

Master's dissertation submitted in order to obtain the degree of Master of Science in Business Engineering (Double Degree) - Operations Management

Academic year 2024-2025

GHENT UNIVERSITY

Confidentiality

Scientific integrity

I declare that the research was conducted in accordance with the rules that apply to scientific and academic integrity. I declare that I have taken note of, and have acted in accordance with, the ethical code of the faculty.

Abstract

This thesis builds upon the foundational GREAN paper, *Green Enterprise Architecture (GREAN) - Leveraging EA for Environmentally Sustainable Digital Transformation* by Vandevenne, Van Riel and Poels, which introduces the GREAN framework as a means to embed environmental sustainability into enterprise architecture (EA) across all organisational layers. While the original GREAN model outlines ten strategic 'Courses of Action' (CoAs) to guide organisations from sustainability ambition to implementation, it lacks concrete, actionable guidance for practical application. In response to the future research recommendations outlined in the GREAN paper, this thesis aims to operationalize and concretize these ten CoAs within the strategic layer of EA.

Using a Design Science Research methodology, this study refines each CoA and links them to business capabilities derived from the Process Classification Framework (PCF), thereby enhancing their practical relevance and usability. The resulting artefact is validated through a case study, demonstrating its potential applicability in real-world organisational contexts. In doing so, this thesis advances the GREAN framework into a more actionable and comprehensive tool, supporting organisations in integrating sustainability, facilitating audits and promoting continuous improvement and strategic alignment.

Key words: Environmental Sustainability, Sustainability Strategy implementation, Green Enterprise Architecture (GREAN), Courses of Action, ES-aware business Capability modelling, Practical guidelines

Resumo

Esta tese baseia-se no modelo original proposto no artigo “GREAN, Green Enterprise Architecture (GREAN) - Leveraging EA for Environmentally Sustainable Digital Transformation”, de Vandevenne, Van Riel e Poels, que apresenta o modelo GREAN como uma forma de integrar a sustentabilidade ambiental na Arquitetura Empresarial (EA) em todos os níveis organizacionais. O modelo original descreve dez “Cursos de Ação” (CoAs) estratégicos para orientar as organizações desde a ambição de sustentabilidade até à sua implementação, no entanto, carece de orientações específicas e mais capazes para a sua aplicação prática.

Em resposta às recomendações para investigações futuras indicadas no artigo, esta tese tem como objetivo operacionalizar e concretizar esses dez CoAs dentro da camada estratégica da EA. Utilizando uma metodologia de Design Science Research, o estudo refina cada CoA e estabelece uma ligação com as capacidades empresariais do Process Classification Framework (PCF), aumentando assim a sua relevância prática e usabilidade. A estrutura resultante é validada por meio de um estudo de caso, demonstrando o seu potencial de aplicação em contextos organizacionais reais.

Assim, o trabalho levado a cabo nesta tese desenvolve o modelo GREAN, transformando-o numa ferramenta mais concreta e abrangente para apoiar as organizações na integração da sustentabilidade, além de que facilita auditorias, promove a melhoria contínua, e fomenta o alinhamento estratégico de toda a organização.

Palavras-chave: Sustentabilidade Ambiental, Implementação da Estratégia de Sustentabilidade, Arquitetura Empresarial Verde (GREAN), Cursos de Ação, Modelagem de Capacidades Empresariais Sensíveis ao Meio Ambiente, Diretrizes Práticas

Foreword

This master's dissertation marks the final milestone in completing my Master in Business Engineering, with a major in Operations Management, at Ghent University. I also had the opportunity to participate in the double degree programme with the University of Porto. As such, this thesis also serves as the concluding component of my Master in Service Engineering and Management at the University of Porto.

I would like to sincerely thank Prof. Dr. Geert Poels, Jonas Van Riel and Dr. Niels Vandevenne for giving me the opportunity to work on this thesis and for their valuable guidance and support throughout the process. I also wish to thank Dr. Antonio Baptista from the University of Porto for his thoughtful supervision and helpful feedback.

Finally, I would like to thank my parents for giving me the opportunity to study at both Ghent University and the University of Porto and for their unwavering support throughout my academic journey. I am equally grateful to my friends, whose encouragement and support have been truly invaluable along the way.

Table of contents

List of abbreviations

Abbreviation	Full Term
AI	Artificial Intelligence
APQC	American Productivity and Quality Center
BDAT	Business, Data, Application, and Technology
CBM	Capability-Based Management
CE	Circular Economy
CoA(s)	Course(s) of Action
CSR	Corporate Social Responsibility
CSRD	Corporate Sustainability Reporting Directive
CSDDD	Corporate Sustainability Due Diligence Directive
DPP	Digital Product Passport
DT	Digital Transformation
DSR	Design Science Research
EA	Enterprise Architecture
EFRAG	European Financial Reporting Advisory Group
ERP	Enterprise Resource Planning
ES	Environmental Sustainability
ESG	Environmental, Social and Governance
ESPR	Ecodesign for Sustainable Products Regulation
ESRS	European Sustainability Reporting Standards
EU	European Union
FSC	Forest Stewardship council
GenAI	Generative Artificial Intelligence

Abbreviation	Full Term
GHRM	Green Human Resource Management
GREAN	Green Enterprise Architecture
GRI	Global Reporting Directive
ICT	Information and Communication Technology
IFRS	International Financial Reporting Standards
IoT	Internet of Things
IS	Information system
ISO	International Organization Standards Board
ISSB	International Sustainability Standard Board
KEIs	Key Environmental Indicators
KPIs	Key Performance Indicators
LCA	Life Cycle Assessment
LCCA	Life Cycle Cost Analysis
MBO	Management by Objectives
NFRD	Non-Financial Reporting Directive
OKR(s)	Objective(s) and Key Result(s)
PCF	Process Classification Framework
RoHS	Restriction of Hazardous Substances
SASB	Sustainability Accounting Standards Board
SBDAT	Strategic, Business, Data, Application and Technology
SBSC	Sustainability Balanced Scorecard
SDG	Sustainable Development Goals
SMEs	Small and Medium- sized Enterprises

Abbreviation	Full Term
SPMS	Sustainable Performance Measurement System
TBL	Triple Bottom Line
TOGAF	The Open Group Architecture Framework
WEEE	Waste 50 Electrical and Electronic Equipment

List of Figures

List of Tables

Introduction

In recent years, more and more studies have explored the connection between enterprise architecture (EA) and environmental sustainability (ES). Although these studies provide valuable insights, they often lack concrete and actionable EA tools, techniques or information that can help organisations improve their sustainability performance (Vandevenne et al., 2023; Zhao et al., 2023).

EA plays a central role in supporting organisations by ensuring value creation, strategic alignment and enterprise coherence. It helps to structure the roles, processes, data, applications and technology needed to achieve business goals (Vandevenne et al., 2023). At the same time, many companies continue to struggle with effectively integrating sustainability into their core operations. Research from Bain's Sustainability Leadership Team (2023) shows that 75% of executives feel they have not successfully embedded sustainability into their business (Van Den Branden et al., 2024). This underlines the need for more practical guidance in this area. The current gap seems to lie in the lack of concrete EA-based approaches to make this integration possible (Vandevenne et al., 2023).

This thesis builds on *Green Enterprise Architecture (GREAN): Leveraging EA for Environmentally Sustainable Digital Transformation* (Vandevenne et al., 2023), which introduces GREAN as a framework for embedding sustainability goals across the different SBDAT layers (Strategic, Business, Data, Application and Technology) of the enterprise architecture of an organisation. One of the key contributions of the GREAN model is the proposal of ten strategic 'courses of action' (CoAs) that aim to help companies move from sustainability ambition to actual implementation.

While the GREAN framework offers a solid direction, it still lacks concrete, actionable guidelines for companies to effectively implement sustainability in practice. As highlighted in the future research recommendations of (Vandevenne et al., 2023) , further work could focus on strengthening the model towards a more comprehensive framework, incorporating best practices and offering detailed guidance on applying the proposed capabilities. In line with these recommendations, this thesis aims to concretise the ten proposed 'Courses of Action' within the strategy layer by translating them into actionable steps and practices that organisations can use in their day-to-day operations.

To further enhance the practical applicability of the framework, the final Course of Action (CoA10) links all preceding CoAs to business capabilities derived from the Process Classification Framework (PCF), developed by the American Productivity and Quality Center (APQC). This integration creates a structured overview of where sustainability can be embedded within the organisation. It enables companies to align sustainability goals with existing processes, responsibilities and objectives, making sustainability both actionable and measurable. CoA10 thus acts as a crucial bridge between strategic intent and operational reality. This approach results in a structured artefact that consolidates the ten CoAs into a practical tool organisations can use to implement sustainability in a concrete and measurable way.

Finally, this thesis includes a case study to explore how the operationalised CoAs and the overall GREAN approach can be applied in practice. In doing so, this work contributes to the further development of GREAN into a more practical and usable framework, one that not only helps companies integrate sustainability, but also supports audits, continuous improvement and strategic alignment over time.

Theoretical background

Defining Strategy and explaining its role in Enterprise Architecture

Defining Strategy

It is important to clearly define the concept of strategy. The meaning of strategy has evolved over time. It originates from the word 'strategos' which was used in the military field and referred to military leadership. Today, the term is commonly used to encompass business and organisational contexts, focusing on competition and achieving long-term goals (Fuertes et al., 2020). The strategy of a company should be clearly aligned with the company's purpose, focused on long-term value creation and driven by leadership, including the CEO and the board (Hutchinson et al., 2024).

Every organisation employs multiple strategies to achieve its goals (Fuertes et al., 2020). A clear growth strategy details how a company plans to expand, such as by developing new products or entering new markets. To differentiate from competitors, it is important to have a competitive strategy. A company's strategy even has an influence on its mission, vision, number and types of jobs provided, where the firm is located and even the wages (Fuertes et al., 2020). As a modern business, it is crucial to have a sustainability strategy to address environmental and social responsibilities.

However, it is crucial to recognize that every organisation, regardless of its size or whether it is a for-profit or non-profit entity, needs a strategy. Startups need a strategy to effectively allocate limited resources, navigate uncertainties and establish a scalable foundation for long-term growth and success (Von Gelderen et al., 2000). In contrast, large enterprises face the complexity of managing diverse strategic portfolios and adapting to rapidly changing environments, requiring sophisticated coordination mechanisms and strategic alignment across multiple units (Morrish & Hamilton, 2022).

Non-profit organisations also develop and implement strategies, but unlike for-profit companies, their primary focus is on maximizing social value and fulfilling their mission to benefit society, rather than pursuing financial returns or competitive advantage. Their strategic decisions are therefore driven by the goal of creating meaningful societal impact (Moore, 2000).

The role of Strategy in Enterprise Architecture

Enterprise Architecture (EA) serves three fundamental purposes: value creation, enterprise coherence and strategic alignment. It configures the roles, processes, information, applications and technologies necessary for an enterprise to achieve its objectives (Van Riel & Poels, 2025)

EA takes a holistic approach that supports organisations in both developing and executing their strategies. It uses architectural principles and methods to guide organisations through the changes in business, information, processes and technology needed to implement their strategic goals effectively (Federation of EA Professional Organizations, 2013).

Enterprise Architecture (EA) is commonly structured around four primary architecture domains as defined by The Open Group Architecture Framework (TOGAF): Business, Data, Application and Technology (BDAT). These domains provide a holistic and transparent view of the organisation, enabling structured growth through defined models, principles and policies (Vandevenne et al., 2023).

Given the growing strategic importance of Environmental Sustainability (ES), Vandevenne et al. (2023) propose the addition of a fifth domain: the Strategy layer. While TOGAF traditionally includes strategic concerns within the Business Architecture domain, separating the Strategy layer explicitly results in the extended SBDAT framework (Figure 1). It allows organisations to more directly integrate sustainability considerations into their strategic planning (Vandevenne et al., 2023).

This Strategy layer defines the organisation's vision, long-term objectives and its key performance indicators (KPIs) and is essential for aligning sustainability goals with architectural decisions. It not only determines *what* the organisation aims to achieve but also *how* these goals should be reached, through the strategic choices made and the direction set. By integrating ES at the strategic level, EA helps drive transformation efforts aimed at environmental sustainability in all other domains (Vandevenne et al., 2023).

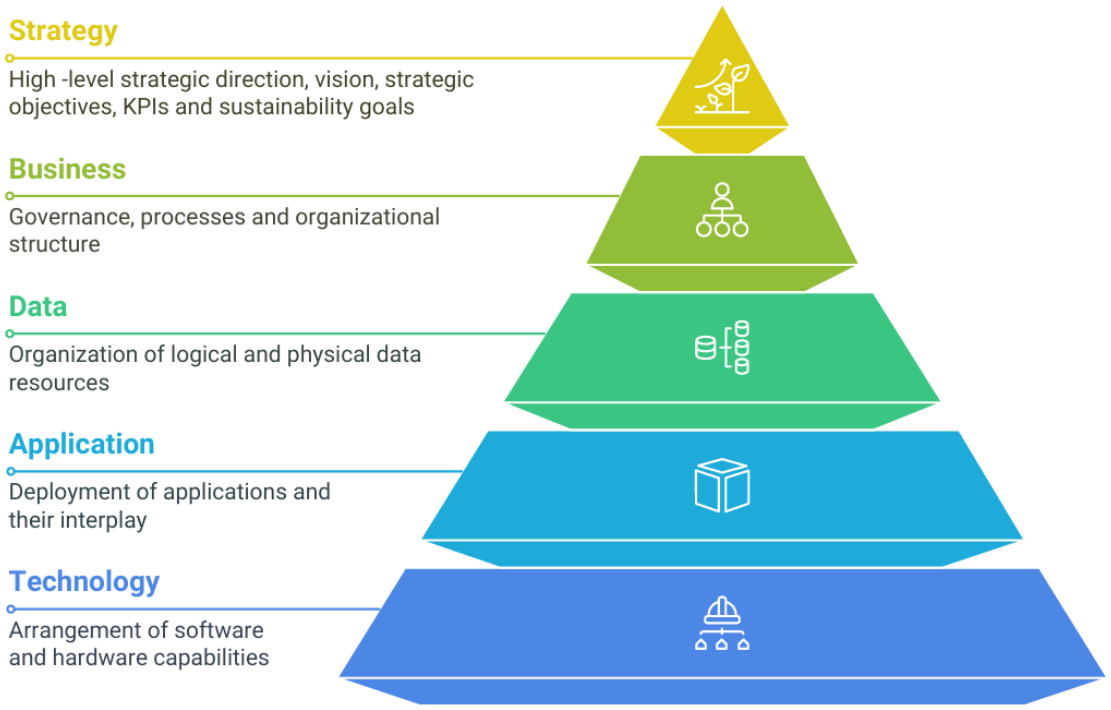

Figure 1: Visualisation SBDAT architecture layers

What is sustainability?

Sustainability is an increasingly common term used in various contexts, but its precise meaning is often unclear. One of the earliest and most widely accepted definitions was introduced by the World Commission on Environment and Development. This definition, often referred to as the Brundtland definition, states: *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).*

Today, sustainability is commonly understood through three dimensions: environmental, social and economic. The concept of sustainability as a multidimensional framework originates from the Triple Bottom Line (TBL) approach, introduced by John Elkington (Elkington, 1997). This framework expands the traditional focus on economic profit by incorporating environmental responsibility (planet) and social equity (people) (Kuhlman & Farrington, 2010). Neither social development nor economic growth should take ecological sustainability for granted. Conversely, environmental protection programs should not assume economic outcomes or public support as a given (Vos, 2007).

Environmental sustainability is the most known dimension. It entails direct environmental management. It includes waste management, energy savings, lower CO2 emissions…. (Kain, 2023)

Economic sustainability is about profitability of a business. A company must be financially viable to remain sustainable in the long term. At the same time, profitability should not be the sole objective but rather an integral part of a broader strategy that also incorporates social and environmental responsibility (Kain, 2023). It seeks to enhance the quality of life of all stakeholders and employees. It also involves the responsible and efficient management of company assets to secure long-term profitability and resilience (Barbier, 1987).

The last dimension, social sustainability, is also the least clearly defined. It focuses on how societies can grow in a fair and resilient way, by reducing social inequalities and improving quality of life (Vallance et al., 2011). This includes protecting human rights, tackling poverty, ensuring access to education and healthcare, and promoting social justice (Kain, 2023).

Sustainability strategy

What is sustainability strategy?

Business activities generate externalities, which can be negative if producers and users want to avoid the costs and instead place them on communities and the environment. These externalities offer companies an opportunity to adopt sustainability strategies, for example by developing technologies that reduce environmental impact while enhancing their reputation (Long, 2021).

When a company intentionally addresses its negative externalities, aiming to reduce or eliminate them, we can speak of a sustainability strategy. A sustainability strategy is an integrated approach that embeds sustainability into an organisation's mission, values, objectives and overall strategic direction. It aims to create long-term value for both the organisation, the environment and society, while actively minimizing environmental impact and addressing social responsibility (Galpin et al., 2015).

Importance of sustainability strategy

There are five main reasons why more and more companies are developing a sustainability strategy. First of all, stricter laws and regulations are being introduced (*Corporate*

Sustainability Due Diligence, n.d.; *Ecodesign for Sustainable Products Regulation*, n.d.; European Commission, n.d.). Secondly, customers increasingly expect companies to take responsibility for environmental and sustainability issues (Cosgrove, 2021). Thirdly, it offers opportunities for competitive advantage and innovation (Hutchinson et al., 2024). Fourthly, sustainable businesses are more attractive to investors (Becchetti et al., 2018; Kim et al., 2014; Nofsinger & Varma, 2014). And finally, a sustainability strategy can lead to cost reductions in the long run. Each of these drivers is explained in the following paragraphs (Hutchinson et al., 2024; N. M. P. Bocken et al., 2014).

1. Legal obligations

Governments are introducing more and more laws related to sustainability, especially for businesses. This is driven by the growing recognition that urgent action is needed to reduce CO_2 emissions, prevent resources from depleting, minimize waste, protect public health and address other critical environmental and social challenges (*Corporate Sustainability Due Diligence*, n.d.; *Ecodesign for Sustainable Products Regulation*, n.d.; European Commission, n.d.). Complying with legislation remains an important reason for companies to become more sustainable.

The European Union has introduced several important sustainability regulations that many companies in the EU must now comply with. One of these is the Corporate Sustainability Reporting Directive (CSRD), which requires large companies to report in detail on their environmental, social and governance (ESG) performance based on the European Sustainability Reporting Standards (ESRS). Another is the Corporate Sustainability Due Diligence Directive (CSDDD), which obliges large companies to identify, prevent and address negative impacts on human rights and the environment, not only in their own operations but also across their subsidiaries and value chains. This directive also requires companies to develop a transition plan for climate change. In addition, the Ecodesign for Sustainable Products Regulation (ESPR) introduces rules around product sustainability, circularity and transparency. It includes legal requirements for things like durability, repairability and the use of a digital product passport. Together, these EU regulations are significantly changing how companies handle sustainability and legal compliance (*Corporate Sustainability Due Diligence*, n.d.; *Ecodesign for Sustainable Products Regulation*, n.d.; European Commission, n.d.).

2. *Customer expectations*

Besides legal pressure, public opinion also plays an increasingly important role. According to Andrew Cosgrove (2021) in the EY Future Consumer Index, a significant 84 percent of global consumers state that sustainability is important when making purchase decisions. Furthermore, 43 percent indicate they would buy more from organisations that benefit society, even if it comes at a higher cost. In addition, 73 percent of global consumers believe that brands have a responsibility to make a positive change in the world (Cosgrove, 2021). These statistics highlight that consumers increasingly value sustainability and companies need to make it a core element of their strategy.

3. *Competitive advantage and innovation*

A sustainability strategy can help companies stand out from competitors, enter new markets and develop innovative business models focused on the future. By integrating sustainability into their core business practices, organisations strengthen their brand, attract more customers and create long-term value (Hutchinson et al., 2024).

4. *Attract investors*

Another reason is that sustainable brands are more attractive to investors. Multiple research papers prove that sustainable businesses carry lower risks and have higher returns in the long run. High ESG-rated funds experience lower losses and investing in high ESG funds may enhance portfolio diversification (Becchetti et al., 2018; Kim et al., 2014; Nofsinger & Varma, 2014). As a result, investors are increasingly allocating funds to sustainable companies (Cerqueti et al., 2021).

5. *Cost reduction*

Finally, a sustainability strategy can lead to lower operational costs. By reducing waste, water usage and energy consumption, companies can significantly cut costs, both in the short and long term (Hutchinson et al., 2024; N. M. P. Bocken et al., 2014).

Methodology

Since this thesis builds upon the *paper Green Enterprise Architecture (GREAN) — Leveraging EA for Environmentally Sustainable Digital Transformation* by Niels Vandevenne, Jonas Van Riel and Geert Poels, this research began with a comprehensive analysis of the paper and its key contributions. Given that the goal of this thesis is to translate the ten Strategy Courses of Action (CoAs) proposed in the GREAN model into concrete, actionable steps that can be effectively implemented in practice, a Design Science Research (DSR) approach was adopted. This methodology is particularly well-suited for addressing real-world problems through the development and evaluation of practical artefacts. Following the DSR framework proposed by Peffers et al. (2007), the research consists of six distinct phases:

1. Identifying and motivating the problem

The first phase is done in the introduction and involves identifying and motivating the research problem.

2. Defining the objectives of a solution

In line with the approach described in the GREAN paper, the artefact developed in this thesis is also intended to be applicable across industries and is not tailored to a specific sector or case. The goal is to create a generally usable and actionable framework that organisations from various domains can use to implement environmentally sustainable strategies through Enterprise Architecture. From this goal, we derive three research objectives:

1. Operationalise the ten Strategy CoAs from the GREAN model by translating them into concrete and practical guidelines.
2. Link the developed guidelines to the APQC Process Classification Framework (PCF) to support structured implementation across business functions.
3. Develop a hands-on artefact that organisations can use to implement, monitor and maintain long-term strategic alignment of sustainability initiatives.

3. Design and development

The third phase of the DSR methodology, design and development, was addressed through a structured literature review and the construction of a practical artefact. Scientific literature was systematically analysed to explore how the ten Courses of Action (CoAs) can be implemented in practice. Scientific literature was found on various platforms like Web of science, Google scholar or just Google. To construct relevant search strings, key terms were first identified based on the ten Strategy Courses of Action from the GREAN framework. These terms were either directly derived from the titles of the Strategy CoAs, drawn from their descriptions in the original GREAN paper or based on commonly used synonyms. For example, in the case of CoA2, search terms such as “ESG reporting” and “sustainability reporting” were applied. For CoA3, expressions like “green company culture” and “Green HRM” were used. A structured overview of all search terms per Course of Action is included in *Appendix 1: Search Terms per Course of Action (Co*A).

Given the objective of this thesis (provide practical and actionable guidance that can be used in practice), these core terms were often combined with qualifiers such as “how to” and “implementation” as well as “practical guidelines for” and “best practices”. In addition to structured database searches, the snowball method was used. When a relevant idea or reference was encountered within a paper, the cited sources were reviewed to identify more detailed or related insights.

First, the titles and abstracts of each paper were screened to assess initial relevance to the topic. If the content appeared potentially useful, the conclusion sections were reviewed for further evaluation.

Subsequently, a set of inclusion and exclusion criteria was applied to determine whether the paper should be retained for analysis. The criteria were grouped into four categories: content, relevance, theoretical value and applicability. Table 1 provides an overview:

Criterion Type	Inclusion Criteria	Exclusion Criteria
Content	Actionable insights, practical guidance or useful frameworks related to ES and EA	Overly theoretical papers with no link to implementation
Relevance	Applicable to general organisational contexts	Focused too narrowly on a single sector, country or niche context
Theoretical value	Theoretical papers included if they clarify key definitions or offer conceptual depth	Lacked broader practical relevance or generalisability
Applicability	Offers concrete value for operationalising sustainability within EA	No direct link to environmental sustainability or enterprise architecture

Table 1: Inclusion and Exclusion criteria

To improve efficiency, the search function within PDF files was used to find keywords related to the Strategy CoA. AI tools such as Copilot, ChatGPT and Perplexity were also used to summarize longer texts and to evaluate whether a document addressed practical implementation questions. For instance, it was examined whether a paper discussed how companies can offer green training programs and what recommendations were provided.

The insights gained were used to translate these CoAs into actionable guidance, supported by relevant KPIs and best practices. Furthermore, each CoA was linked to enterprise capabilities in order to facilitate practical application. This process resulted in the first version of a generalizable artefact aimed at supporting organisations in their environmentally sustainable digital transformation efforts.

4. Demonstration

A case study will be conducted, using the same fictitious business scenario presented in the GREAN paper, to demonstrate the applicability of the developed artefact in practice.

5. Evaluation

Evaluation can be done by doing different case studies. This way, the effectiveness of the proposed actions can be evaluated. Due to time and scope constraints, a full evaluation was not included, but this step is outlined for future work. Nevertheless, a small evaluation was conducted through the case study. This made it possible to assess whether the objectives of the artefact were achieved.

6. Communication.

The final step is communication, this thesis will be published in the internal database of the UGent.

Artefact Design and Development

This section corresponds to the third phase of the Design Science Research (DSR) methodology: Design and Development. In order to translate the ten strategic Courses of Action (CoAs) identified in the GREAN framework into concrete and actionable guidance, a structured literature review was conducted. Figure 2 provides a visual overview of the ten CoAs proposed in the GREAN framework.

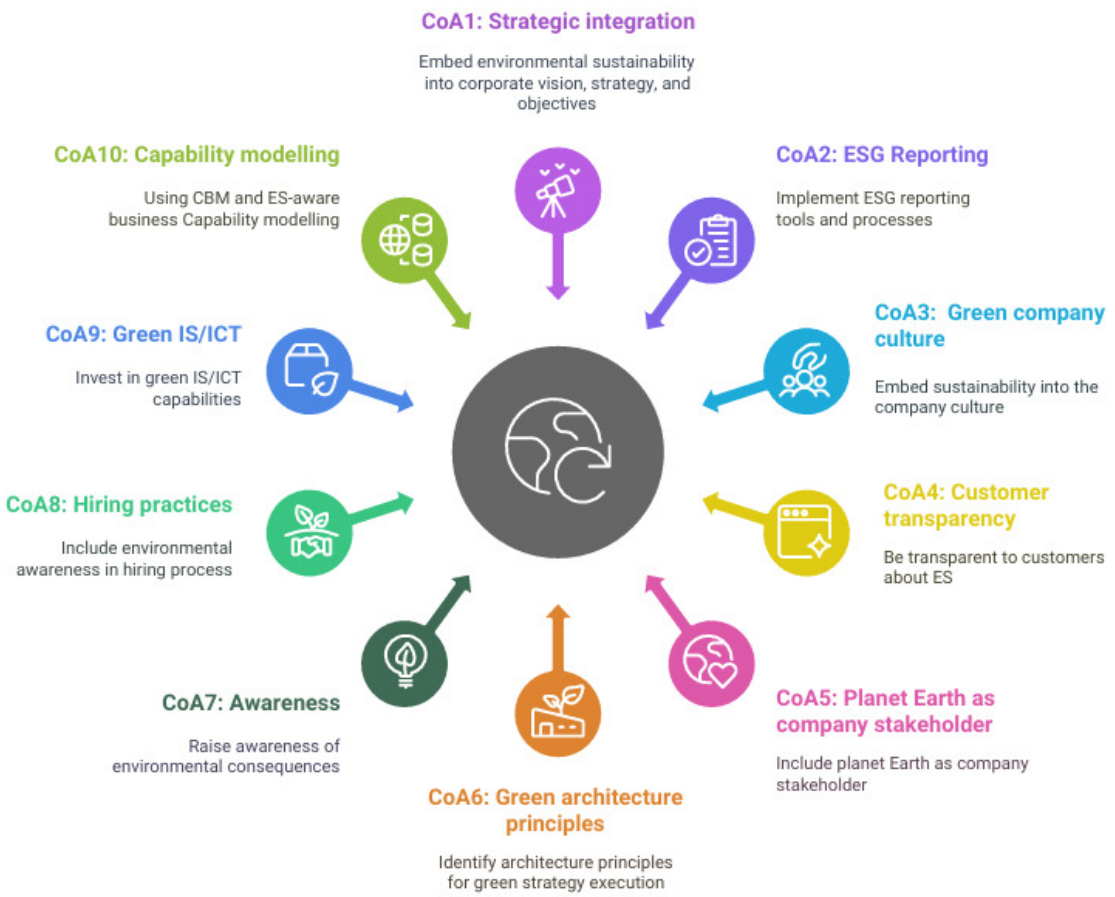

Figure 2: The 10 Strategy courses of action

Each CoA is first briefly introduced, followed by an in-depth exploration based on relevant academic and professional literature. The tenth CoA links the previous other nine CoAs with a capability map. The goal is to create an artefact that provides practical guidance on how each CoA can be effectively implemented.

CoA1. Embed environmental sustainability into the corporate visions, strategy and objectives

The first CoA to integrate sustainability into a company's strategy is "embed environmental sustainability into corporate visions, strategy and objectives".

This section discusses the importance of strong board-level oversight through sustainability committees, the role of vision and mission statements in communicating commitment, the alignment of objectives with measurable key results (OKRs) and the use of Key Environmental Indicators (KEIs) to track and manage progress.

1. Establish a board sustainability committee

A board sustainability committee is a specialized group that focuses on the organisation's sustainability actions (Orazalin, 2020). One of the main goals is to monitor and guide the company's strategies related to environmental, social and governance (ESG) issues. It has to ensure that the company aligns its operations with its sustainability goals (Orazalin, 2020). Sustainability committees have become increasingly common, rising from just 27 companies in the Fortune 100 having such a committee in 2018 to 89 by 2024. Similarly, the percentage of these firms with ESG credentials grew significantly, from 29% in 2018 to 49% in 2024 (Whelan, 2024).

Due to the increasing pressure on modern businesses to incorporate sustainability and corporate sustainable responsibility (CSR) strategies that are essential for sustainable development, Nurlan Orazalin (2020) conducted a study on whether a board sustainability committee contributes to corporate environmental and social performances. The empirical results indicate that such committees enhance the effectiveness of CSR strategies. This suggests that companies with a sustainability committee tend to demonstrate stronger environmental and social performance (Orazalin, 2020).

There are a lot of other studies that confirm the positive relation of a sustainability committee and the firm's environmental performance (Tumewang et al., 2025; Li et al., 2023).

2. Embed environmental sustainability in mission and vision

To successfully embed environmental sustainability into an organisation's core strategy, it is essential to start at the top: with a clearly defined mission and vision. These foundational elements shape the long-term direction and purpose of a company, guiding decision-making and aligning stakeholders around shared values and goals.

In this section, the importance of both the vision and mission is discussed, including how to formulate them with sustainability in mind and how different ambition levels can reflect a company's true commitment.

Mission

A mission statement translates a company's strategic goals into actionable steps and provides a rationale for resource allocation. It is a concise and clear statement that defines the organisation's purpose, explaining why it exists, what it does and how it operates. As such, it serves as an effective communication tool (Penco et al., 2019). A well-crafted mission statement is essential for a company's success.

Penco, Profumo and Tutore (2019) state that the wider the number of stakeholders mentioned in the mission, the higher the firms CSR performance. To be effective, a mission statement should reflect core values, address sustainability and highlight commitments to stakeholders. It should be clear, brief and inspire both internal and external audiences.

If you include sustainability in your mission, you should also specify your company's ambition level (Fehre et al., n.d.). According to Kersten Fehre and Kurt Verweire (2025), both professors at Vlerick Business School, there are 5 levels of ambition. The lowest ambition level is regulatory compliance. In that level, a company makes just enough efforts to comply with the existing laws and regulations. Businesses that operate in this level see ESG as an additional, unnecessary cost and a distraction from the core business. The second level is Philanthropic corporate social responsibility. Firms in the second level mainly invest in local community projects or donate money to charities. It is a rather defensive approach often focussed on initiatives that are situated in the periphery of the company's core business. When a company's goal is to be more responsible for its impacts on the environment, it is in the level 'do less/ no harm'. These firms try to reduce or minimise the negative externalities (emission of greenhouse gases, create waste…). It is an interesting level for polluting industries of firms

that produce harmful products because they can improve their reputation, reduce cost base or even differentiate from competitors. The fourth level is ‘Do good: create value for stakeholders and society’, in this level organisations put stakeholders’ needs first by creating positive returns for them. Profits may rise, which is positive for shareholders. When the firm’s goal is to solve some of the world's most pressing problems, then it finds itself in the highest ambition level: ‘Solve problems of the world’. Companies start from a big, urgent societal problem and build a business around it (Fehre et al., 2025).

Vision

A vision is a statement that reflects a dream. What an organisation aims to achieve in the future. It outlines a long-term goal or aspiration that provides direction and purpose (Penco et al., 2019).

A vision should be brief, clear, future-oriented, stable, challenging, abstract and desirable with content about increasing stakeholder satisfaction. A vision should be clear and understandable to those who follow it, supported by those who pursue it and stable over time, to prevent frustration and loss of direction (Zasa & Buganza, 2023).

A strong sustainability vision should emphasize enhancing the satisfaction of various stakeholders, such as shareholders, customers, employees, the environment and local communities. The term "society" effectively captures this broad range of stakeholders. It should include all organisational interests to attract all members of the organisation. To be motivating, it must include a degree of challenge, stretch or difficulty. Because it is a desirable future state, it must offer a long-term, desirable view of the organisation. (Kantabutra, 2020)

3. Align sustainability goals with Objectives and Key Results (OKRs)

To ensure alignment within a company, the Objective and Key Result (OKR) method can be a valuable tool. The main goal is to align employees and get them to work together towards one common goal (Helmold & Terry, n.d.). OKRs refine the traditional management by objectives (MBO) approach by making it a more collaborative process rather than a top-down bureaucratic system (Sparks, n.d.). Teams can create their own high-level objectives and refine them for specific areas (Sparks, n.d). This clarity helps teams direct their efforts more effectively (Long, 2024).

An OKR consists of two main components: objectives and key results. Objectives define long-term, aspirational goals by outlining what needs to be achieved. They should be ambitious, meaningful and action-oriented. Objectives should align with your company's vision, mission and values to motivate your employees (Helmold & Terry, n.d.). Key results outline the actionable steps required to achieve these objectives. They follow the SMART criteria, being specific in their focus, measurable for tracking progress, achievable within available resources, relevant to the organisational goals and time-bound to ensure timely completion (Saragih et al, 2022). Each objective is supported by 3-5 key results that measure progress and success.

It is important to not only look at the two separate parts, but at the 'OKR process' as a whole. Strategic objectives that aren't regularly measured and adjusted, can quickly become outdated and lose their relevance. Additionally, it is crucial to identify key results that serve as leading indicators of progress, rather than relying on lagging indicators (Sparks, n.d.).

Companies that are committed to sustainability should define clear sustainability goals that align with their mission and values. You can use your mission as a starting point (if sustainability is already integrated). Start by defining OKRs at company level and then work out to departmental goals that align with overall company objectives (Long, 2024).

Some examples of an OKR:

Objective 1: Reduce the CO_2-emissions of the company in 2025

OKRs:

1. Switch to 80% of renewable energy for the offices.
2. Obtain a third-party certification for complying with the recognized environmental standard ISO 50001
3. Reduce greenhouse gas emissions by 15% by implementing energy-efficient practices.

Objective 2: Improve employee welfare and safety

OKRs:

1. Ensure 100% of the employees are trained in safety protocols by Q1 of 2026

2. Host 2 team buildings a year
3. Conduct quarterly safety audits

4. Set up Sustainability KPIs

Key Performance Indicators (KPIs) are measurable indicators used to monitor and compare the performance of organisations. They provide clarity in objectives, improve performance assessment in meeting strategic goals and reflect the objectives. Once an organisation has defined its goals, an appropriate KPI system must be developed. The KPIs should be thoroughly defined: (a) they should be directly linked to the strategic objectives, (b) be relevant and effective in representing and explaining the value creation process and (c) be reliable, comprehensive, consistent and comparable (Hristov & Chirico, 2019).

Sustainability KPIs can be categorized into three main types: environmental, social and governance metrics. When KPIs specifically focus on environmental sustainability performance, they are referred to as Key Environmental Indicators (KEIs). KEIs are a subset of KPIs that allow companies to integrate environmental sustainability goals into their overall strategy in a measurable and trackable way. To define meaningful KEIs, organisations should first identify their broader sustainability objectives (Hristov & Chirico, 2019). The most impactful environmental KEIs related to value creation are linked to four strategic areas: greenhouse gas emissions, renewable resources, resource consumption and waste management (Hristov & Chirico, 2019).

Social KPIs focus on the well-being of employees and citizens, working conditions, human rights and participation in social initiatives. Commonly used KPIs in this category include employee attraction, equality rate (male to female), social security rate, charity donation rate, etc (Hristov & Chirico, 2019).

Economic KPIs focus on promoting long-term economic growth, boosting employment and optimizing resource use. Relevant KPIs within this category include gross margin growth, investment in environmental conservation and financial measures of value creation. In addition, management system certifications, such as ISO 9001, ISO 14001, ISO 50001 and OHSAS 18001 are essential for ensuring sustainability performance (Hristov & Chirico, 2019).

The sustainability KPIS can be used in Kaplan and Norton's balanced scorecard. The balanced scorecard is a strategic tool that helps companies define and achieve their objectives through KPIs. A scorecard that takes into account the SDG goals is often called a Sustainability Balanced Scorecard (SBSC) (Hansen & Schaltegger, 2016).

CoA2. Implement ESG reporting tools and processes

ESG reporting has become essential for companies to demonstrate sustainability and responsible practices, driven by increasing regulatory and stakeholder expectations. Tools like the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) offer frameworks for consistent reporting (GRI, n.d.; SASB, n.d.). The EU's Corporate Sustainability Reporting Directive (CSRD) aims to standardise and expand sustainability disclosures, enhancing transparency and accountability (European Union, 2022). Additionally, Generative AI is transforming ESG reporting by improving efficiency, data accuracy and real-time verification, while also addressing challenges like greenwashing (Rane et al., n.d.; de Villiers et al., 2024). However, it is crucial to maintain human oversight to avoid risks such as biases and over-reliance on AI (de Villiers et al., 2024). This section explores these reporting tools and processes, highlighting their role in the evolving ESG landscape.

1. Enhance transparency through ESG reporting

The EU has the Non-Financial Reporting Directive (NFRD), in force since 2017, which requires large companies to disclose non-financial information, including environmental, social and governance (ESG) factors. In upcoming years, the NFRD will be replaced by the Corporate Sustainability Reporting Directive (CSRD), which further expands reporting requirements, especially for smaller companies. Standardised sustainability reporting will become mandatory for more companies, enhancing transparency and improving comparability across organisations (de Villiers et al., 2024).

In addition to mandatory reporting standards, organisations can also choose to report voluntarily under frameworks such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB). According to KPMG, sustainability reporting is already a standard business practice for nearly all of the world's top 250 companies, as well as for the vast majority of the top 100 companies in each country (KPMG, 2024).

Sustainability reporting requires both time and financial investments, but it offers significant advantages for companies. It strengthens their competitive position and positively impacts their financial performance by enhancing transparency and trust among stakeholders (Buallay, 2019).

In this section, three reporting tools will be explained.

The corporate sustainability reporting directive (CSRD)

The CSRD is an initiative of the European Commission and is part of the European green deal and action plan 'Financing Sustainable Growth' (pwc, n.d.). The directive aims to improve and standardise sustainability reporting across the EU by imposing disclosure requirements on organisations (Operato et al., 2025). Another objective of the European Commission with this directive is to combat greenwashing (European Union, 2022).

The CSRD was first proposed as follows: companies already covered by the NFRD must comply with the CSRD from the 2024 financial year. Additionally, large companies that meet at least two of the following three criteria must also meet the requirements of the CSRD from 2025:

- Annual turnover exceeds €50 million per year
- A balance sheet total of more than €25 million
- More than 250 employees (average over one year)

The directive will also be mandatory for listed SMEs from financial year 2026 onwards, with an opt-out option until 2028. Finally, non-EU companies generating over €150 million in EU revenue must comply from the 2028 financial year under a tailored reporting framework (European Commission, 2024).

The CSRD has been significantly revised through the Omnibus proposal to reduce the sustainability reporting burden on companies and to ensure closer alignment with the upcoming Corporate Sustainability Due Diligence Directive (CSDDD). One of the main changes concerns the scope of application, which will now be limited to companies meeting specific criteria (Suykens, 2025). Under the revised criteria, the CSRD will apply to European companies that meet both of the following conditions:

- an average of more than 1,000 employees; and
- at least one of the following thresholds

- an annual net turnover exceeding 50,000,000 EUR; or
- a balance sheet above 25,000,0000 EUR.

For non-European companies, the CSRD will apply if they meet following criteria:

- an average of more than 1,000 employees; and
- at least one of the following thresholds:
  - an annual net turnover exceeding 50,000,000 EUR; or
  - a balance sheet above 25,000,0000 EUR.

In addition to the narrowed scope, several other adjustments have been introduced. Publicly listed small and medium-sized enterprises (SMEs) will no longer be subject to CSRD reporting obligations. Furthermore, companies in the value chain that are not directly under CSRD will only be asked to provide sustainability data on a voluntary basis. Finally, the implementation timeline has been adjusted: companies affected by the second and third wave of the CSRD will now benefit from an additional two years to prepare themselves (Suykens, 2025).

The CSRD establishes stricter and standardised reporting requirements based on the European sustainability Reporting Standards (ESRS), which consist of 12 standards (European Commission, n.d.). The first two outline general principles, covering strategy, governance and decisions about materiality. The remaining 10 focus on the ESG aspects. A company should only report on the standards it relates to (pwc, n.d.). Table 2 provides an overview of these 12 standards.

Group	Number	Subject
Cross-cutting	ESRS 1	General Requirements
Cross-cutting	ESRS 2	General Disclosures
Environment	ESRS E1	Climate
Environment	ESRS E2	Pollution
Environment	ESRS E3	Water and marine resources
Environment	ESRS E4	Biodiversity and ecosystems
Environment	ESRS E5	Resource use and circular economy
Social	ESRS S1	Own workforce
Social	ESRS S2	Workers in the value chain
Social	ESRS S3	Affected communities
Social	ESRS S4	Consumers and end users
Governance	ESRS G1	Business conduct

Table 2: 12 ESRS (European Commission, 2023)

An important part of the CSRD is the double materiality assessment, meaning that companies must assess sustainability from two perspectives. On one hand, organisations impact the environment and people (inside-out perspective). For example through environmental damage or human right violations. On the other hand, the outside-in perspective represents the impact sustainability-related developments have on the company. Sustainability development creates new risks and opportunities such as regulatory changes, climate risks and shifts in consumer trends/preferences. By considering both perspectives, companies enhance transparency and take greater responsibility for their sustainability impact (pwc, n.d.).

The Global Reporting Initiative

The Global Reporting Initiative (GRI) is the world's most widely used sustainability reporting framework. Referenced or required by over 160 policies in more than 60 countries and regions, GRI provides a globally recognized standard for sustainability reporting. The framework helps companies report transparently on their economic, environmental and social performance and plays a key role in harmonizing sustainability reporting practices across organisations and sectors (Bais et al., 2024).

As an independent organisation, GRI offers standards, tools and training to help organisations enhance their skills, capabilities and data management, enabling them to create long-term sustainable value (GRI, n.d.). The GRI Standards are designed for consistent and transparent reporting and are applicable to any organisation, regardless of size, sector or location. In addition, GRI collaborates with other standard-setting bodies, such as the International Sustainability Standard Board (ISSB) and European Financial Reporting Advisory Group (EFRAG), to improve alignment and reduce the reporting burden for companies.

The GRI framework promotes stakeholder inclusiveness by encouraging organisations to consider and respond to the needs and expectations of a broad range of stakeholders.

Adopting the GRI standards offers numerous benefits for organisations: the framework helps improve transparency, strengthens stakeholder trust and enhances comparability across industries. By using the GRI Standards, companies gain insights that support strategic decision-making and encourage them to reflect on their environmental, social and economic

impact. In this way, GRI contributes to more sustainable and responsible business practices (Bais et al., 2024).

Sustainability Accounting Standards Board (SASB) standards

SASB is a non-profit organisation that helps companies identify the risks and opportunities related to sustainability and communicate them effectively to investors. The SASB standards identify the sustainability-related risks and opportunities most likely to affect an entity's cash flows, access to finance and cost of capital over the short, medium or long term and the disclosure topics and metrics that are most likely to be useful to investors (SASB, n.d.).

Since 2022, the International Sustainability Standards Board (ISSB) of the IFRS Foundation has been responsible for maintaining, enhancing and evolving the SASB standards. Unlike the Global Reporting Initiative (GRI), the SASB standards are industry-specific. They provide tailored standards for 77 industries, recognising that risks and opportunities vary highly across sectors (SASB, n.d.).

The SASB standards have five sustainability dimensions: business model and innovation, the environment, leadership and governance, social capital and human capital. These dimensions provide a structured approach to demonstrate how sustainability issues affect a company's operational and financial performance. That way, investors can ultimately make more informed decisions (Jeffrey Hales, 2021).

The Sustainability Accounting Standards Board (SASB) standards provide several key benefits for companies. Firstly, they improve access to capital by helping organisations communicate essential sustainability information to investors, making them more attractive to sustainability-conscious investors (SASB, n.d.). Secondly, SASB supports strategic decision-making by offering sector-specific standards that align with long-term sustainability goals (SASB, n.d.). Thirdly, the framework provides a competitive advantage within the industry, enabling companies to differentiate themselves from competitors by being transparent about their sustainability practices. Finally, SASB ensures sector-specific relevance, allowing companies to focus on the most material sustainability issues for their industry, thereby enhancing the accuracy and impact of their reporting (SASB, n.d.).

2. Using GenAI in ESG reporting

In recent years, generative artificial intelligence (GenAI) has rapidly evolved, transforming various industries by enhancing efficiency, innovation and decision-making. It also provides numerous innovative solutions for improving the environmental, social and governance practices within a business (Rane et al., n.d.).

As AI is quicker in analysing and interpreting large volumes of data than humans, companies can reduce the manual effort and costs. While AI minimizes human biases in data processing, it is crucial to have human oversight in cases where judgment or decision-making is required (de Villiers et al., 2024).

AI can combine financial and non-financial reports, which makes an integrated report possible. This helps managers get the full picture of the reality and make better and more relevant decisions (de Villiers et al., 2024).

Another reason companies may use AI is its ability to provide information about sustainability reporting requirements (de Villiers et al., 2024). Some sustainability-related topics are complex and require additional information. Instead of struggling to understand these requirements, AI can explain you how it should be done. If you have additional questions, you have an answer right-away.

Unfortunately, greenwashing still happens. While it may seem more important for regulators and auditors to identify it, it is just as crucial for businesses to ensure they are not engaging in it. Generative AI can help companies by comparing their sustainability reports against other sources, allowing them to check if their claims are truly aligned with their actions. This way, businesses can avoid unintentional greenwashing and ensure their practices are transparent and trustworthy, ultimately protecting their reputation and reinforcing their genuine commitment to sustainability (de Villiers et al., 2024). AI also helps to verify ESG data and identify inconsistencies or fraudulent claims (de Villiers et al., 2024).

Sustainability reports often contain more text than other reports, such as financial reports. This is due to the fact that sustainability reports not only contain quantitative data but also qualitative and narrative data. AI can support the writing of sustainability report content (de Villiers et al., 2024).

Besides all the positive contributions of generative AI, it also comes with significant risks and companies should always be aware of that!

If a company over-relies on AI, it weakens critical thinking and ethical decision making. (de Villiers et al., 2024). It is therefore valuable to explore human-machine interaction. In such a system, humans and machines share information to enhance decision-making, increase productivity and simplify complex situations (Ahmed et al., 2024).

AI models are trained on large datasets that may contain "greenwashed" information, there is a risk that AI will reproduce such content. As a result, AI could contribute to the replication of misleading sustainability claims (de Villiers et al., 2024).

AI systems have a lot of biases from their training data, this may be in favour of some outcomes. You should thus never just copy things from AI, always check what is written and think critically.

AI can also help regulators and auditors verify ESG disclosures, improving accuracy and efficiency. But again, it is important to be cautious about over-reliance on AI and the loss of human oversight (de Villiers et al., 2024). Although investors and stakeholders can also use AI to analyse ESG reports, these aspects fall outside the scope of this paper and are therefore not discussed in detail.

CoA3. Embed sustainability into the company culture

Business leaders experience both internal and external pressure to fulfil corporate sustainability strategies. Transitioning to a green company requires more than just implementing new policies or goals, it demands a fundamental shift in company culture. But how can this transformation be achieved? This section looks at key strategies that help make sustainability a core part of a company's culture, ensuring that environmental responsibility is shared by all employees.

1. Use OKRs to embed sustainability across the organisation

OKRs were discussed in section '3. Objective and Key Results (OKR)' of CoA1, but they are also relevant to this CoA. When companies set OKRs related to sustainability, the entire organisation, including all teams, takes responsibility for progress. These OKRs make

employees more aware of sustainability goals, fostering a sense of shared responsibility. By assigning both targets and accountability, sustainability becomes a collective priority across the company (Zasa & Buganza, 2023).

2. Empower a green workforce through Green Human Resource Management (GHRM)

Green recruitment and selection

Employees are a company's greatest asset and more organisations are realizing that investing in their workforce is more beneficial than focusing solely on material resources. That's why ensuring the right people are brought into the organisation is so crucial (Kang et al., 2022).

Recruiting the right people is the first step in building a workforce that aligns with a company's values. Although green recruitment and selection are people-intensive, they provide long-term benefits for the company. When potential employees share the same ecological values as the organisation, they are more likely to accept the job, pursue the job and experience a greater job satisfaction. Using a green recruitment and selection procedure, facilitates later stages after entry, such as employee involvement and green training (Pham & Paillé, 2020).

To attract environmentally conscious applicants, companies can position themselves as a green company (Pham & Paillé, 2020). Showing a strong green image enhances a company's reputation as an environmentally responsible employer. This improved reputation helps attract environmentally conscious talent and develop pride in employees, boost greater engagement and commitment to organisational goals (Arulrajah et al., 2016).

Organisations assess candidates on environment-related skills and experience, but there are no standardised green selection criteria. To ensure alignment with sustainability goals, many companies implement value-based recruitment processes to evaluate whether applicants fit the organisation's core values, mission and vision (Galpin et al., 2015). Suggested approaches include assessing pro-environmental attitudes, utilizing personality tests to measure green competencies, reviewing candidates background and awards won for eco-initiatives/solutions (Pham & Paillé, 2020). Companies can incorporate sustainability responsibilities and tasks into job descriptions, ensuring that recruiters are aware of these goals and align the hiring process with the organisation's sustainability strategy (Arulrajah et al., 2016).

Induction and training

Once the right candidates are recruited, they undergo an onboarding process that helps them integrate effectively into the organisation. Since employees are the greatest asset of a company, investing in their training and development is essential. Sustainability training provides employees with knowledge, skills and attitudes that contribute to sustainable business goals (Kang et al., 2022). This training not only enhances individual responsibility but also aligns employees with the company's broader objectives for sustainable business practices.

The HSBC case study in Hong Kong highlights how such initiatives enhance employees' awareness, attitudes and behaviours toward environmental responsibility. These programs build trust, improve public perception and help align individual learning with long-term corporate strategies. While they require investment, their benefits, such as stronger employee engagement and a deeper sense of corporate responsibility, are vital for achieving sustainable development (Law et al., 2017).

Sustainability training should be provided at all levels within the organisation to ensure that sustainable practices are embedded throughout the company (Haugh & Talwar, 2010; Sammalisto & Brorson, 2008). However, it is essential for managers to receive more in-depth training on the triple bottom line to effectively integrate sustainability principles into decision-making processes (Sammalisto & Brorson, 2008).

Training starts immediately after recruitment. Companies can provide a general sustainability induction and a job-specific induction (Arulrajah et al., 2016).The general induction provides fundamental information about the company's environmental policies, systems and practices, while job specific induction introduced them to environmental programmes and responsibilities relevant to their specific job (Arulrajah et al., 2015).

In Addition to initial training (induction), continuous training is crucial for improving overall company performance, enhancing employees' skills and proactively addressing workplace challenges (Kang et al., 2022). One-time training programs often have limited impact, making it essential to design sessions that foster lasting knowledge and behavioural change among employees. To ensure relevance, training should be regularly evaluated and updated (Perron et al., 2006).

To maximize the impact, sustainability training should always align with the company's strategic objectives. Training programs should be tailored to the company's specific sustainability goals, ensuring that employees gain relevant, actionable knowledge (Sult et al., 2024). Sustainability training can cover many topics such as environmental management, corporate governance, business ethics, sustainable development, energy efficiency, waste management, recycling, development of green personal skills, etc (Arulrajah et al., 2016; Kang et al., 2022).

Collaborative training is an effective way to integrate corporate sustainability as it promotes interaction and leads to more sustainable behaviour than traditional lecture-based methods. To make training more impactful, it should be practical, engaging and action-oriented, allowing employees to apply their knowledge in real-life situations (Sult et al., 2024).

Companies can assess the effectiveness of sustainability training by implementing specific KPIs that measure its impact. For example, it is common to look at the percentage of employees who take part in a training and how many complete it successfully. Metrics like the average time needed to finish the course and the results of knowledge tests afterwards help to assess the overall effectiveness and efficiency of the programme. It is also useful to track whether employees actually apply what they have learned in practice. This can be done by for example monitoring behavioural changes or performance improvements. Participant satisfaction, based on evaluations or feedback scores, is another important indicator (Mammoth climate, n.d.)

When it comes to sustainability training, companies can also include KPIs that are directly linked to environmental performance. These include the number of sustainability certifications obtained, shifts in day-to-day behaviour towards more sustainable practices and measurable outcomes like reductions in energy or water consumption, less waste and higher recycling rates. By monitoring these KPIs in a structured way, organisations can demonstrate the real impact of their training efforts and adjust where necessary (Mammoth climate, n.d.; Kang et al., 2022).

Implement an eco-conscious reward system

Employees can be encouraged to engage in environmentally friendly behaviour through a well-designed reward system. Implementing such systems helps foster a greater sense of

environmental responsibility among employees, strengthening sustainable practices within the organisation and may increase employee engagement and loyalty. It also helps to accomplish the organisations environmental goals and creates green creativity and innovation (Kang et al., 2022).

Rewards can take two forms: monetary, such as cash, bonuses or gift cards and non-monetary, such as additional vacation days, praise, compliments or constructive feedback (Arulrajah et al., 2016; Kang et al., 2022).

CoA4. Be transparent to customers about ES

Research by EY (2023) indicates that 84% of global consumers consider sustainability an important factor in their purchasing decisions. Additionally, 43% state that they would buy more from companies that contribute positively to society, even at a higher cost (EY, 2023).

Customers increasingly demand transparency from companies. Being transparent enhances trustworthiness, strengthens customer relationships and fosters long-term loyalty (Liu et al., 2023). It also helps customers to make more informed decisions about their purchases. Additionally, transparency helps reduce risks such as greenwashing by ensuring that disclosed information is accurate and reliable. Furthermore, when customers perceive a company as environmentally transparent, they are more likely to adopt pro-environmental behaviour (Vaccaro & Echeverri, 2010).

1. Communicate accessible and clearly about your sustainability initiatives

There are various ways to communicate as a firm about your sustainability initiatives. You can use your website, social media accounts and campaigns. Corporate websites can serve as hubs for detailed sustainability reports and updates, ensuring transparency and accessibility. Social media platforms are emphasized for their dynamic engagement capabilities, allowing companies to share real-time updates and foster community trust. Advertising campaigns are noted for their ability to promote eco-friendly products and appeal to environmentally conscious consumers (Braga et al., 2024).

Accessible communication is an essential part of transparency and helps strengthen relationships between companies and their stakeholders. It is not just about sharing data, but about presenting it in a way that is understandable, relevant and useful to your customers

(Wong et al., 2021). A clearly formulated mission and vision that reflect the company's sustainability values also contribute significantly to effective communication. They help create a clear and consistent story, making it easier for customers to understand the company's long-term goals and commitment to sustainability (Penco et al., 2019).

Sharing both positive and negative results also helps to build trust. Tools such as product labels, ESG dashboards and reports can bridge the gap between data and consumer understanding (Vaccaro & Echeverri, 2010). By focusing on accessible communication, companies meet stakeholder expectations and support transparency, trust and long-term impact.

Effective tools for this include interactive platforms, social media and well-structured reports that make environmental information more accessible (Wong et al., 2021). Companies should tailor their channels to the audience, using tools like social media, websites and digital technologies (Borges et al., 2023).

2. Publish clear ESG reports

The use of GRI and CSRD enhances transparency in sustainability reporting by requiring companies to disclose structured and verifiable information about their environmental and social impact. GRI focuses on broad societal reporting, providing consumers with insights into how companies address sustainability (Bais et al., 2024). CSRD mandates companies in the EU to include standardised sustainability data in their annual reports (Operato et al., 2025, n.d.). By adhering to these frameworks, companies increase their credibility and facilitate access to reliable information, enabling consumers and stakeholders to make more informed decisions.

3. Provide product-level transparency

If your organisation produces or sells physical products, it is essential to provide customers with clear and accessible information about those products. People want to know where a product is made, what materials were used, under what conditions it was produced and how it can be recycled or disposed of responsibly. One effective way to communicate this is through product labelling and the use of trusted sustainability certifications. These tools help increase product-level transparency, making it easier for customers to make informed, sustainable choices.

Product labels, standards and certifications

A product label is an informative label attached to a product or on its packaging. It contains important details about the product, such as its composition, origin, instructions for use and nowadays environmental or sustainability information. It is a practical tool to show customers how sustainable a product is. Eco-labels act as clear and informative signals, helping consumers distinguish products based on their environmental impact (Horne, 2009). They provide clarity and credibility, enabling customers to make more conscious and informed choices. There are quite a few product labels related to sustainability, some are broad and cross-sectoral, others are specific to a particular product group or impact category (such as environment, animal welfare or fair trade). Some labels, such as the EU Ecolabel, FSC (Forest Stewardship Council), Fairtrade and Rainforest Alliance, further enhance transparency, as they are verified by independent third parties (Gorton et al., 2021; Horne, 2009).

One way to identify or develop meaningful product labels is by performing a Life Cycle Assessment (LCA), which is discussed in detail in the CoA5 under the subtitle 'Embrace Circularity – Life Cycle Assessment' (Agarwal *et al.*, 2012).

Another way to represent the quality of products is by using standards like the ISO standards, which provide internationally recognized guidelines for ensuring environmental sustainability and product quality. ISO standards help companies demonstrate their commitment to sustainability through rigorous and measurable criteria, fostering trust and accountability with consumers (ISO, n.d.). These standards, such as ISO 14001 for environmental management systems, provide frameworks for organisations to assess and improve their sustainability practices. Later in this thesis, we will delve deeper into various ISO standards for circularity.

Today, more companies use QR codes with more information about the product. By using QR codes on packaging, key information about product origins, production processes and quality can be easily accessed by end consumers using their smartphones (Tarjan et al., 2014).

For example, ALDI uses QR codes on meat products to provide transparency about the origin and processing, increasing customer trust (ALDI, 2024). Another example: In collaboration with The R Collective, Levi's launched a collection where each piece contains a QR code that provides information on the supply chain, maintenance tips and recycling opportunities.

Digital Product Passport (DPP)

The Ecodesign for Sustainable Products Regulation (ESPR), an European regulation aimed at improving the sustainability and circularity of products throughout their entire life cycle, introduced the Digital Product Passport (DPP). The DPP aims to increase transparency across product value chains by providing detailed digital information on a product's origin, materials, environmental impact and end-of-life instructions. It includes key data such as compliance documents, safety guidelines and information on substances of concern. By aligning with open data principles, the DPP promotes accessibility and standardisation, supporting better collaboration, regulatory compliance and sustainability efforts. Overall, it marks a major step toward a more transparent and responsible European market (European Union, 2024).

CoA5. Include planet Earth as a company stakeholder

Adopting a sustainable business strategy requires recognising planet Earth as a key stakeholder of the company. This course of action emphasises innovation in product development, waste minimisation and the integration of circular economy principles. Within the framework of the European Green Deal, the Circular Economy Action Plan aims to accelerate the shift towards a circular and sustainable economic model (Papamichael et al., 2023).

This section opens with an exploration of the circular economy, followed by a discussion of influential frameworks that facilitate its application. It proceeds to examine international standards for sustainable practices and concludes by outlining key performance indicators (KPIs) used to assess circularity in business operations.

1. Embrace circularity

The transition from a linear to a circular economy is a critical step towards sustainability. A widely accepted and frequently cited definition of the circular economy comes from the Ellen MacArthur Foundation (2019), which describes it as: *"A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use and regenerating natural systems."* By shifting away from the traditional linear "take-make-dispose" model, the circular economy promotes sustainability throughout the entire lifecycle of a product.

The key strategies of a circular economy are recycling, reusing and reducing (Mhatre et al., 2021). These principles can be directly linked with three resource loops that drive circular business models (N. Bocken & Ritala, 2022). Closing loops corresponds to recycling, focusing on the reintegration of materials back into production systems. Philips' “pay-per-lux” model ensures that lighting components are recycled at the end of their lifecycle, reducing electronic waste. Slowing loops aligns with reuse, aiming to extend product lifecycles through maintenance, refurbishment and second life applications. Rolls-Royce’s “power by the hour” service provides aircraft engine maintenance, ensuring longevity and reducing the need for new materials. Narrowing loops relates to reduction, emphasizing efficiency in design and production to minimize resource consumption. In recent years, Apple has taken concrete steps to optimize its product packaging with the aim of reducing material use and lowering CO_2 emissions (N. Bocken & Ritala, 2022) .

A fourth loop in circular business models is regenerating loops. It aims to revive natural resources and create a net-positive environmental impact. Companies adopting this approach invest in sustainable sourcing, ecosystem restoration and regenerative agriculture. Danone supports regenerative agriculture by helping farmers implement soil-friendly practices such as reducing chemical fertilizers and promoting carbon sequestration. Through partnerships like its collaboration with WWF, the company enhances biodiversity while ensuring sustainable food production (N. M. P. Bocken & Geradts, 2021).

Collectively, these strategies shift the focus from end-of-life management to maintaining the value of resources throughout their lifecycle (N. M. P. Bocken & Geradts, 2021; N. Bocken & Ritala, 2022). For optimal circularity, it is recommended to use these three strategies together.

The butterfly diagram

The butterfly diagram, illustrated in Figure 3 and developed by the Ellen MacArthur Foundation, visualises the circular economy by illustrating the continuous flow of materials through two distinct cycles: the technical cycle and the biological cycle. In the technical cycle, materials are kept in circulation through reuse, repair, remanufacturing and recycling. Meanwhile, the biological cycle focuses on safely returning biodegradable materials to the

environment, where they can regenerate natural systems (*The Butterfly Diagram: Visualising the Circular Economy*, 2021).

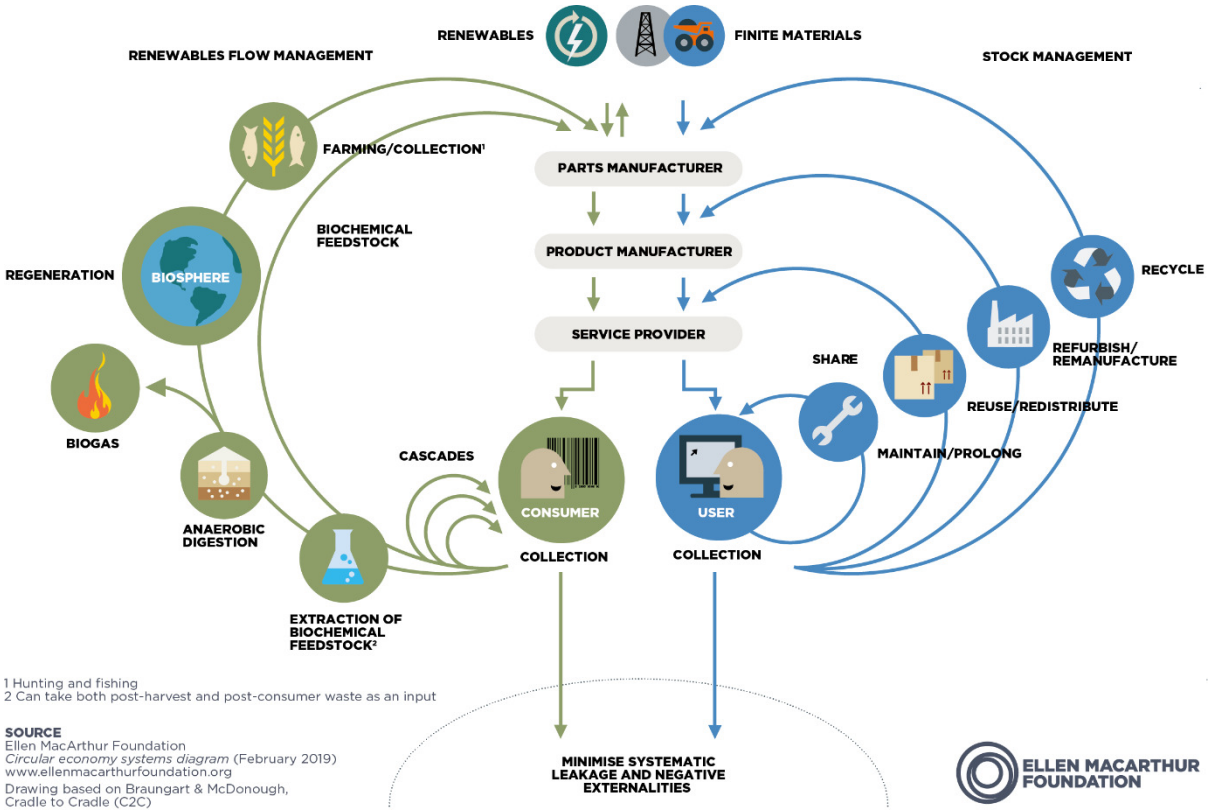

Figure 3: The butterfly diagram (Ellen MacArthur Foundation, 2019)

The resource loops narrowing, slowing and closing can be clearly situated within the technical cycle of the butterfly diagram. The aim is to keep materials in the industrial cycle through reuse, recycling and repair.

In contrast, the regenerating loop belongs to the biological cycle, which focuses on restoring ecosystems through the safe return of organic materials. This loop goes beyond minimizing harm, it aims to create positive environmental value, especially relevant for sectors linked to agriculture, forestry or food. Businesses adopting regenerative practices contribute to soil health, biodiversity and carbon capture (*Ellen MacArthur Foundation, 2022)*.

Life Cycle Assessment (LCA)

Life Cycle Assessment (LCA) is key to creating more effective Circular Economy strategies, as it helps evaluate the environmental impacts at every stage of a product's life, from production to disposal. It takes into account both upstream and downstream effects, considering all necessary resources and impact areas. When LCA is thoroughly implemented, it provides a

comprehensive approach to decision-making that goes beyond just environmental impact, also incorporating economic and social considerations (Peña et al., 2021).

Life Cycle Assessment (LCA) consists of four main phases. The first phase, Goal and Scope Definition, sets the purpose of the study and establishes system boundaries. The second phase, Life Cycle Inventory, involves collecting data on material and energy use, as well as emissions and waste associated with the product or process. In the third phase, Life Cycle Impact Assessment, the environmental effects of the collected data are evaluated, focusing on categories like global warming potential or resource use. The final phase, Interpretation, involves analysing the results to support data-driven decisions that lead to more sustainable practices. LCA helps companies identify environmental hotspots and strengthen their circular economy strategies (Ganigué & Van de Wiele, 2023; Dewulf & Huysveld, 2020).

Using LCA is crucial for identifying processes, ingredients and systems with significant environmental impacts, as well as for comparing different approaches within a specific process to minimize these effects. LCA offers a way to pinpoint where environmental impacts and their associated costs are highest across a product's lifecycle. By reducing energy, water, material use and waste, companies can improve sustainability while achieving cost savings and reducing regulatory risks (Agarwal *et al.*, 2012).

Manufacturers have the greatest potential to influence a product's environmental impacts, as they can affect the environmental characteristics of the supplies they use, contribute to a significant portion of waste generation and influence the product's use and disposal impacts (Ganigué & Van de Wiele, 2023). Consequently, manufacturers need to take LCA into account. It helps them identify environmental impacts throughout a product's life cycle so they can make sustainable choices during product development and production.

2. Adopt and align with sustainability standards

Products have a significant environmental impact throughout their life cycle. To reduce this impact, various regulations and standards have been developed within Europe and worldwide to help companies operate more sustainably. This section highlights two key frameworks: the European Ecodesign for Sustainable Products Regulation (ESPR) and international ISO standards. Both initiatives encourage organisations to integrate circular principles into their

products, processes and chains, providing essential guidelines for companies that want to contribute to a more sustainable future.

Ecodesign for Sustainable Products Regulations (ESPR)

In July 2024, the Ecodesign for Sustainable Products Regulation (ESPR) came into force. This regulation is part of the European Commission's broader drive to make products more sustainable and circular. The ESPR will support the EU in meeting its climate and environmental targets, increasing energy efficiency and doubling the circular use of materials by 2030 (European commission, n.d.).

The regulations require manufacturers, importers and distributors to design products with the full life cycle in mind: from raw material to end-of-life, including durability, repairability, reusability and recyclability. This is done by the ecodesign requirement, these are performance and information rules for almost all categories of physical goods (European commission, n.d.). The rules are adopted either on a product-by-product basis or based on groups of products with the same characteristics.

One of the most innovative elements of the ESPR is the Digital Product Passport. As previously discussed in CoA4: 'Be transparent to customers about ES', specifically under the section 'Provide product-level transparency', this tool plays a key role in increasing insight into product attributes and sustainability performance.

The European commission also puts a ban on the destruction of unsold products. These often contain valuable resources. The ESPR introduces more specifically a ban on the destruction of unsold textiles and footwear. This is only a starting point, it opens doors for similar bans in other sectors. This ban also requires companies across all product sectors to disclose annual information about unsold products (European Commission, n.d.).

Businesses can prepare effectively by taking four key steps:

1) Conducting a product audit to assess the sustainability and circularity of materials and design
2) Investing in digital tools to manage and track compliance data
3) Collaborating with suppliers and stakeholders to align sustainability goals across the value chain
4) Educating employees to ensure internal understanding and engagement.

These actions not only support regulatory compliance but also strengthen transparency, efficiency and long-term sustainability performance (Shvets, 2025).

ISO standards

Certain specific standards are crucial for achieving circularity in product policy. As stated on the site of ISO: *"International Standards help companies ensure that their products align with principles like durability, reusability, upgradability or repairability. They foster consumer trust in shared, recycled, repaired or upcycled goods and components as well as relevant services and enable collaboration between economic partners*" (ISO, n.d.).

In 2024, ISO published the ISO 59000 family, a set of standards specifically designed to support the implementation of circular economy principles. These standards aim to assist organisations in transitioning their value creation models and networks from a linear to a circular framework. They are applicable to any type of organisation and voluntary, although they match with emerging regulations (Mensch, 2025; ISO, n.d.). The most relevant standards in this family are (ISO, n.d.):

- ISO 59004: Vocabulary, principles and guidance for implementation
- ISO 59010: Guidance on the transition of business models and value networks
- ISO 59014: Environmental management and circular economy- Sustainability and traceability of the recovery of secondary materials — Principles, requirements and guidance
- ISO 59020: Measuring and assessing circularity performance
- ISO 59040: Product circularity data sheet

In addition, the ISO 14000 family also provides essential frameworks for integrating circular economy principles into business operations, particularly in areas such as environmental management, eco-design and performance assessment. Key standards include (ISO, n.d.):

- ISO 14001: Environmental Management systems- requirements with guidance for use
- ISO 14031: Environmental performance evaluation- guidelines
- ISO 14052: Environmental management - Material flow cost accounting - illustrative example with inputs and outputs

- ISO 14053: Environmental management- Material flow cost accounting- Guidance for phased implementation in organisations

Suppliers are essential for effective, sustainable supply chain management. Companies should encourage and sometimes require their suppliers to meet relevant standards to ensure sustainability and quality throughout the supply chain (Carter & Rogers, 2008).

Although not every standard is mandatory, it is important for organisations to assess which ISO standards are most relevant to their sector, operational context and sustainability goals and include these standards in their business.

3. Use KPIs to measure circularity

KPIs allow companies to evaluate the effectiveness of their circular strategies, ensuring that their operations contribute to reducing resource consumption, waste generation and carbon emissions while maintaining competitiveness in the market. As always, there is no standard set of KPIs that a company should measure.

Research by Paolo Taticchi and Melina Corvaglia-Charrey (2023), in collaboration with the Circular Economy Indicators Coalition (CEIC) and supported by Accenture, provides a structured approach to circular target-setting. They suggest that companies focus on four outcomes. The first one is circular inputs, which highlights the use of sustainable, non-virgin materials in products and packaging. The goal is to minimise dependence on finite resources and reduce total material consumption by integrating more circular alternatives. For example, a company might track the percentage of materials used from renewable sources or the reduction in virgin material consumption (Taticchi & Corvaglia-Charrey, 2023).

The second outcome is operational waste, which aims to reduce waste and increase value recovered from it. According to Taticchi & Corvaglia-Charrey (2023), companies can measure this outcome by tracking metrics like reduction in waste produced across operations or looking beyond zero waste to landfill. A third outcome is circular outputs, which targets a higher recovery of post-use materials through reuse or recycling. Metrics in this area could include the quantity of post-use products and materials recovered or the share of addressable post-use waste that is reused or recycled (Taticchi & Corvaglia-Charrey, 2023). The last outcome is circular revenues, which reflects the share of income generated from circular

products or services. As described in Taticchi & Corvaglia-Charrey (2023) relevant metrics in this area include the share of revenue from circular products, services and solutions.

The research also mentions four enablers that help the accomplishment of the four outcome KPIs. These enablers include circular design, which encourages companies to design products and packaging with reuse, repair and recycling in mind from the outset. Waste production and transparency focus on minimizing waste generation while improving tracking and reporting across operations. Product life extension and utilisation aims to increase how long and how efficiently products are used. Lastly, output collection measures the amount of post-use waste that is successfully collected, laying the foundation for high-value recovery and recycling. These enablers support the implementation of circular strategies across the value chain (Taticchi & Corvaglia-Charrey, 2023).

A study by Moraga et al. (2019) highlights the importance of Life Cycle Thinking (LCT) in developing circular KPIs. LCT considers the full lifecycle of a product from design to disposal while accounting for environmental, social and economic impacts. This approach helps prevent burden-shifting between lifecycle stages and aligns with EU circular economy policies, making it essential for effective and future-proof strategy development. The study introduces several insightful KPIs. For instance, the Ease of Disassembly Metric (eDiM) measures how easily a product can be taken apart to enable reuse or recycling. The Number of Times of Use of a Material (NTUM) tracks how often a material is reused across various product categories. Lastly, the End-of-Life Recycling Rate (EOL-RR) shows what share of a product is actually recycled at the end of its use (Moraga et al., n.d.).

Since suppliers play a key role in enabling circularity across the value chain, it makes sense to define a set of KPIs that reflect their contribution. For example, the company could track the percentage of suppliers that meet certain circularity criteria or comply with standards like ISO 14001, ISO 59000 family and ESPR. These KPIs help ensure that supplier practices are aligned with the company's sustainability goals, while also supporting compliance, reducing supply chain risks and increasing overall transparency.

CoA6. Identify architecture principles for green strategy execution

Principles are general rules and guidelines that help an organisation realise its mission and strategy. They are designed to be stable and long-lasting and provide direction from the

organisation's core values all the way to concrete actions and outcomes. Architecture principles serve as fundamental rules that guide the execution of enterprise architecture activities. They influence how the architecture is designed, updated and utilized throughout the organisation (The Open Group, n.d.)

These principles form the most stable and fundamental part of enterprise architecture. They guide how the architecture is designed and evolves over time, ensuring that changes happen in a consistent and purposeful way rather than through ad-hoc decisions. In this way, EA principles support organisations in structuring and developing their IT landscape and business processes, so that everything aligns with and contributes to their strategic goals (Haki & Legner, 2021).

1. Apply five general architecture principles for green strategy

The Open Group Architecture Framework (TOGAF) provides a clear structure for defining principles, using the following elements (The Open Group, n.d):

- Name: Should represent the essence of the principle and be easy to remember
- Statement: A clear, unambiguous formulation that summarizes the principle
- Rationale: Explain why the principle is important and how it supports business objectives
- Implications: Describe the impact of the principle on the organisation, including requirements and consequences

By using this structure, the identification of green architecture principles becomes transparent, reusable and aligned with broader ES practices (The Open Group, n.d.). This thesis identifies five key principles that organisations can follow in order to successfully reach their sustainability objectives. These are designed to support the execution of a sustainability strategy at the enterprise level. Since the strategy layer of GREAN is proposed by Vandevenne et al. (2023), there is currently no scientific literature on green architecture principles for the strategy layer. The five principles outlined here include one originally proposed by Vandevenne et al. (2023): *Always include environmental sustainability in future transformation projects.* The remaining four principles are newly derived based on the Strategy CoAs discussed in this thesis.

Principle 1: Always include ES in future transformation projects (Vandevenne et al., 2023)

Statement: ES must be a standard consideration in all future digital and organisational transformation projects.

Rationale: If sustainability is included from the beginning, it becomes part of the foundation rather than something added on later. This helps ensure that solutions are aligned with the organisation's environmental goals from the start.

Implications:

- All projects should also asses their environmental impact (Co_2-emission, waste, water usage, energy consumption…) and include this as a factor when comparing different options or technologies.
- Environmental impact should be considered as a key quality attribute when evaluating different architectures or technologies (Vandevenne et al., 2023).

Principle 2: ES is everyone's responsibility

Statement: Environmental sustainability should be a responsibility shared by everyone in the organisation, not just management or a specific team.

Rationale: If only the management or a specific team are responsible for ES, the impact will be minimal. When everyone contributes, sustainability thinking becomes part of daily operations and culture.

Implications:

- Cross-functional teams should collaborate on sustainability initiatives, making sure everyone contributes.
- Training and workshops should be given to educate all employees on sustainability practices and their role in achieving the organisation's sustainability goals and encourage them to adopt more sustainable habits in their daily lives.
- Sustainability metrics should be integrated into performance reviews and individual objectives for all employees.

Principle 3: ES is a core strategic concern

Statement: ES must be treated as a core strategic priority, just like performance, cost, risk and growth

Rationale: Only when ES is fully integrated in the strategy, it will influence key decisions, investments and overall direction of the organisation

Implications:

- All major decisions, including investments and mergers, should be evaluated for their environmental impact.
- KEIs should be tracked and reported to ensure alignment with organisation's overall strategy.
- Long-term sustainability goals should be incorporated into the organisation's strategic plan and be reflected in its overall business objectives.
- The organisation should have a sustainability committee that guides and monitors the company's sustainability strategy.

Principle 4: Embed sustainability in EA

Statement: EA is used as a bridge between sustainability strategy and effective execution across business and IT.

Rationale: Because EA looks across both business and technology, it is in a perfect position to connect high-level sustainability goals to the actual systems, processes and capabilities needed to deliver them.

Implications:

- EA should include specific sustainability drivers and objectives.
- Enterprise architects should be trained to evaluate environmental impacts during solution design.
- Sustainability-related metrics should be used to enable effective tracking and reporting on processes.
- Identify relevant sustainability architecture principles on each of the BDAT layers.

Principle 5: Include lifecycle thinking in the design

Statement: Products, systems and processes should be designed with their full lifecycle in mind.

Rationale: Thinking about the lifecycle helps make more sustainable decisions, as many environmental impacts happen before or after the usage phase. Think about the extraction of raw materials, production and disposal.

Implications:

- Products, systems and processes should be designed with a focus on energy efficiency, recyclability, disposal and minimising waste at each phase of their lifecycle.
- A lifecycle assessment (LCA) and lifecycle cost analysis (LCCA) should be conducted when evaluating design options.
- Suppliers should be selected keeping the lifecycle in mind, not the initial cost
- Designers should prioritize modular, reusable and adaptable designs.

2. Develop business-specific green architecture principles

Since this thesis takes a general, non-sector-specific approach, companies must reflect on their own strategic goals and obligations and define architecture principles that align with them. The combination of business-specific architecture principles and those five general ones creates a strong foundation for aligning sustainability strategy with enterprise architecture practice. While the general principles offer a solid baseline applicable across industries, business-specific principles allow organisations to tailor their approach to their unique context, strategic goals and regulatory requirements. By doing so, organisations ensure that their architecture not only supports environmental goals in a general sense but also responds effectively to sector-specific challenges and opportunities. This dual approach promotes both consistency and relevance, enabling more effective execution of green strategies across the enterprise.

CoA7. Raise awareness of environmental consequences

Employees are crucial drivers of organisational success. Strengthening internal readiness begins by enhancing employees' skills and knowledge about sustainability. This Course of Action focuses on building employee awareness and understanding. Employees must

recognize the environmental impact of their actions, as greater awareness fosters a sense of responsibility and encourages sustainable behaviour throughout the organisation.

1. Provide targeted training and workshops

Sustainability training and workshops help employees become aware of their environmental impact and equip them with the right knowledge on this topic. This topic has already been extensively covered in CoA3: *Embedding Sustainability in the Corporate Culture*, specifically in the sections on induction and training.

2. Implement information campaigns

A simple yet effective way to raise employee awareness is through information campaigns. Sharing information about how their actions impact the environment and teaching some practical steps they can take to reduce their environmental footprint can be done via regular, accessible newsletters, posters, videos or infographics (Katarzyna, 2024).

3. Use digital visualisation tools

Knowledge transfer within an organisation can be enhanced using visualisation tools. These tools enable managers to effectively communicate knowledge to diverse groups of stakeholders, fostering a strong shared understanding among different parties. Common formats include diagrams, graphics and schemas (Troise, 2022).

One key benefit of visualisation tools is flexibility, they can be easily adapted, modified or enriched with new elements and data. Interactivity is another advantage, as these tools engage employees more effectively, increasing their involvement and encouraging proactive action. Agility is a third benefit, as visualisation tools allow managers to respond swiftly to changes and new developments (Troise, 2022).

Troise also highlights their value in brainstorming and co-creation processes, as they facilitate collaboration and help teams work together more effectively.

CoA8. Include environmental awareness in the hiring process

The concept of COA8 has been explained in CoA3 under section 2, *Green Human Resource Management (GHRM).*

CoA9. Invest in Green IS/ICT capabilities

As Green IS and Green ICT practices have been shown to drive cost reductions, enhance corporate reputation and foster green innovation capabilities, it is crucial for organisations to build strong internal Green IS/ICT capabilities (Vandevenne et al., 2023).

1. Green IS

Green IS refers to the design and use of information systems that support sustainable business processes. It primarily aims to develop and implement systems that assist environmental management processes. Pollution prevention, product stewardship and sustainable development are the three categories of green IS (Baggia et al., 2019).

Green IS initiatives can generate multiple organisational benefits. They help reduce costs by improving the resource efficiency of IT infrastructure and business processes and by lowering energy consumption. Green IS also enhances corporate reputation by shrinking the environmental footprint and enabling better environmental reporting. Furthermore, these initiatives strengthen innovation capabilities through green product and process development, while contributing to broader outcomes such as reduced waste and emissions, greater corporate social responsibility, higher employee environmental awareness and an improved public image (Baggia et al., 2019).

Managers should start by ensuring that the organisation's motivation for adopting Green IS comes from internal commitment. Additionally, it is important to embed Green IS adoption within the organisation’s strategic priorities, making sustainability a clearly defined focus at the strategic level (Baggia et al., 2019).

There are multiple actions businesses can take. In this thesis, only a few of them are discussed.

Real-time emission tracking

Real-time emission tracking is a powerful tool for pollution prevention. By using IoT-enabled devices equipped with sensors, companies can continuously monitor key parameters such as CO_2- levels and volatile organic compounds. This provides an up-to-date and accurate picture of their environmental impact, allowing organisations to respond quickly to emission spikes and to target specific areas for process improvements (Blessing Ameh, 2024).

Additionally, real-time emission tracking supports regulatory compliance by automating emission reporting, allowing organisations to easily provide accurate and up-to-date information (Blessing Ameh, 2024).

Real-time emission monitoring is becoming a crucial component of last-mile delivery. IoT devices, including sensors on vehicles and shipping containers, collect data on fuel usage, vehicle performance and environmental conditions. This allows logistics companies to identify and fix inefficiencies, such as excessive idling, fuel waste and emission. For example, DHL uses IoT devices to monitor real-time emissions and improve vehicle performance (Greg Urban, 2024).

Moreover, when combined with route optimisation software that integrates traffic and vehicle capacity data, real-time emission tracking can significantly reduce emissions. As Greg Urban states, this technology has the potential to cut CO_2 emissions by up to 30% and lower delivery costs by nearly 20%, making it a game-changer in emission reduction (Greg Urban, 2024).

It is essential to ensure that employees are properly trained to use these devices and interpret the data effectively (Blessing Ameh, 2024). This can be done through job-specific training. We have talked about training in CoA3: Embed sustainability into the company culture, more specifically in GHRM.

Digital twin for product design and development

Using digital twins (DT) is beneficial for pollution prevention, product stewardship and sustainable development. A Digital Twin is a virtual representation of a physical entity, continuously updated through real-time data collected from its physical counterpart. It creates a continuous connection between the physical and virtual worlds by gathering real-time data from the physical object and updating its digital replica accordingly (He & Bai, 2021; Grieves & Vickers, 2016).

The virtual entity contains all relevant properties, information and states of the physical entity (Poels et al., 2022). In terms of functionality, a digital twin operates through two main processes: mirroring and virtual processing. Mirroring ensures real-time synchronisation between the physical and virtual entities, supported by sensors, actuators and sometimes human input. Virtual processing involves running algorithms on the virtual entity to model,

optimize and simulate the physical entity, allowing businesses to predict outcomes, improve operations and enhance system performance within a closed-loop environment (Poels et al., 2022).

A digital twin can be highly beneficial to a company in many ways. It offers a variety of advantages by digitally replicating physical objects, processes or systems and gathering real-time data. By implementing digital twins in various stages of the product lifecycle, organisations can significantly reduce their environmental impact.

To begin, using digital twins in product design enables engineers to quickly identify flaws and inefficiencies. Through digital twins, they can track the lifecycle of a product and its components, allowing them to test and optimize designs virtually, including strategies for recycling and reuse. This approach promotes the use of eco-friendly materials, energy-efficient solutions and recyclable designs, resulting in less material waste and a lower environmental impact (He & Bai, 2021; Tsolev, 2024). This part can also be linked to CoA5: Include planet earth as a company stakeholder.

Moreover, to enhance sustainability in manufacturing, digital twins can be used to simulate production for peak productivity and efficiency (He & Bai, 2021). Inefficiencies in the production process are eliminated before they occur in the physical world. Digital twins enable real-time monitoring of energy consumption, allowing companies to optimize processes, minimize energy waste, achieve substantial cost savings and reduce their carbon footprint. This proactive strategy minimizes material waste, decreases emissions and mitigates environmental pollution (Tsolev, 2024).

Another major advantage of digital twins is their ability to improve predictive maintenance. By continuously tracking the condition of equipment and machinery, digital twins can forecast when maintenance is needed, helping to prevent unexpected failures and extend asset lifespans. This proactive approach not only decreases downtime and maintenance expenses but also reduces the environmental impact caused by production disruptions and repair activities (Tsolev, 2024).

Sustainability performance management systems (SPMS)

Sustainability Performance Measurement Systems (SPMS) are essential tools for organisations aiming to embed sustainability into their core business processes and decision-

making. An SPMS can be defined as a system of indicators that provides companies with the information needed to plan, control, manage and evaluate their economic, environmental and social activities in both the short and long term (Searcy, 2012). As stakeholder expectations around accountability and sustainability performance continue to grow, the development and implementation of SPMS have become increasingly important (Vitale et al., 2025).

Organisations should start with the design phase of an SPMS by identifying their sustainability priorities and selecting relevant indicators that cover the triple bottom line: economic, environmental and social performance (Searcy, 2012). Frameworks such as the Global Reporting Initiative (GRI) offer valuable guidance during this phase, ensuring that indicator selection aligns with stakeholder expectations and international standards (Vitale et al., 2025).

Once the indicators are selected, the next step is to integrate them into existing information systems such as Enterprise Resource Planning (ERP) platforms or business intelligence tools. This integration enables real-time monitoring, transparency and data-driven decision-making across the organisation (Searcy, 2012; Vitale et al., 2025). Embedding sustainability metrics into the IT infrastructure ensures that sustainability data is consistently captured, analysed and made accessible across different business functions.

During the use phase, organisations must regularly analyse the collected data to track progress towards sustainability goals, identify improvement opportunities and communicate performance to both internal and external stakeholders (Searcy, 2012). Continuous review and adaptation of the SPMS is crucial to maintain its relevance, particularly in response to changing business strategies, stakeholder demands and regulatory requirements(Vitale et al., 2025). This flexible approach supports continuous improvement and fosters a culture of accountability and transparency.

2. Green ICT

The relationship between information and communication technologies (ICT) and environmental sustainability is complex. On the one hand, the widespread use of ICT has contributed to increased energy consumption, higher CO_2 emissions and growing volumes of electronic waste. However, ICT can also play a positive role in advancing sustainability.

Technologies such as digital platforms, online services and monitoring applications enable dematerialisation, reduce the need for transport and travel, improve energy efficiency and support product stewardship and recycling efforts (Radu, 2016).

Green IT refers to measures and initiatives that aim to reduce the negative environmental impact of IT equipment and infrastructure. It focuses on developing, using and managing hardware, software and ICT infrastructure in ways that minimise environmental harm. Key objectives include reducing energy consumption, lowering CO_2 emissions, and minimising e-waste throughout the IT lifecycle. Additionally, Green IT promotes recycling practices and encourages the efficient use of resources to support environmental sustainability (Baggia et al., 2019; Radu, 2016).

Investing in energy-efficient hardware and software

A central aspect of Green ICT is the use of energy-efficient hardware and software across the organisation. By opting for computers, servers and network equipment designed for lower power consumption, organisations can significantly reduce their environmental impact. Both radical innovations, such as the development of new eco-friendly devices and incremental improvements, like upgrading to more efficient components, contribute to lower energy consumption and reduced CO_2 emissions (Radu, 2016).

E- waste management

The rapid increase in the use of electronic devices globally has led to a significant rise in electronic waste (e-waste). This waste stream is problematic as it contains hazardous substances like lead, cadmium and mercury, which pose serious risks to both the environment and human health if not properly managed (Panda, 2013). Addressing e-waste challenges requires a holistic approach that covers the entire product lifecycle, from design and use to final disposal (Panda, 2013; Pazowski, 2015).

The first step toward effective e-waste management is green design. Product design is already partly covered in CoA5: Include planet Earth as a company stakeholder. Here, the focus lies specifically on the design of electronic products with minimal environmental impact throughout their lifecycle. Manufacturers should prioritize using non-toxic materials, replacing harmful substances such as lead with safer alternatives like copper or silver. Additionally, designing products with modular components that allow for easy repairs and

upgrades can extend their lifespan and facilitate recycling at the end of their use (Pazowski, 2015; Panda, 2013). Energy-efficient manufacturing is another important aspect of reducing the ecological footprint of electronic devices (Panda, 2013).

How a product is used is also a crucial aspect in minimizing e-waste. Businesses can lower their environmental impact by repairing and upgrading their devices instead of replacing them prematurely (Panda, 2013). Energy-saving practices, such as turning off devices instead of leaving them in standby mode, combined with choosing energy-efficient equipment with high ratings, can significantly reduce energy consumption and lower the environmental impact during the usage phase (Panda, 2013; Pazowski, 2015).

Extending the life of materials is a crucial strategy for promoting environmental sustainability and reducing resource depletion. By prioritizing reuse, repair and refurbishment, organisations can maximise the value extracted from raw materials while minimizing waste generation (Panda, 2013).

When devices reach the end of their useful life, proper disposal is essential to prevent environmental contamination. E-waste should never be disposed of in landfills or incinerated, as these methods release toxic substances into the soil, air and water, leading to severe pollution and health risks (Panda, 2013). Instead, e-waste should be collected separately and processed by certified recycling centres that adhere to environmentally safe methods (Pazowski, 2015). Reusing or donating working electronics is another way to reduce waste and extend the life of products. Manufacturers should be encouraged (or required) to establish take-back and recycling programs to ensure safe end-of-life handling of their products (Pazowski, 2015).

Governments and policymakers are also essential in promoting effective e-waste management by implementing and enforcing regulations such as the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive and the Restriction of Hazardous Substances (RoHS) Directive. These regulations limit the use of toxic materials in electronic products and encourage recycling and recovery of valuable materials (Panda, 2013; Pazowski, 2015). Public awareness campaigns, as well as incentives for consumers to return old electronics, can also increase collection rates and improve environmental outcomes. A recent

example from Belgium is the collaboration between Recupel and artist Pommelien Thijs: fans who return three old mobile phones for recycling receive a free ticket to her concert.

Dematerialise business processes

Some papers argue that ICT can contribute to dematerialisation, meaning a reduction in the use of physical resources, by enabling digital alternatives to material goods, improving efficiency and replacing more resource-intensive sectors (Radu, 2016). For example, ICT allows for the digitisation of documents, virtual meetings instead of business travel and the replacement of physical media with streaming services. These mechanisms can reduce the demand for paper, transport and plastic, thereby lowering overall material consumption. Furthermore, ICT can increase efficiency in production and logistics, enabling companies to optimize resource use and reduce waste across various sectors of the economy (Rieger, 2021).

However, the relationship between ICT and dematerialisation is complex and does not always lead to a net reduction in resource use. As highlighted by Rieger (2021), while ICT has the potential to reduce material consumption, it also introduces new forms of resource use and environmental impact. The production, operation and disposal of ICT devices themselves require significant amounts of raw materials and energy and generate hazardous waste (Rieger, 2021). Additionally, the widespread adoption of smartphones and personal devices has led to a higher number of devices per person and shorter product lifespans, increasing electronic waste and material flows (Rieger, 2021). This suggests that the efficiency gains and digital substitution enabled by ICT are largely balanced out by additional consumption and the resource demands of the ICT sector itself. As a result, the promise of dematerialisation through ICT remains conditional and context-dependent, requiring careful consideration of rebound effects, product lifecycles and broader patterns of consumption (Rieger, 2021).

3. Deploy AI wisely for sustainable outcomes

Artificial Intelligence is part of both ICT and IS. On the one hand, it relies on data centres and computing power, which are part of ICT. On the other hand, AI supports companies in making better decisions, making it also an important component of IS.

Artificial Intelligence (AI) offers promising opportunities for companies to improve their sustainability performance. By analyzing large datasets and recognizing patterns, AI systems can help optimize business operations, reduce resource waste and improve energy and

material efficiency. Within supply chains, AI supports tasks like demand forecasting, inventory control and real-time emission monitoring, which can lower overproduction, minimize waste and reduce energy use (Pournader et al., 2021).

Beyond operational improvements, AI can also contribute to broader sustainability goals. For example, AI technologies are used to support circular economy initiatives by identifying opportunities for reuse and recycling. They also play a role in detecting equipment defects early, extending product lifespans and (as previously mentioned) enhancing sustainability reporting through decision support tools (Kar et al., 2022).

However, it is important to recognize that AI itself is not without environmental impact. The development and deployment of AI models require significant computational power and energy. These processes are often hosted in large data centres that consume high amounts of electricity and contribute to carbon emissions (Kar et al., 2022). Manganelli et al. (2021) discuss how data centres can become more sustainable by adopting energy-efficient technologies, integrating renewable energy sources and applying innovative cooling techniques. Data centres can implement advanced cooling systems and utilize low-power electronics to reduce energy consumption. Additionally, they can transition to renewable energy sources such as solar and wind power. An interesting concept discussed is the reuse of excess heat from cooling systems for other applications, contributing to circular energy solutions (Manganelli et al., 2021).

It is crucial to realise that efficiency gains made possible by AI can sometimes be offset by rebound effects, where increased consumption or production cancels out sustainability improvements.

To ensure that AI truly contributes to a more sustainable future, organisations need to consider both its benefits and its environmental footprint. This means investing in energy-efficient AI infrastructure and evaluating the full lifecycle impact of AI applications, from training to deployment (Kar et al., 2022; Pournader et al., 2021).

CoA10. Adopt the practice of CBM and the use of ES-aware business Capability modelling

To bridge the gap between sustainability strategy and actual implementation, Van Riel proposes Capability-Based Management (CBM) as a guiding organisational mechanism (Vandevenne et al., 2023). Within this approach, ES-aware business capability modelling is proposed, which allows organisations to understand their environmental performance (Environmental Footprint) linked to their core capabilities. This modelling provides a valuable tool for identifying, evaluating and monitoring sustainability initiatives in line with strategic objectives. This constitutes an essential step towards making the organisation sustainable and integrating environmental awareness into transformation processes (Vandevenne et al., 2023).

1. Link between CoAs and Process Classification Framework

The first step is to map the first nine CoAs to a capability map. To do this, the Cross Industry Process Classification Framework (PCF) from APQC is used. This choice establishes a clear connection between this thesis and the paper *Green Enterprise Architecture (GREAN): Leveraging EA for Environmentally Sustainable Digital Transformation*. The PCF is an industry-neutral framework that can be applied to all types of business organisations, regardless of their sector, size or location (APQC, 2018). The PCF is organised into 13 high-level process categories, ranging from strategic planning to risk management, as shown in Figure 4.

In Table 3, the CoAs are linked to the level 1-category. Linking the CoAs to the PCF clearly highlights the impact of each action. *Appendix 2* presents the mapping of the Courses of Action (CoAs) to the Level 2 process groups of the APQC's Process Classification Framework. This additional mapping offers a more detailed view of where the CoAs can be applied within an organisation's core processes, thereby enhancing the practical applicability of the framework.

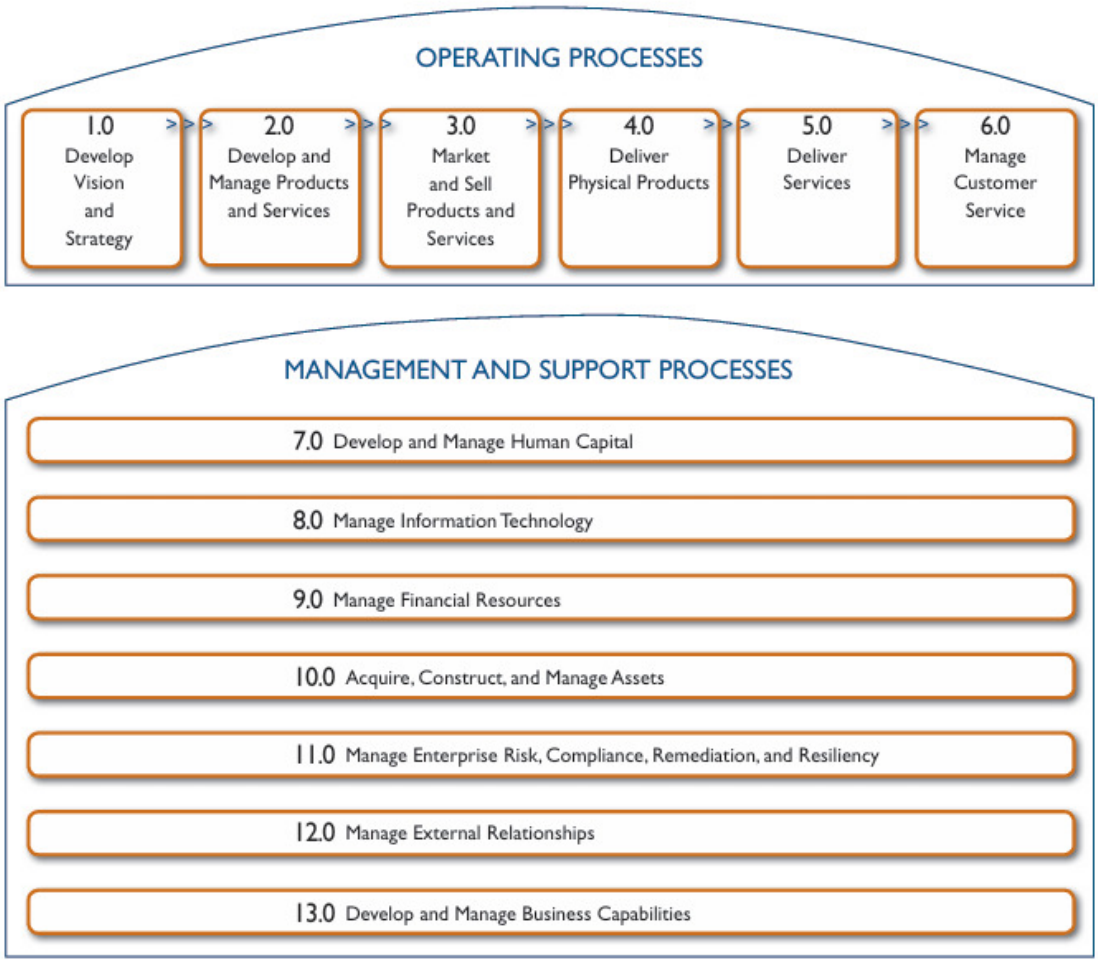

Figure 4: The process Classification Framework (APQC, 2018)

CoA	Action	Level 1 - Category
CoA1	Establish a board sustainability committee	• 1: Develop Vision and Strategy • 11: Manage Enterprise Risk, Compliance, Remediation, and Resiliency • 13: Develop And manage business capabilities
	Embed environmental sustainability in mission and vision	• 1: Develop Vision and strategy
	Align sustainability with OKRs	• 1: Develop Vision and strategy
	Set up sustainability KPIs	• 1: Develop Vision and strategy • 11:Manage Enterprise Risk, Compliance, Remediation and Resiliency • 13: Develop and Manage Business Capabilities

CoA2	Enhance transparency through ESG reporting	• 9: Manage financial resources • 11: Manage enterprise risk, compliance, remediation and Resiliency • 12:Manage External relationships
	Using GenAI in ESG reporting	• 8: Manage information Technology
CoA3	Use OKRs to Embed Sustainability Across the Organisation	• 1: Develop Vision and strategy • 7: Develop and Manage Human Capital
	empower a green workforce through GHRM	• 7: Develop and Manage Human Capital • 13: Develop and Manage business capabilities
CoA4	Communicate accessible and clearly about your sustainability initiatives	• 3: Market and Sell products and services • 12: Manage External Relationships
	Publish clear ESG reports	• 9: Manage financial resources • 11: Manage enterprise risk, compliance, remediation and Resiliency • 12: Manage External relationships
	Provide product-level transparency	• 3: Market and Sell products and services • 12: Manage external Relationships
CoA5	Embrace circularity	• 4: Deliver physical products
	Adopt and align with sustainability standards	• 4: Deliver physical products
	Use KPIs to measure circularity	• 1: Develop Vision and strategy • 11:Manage Enterprise Risk, Compliance, Remediation and Resiliency • 13: Develop and Manage Business Capabilities
CoA6	Apply 5 general Architecture principles for Green Strategy	• 13: Develop and Manage Business Capabilities
	Develop business-specific green architecture principles	• 13: Develop and Manage Business Capabilities
CoA7	Provide targeted training and workshops	• 7: Develop and Manage Human Capital • 13: Develop and Manage Business Capabilities
	Implement information campaigns	• 7: Develop and Manage Human Capital • 13: Develop and Manage Business Capabilities
	Use digital visualisation tools	• 7: Develop and Manage Human Capital

		• 13: Develop and Manage Business Capabilities
CoA8	N.A.	• 7: Develop and Manage Human Capital • 13: Develop and Manage business capabilities
CoA9	Green IS	• 8: Manage information Technology
	Green ICT	• 8: Manage information Technology
	Use AI wisely for sustainable outcomes	• 8: Manage information Technology

Table 3: Linkage CoA and PCF

2. Evaluate capabilities on ES performance

The next step is to evaluate the capabilities based on their environmental sustainability (ES) performance. Capabilities are cross-functional in nature, composed of people, processes, technology and information (Lankhorst & Van Dijk, 2025; Van Riel & Poels, 2023). Vandevenne et al. (2023) suggest that organisations conduct a RAG (red, amber, green) assessment of each capability, evaluating their ES performance (CO_2-emission, waste, water usage…) across the four dimensions. Depending on their strategic priorities, organisations may choose to assign varying weights to environmental sustainability across capability dimensions (Vandevenne et al., 2023).

Organisations can also assess the ES performance of their capabilities by using Key environmental indicators (KEIs). These indicators help measure the environmental impact of each capability's underlying processes. By aggregating these KEIs, organisations can identify which capabilities have the highest environmental impact.

3. Identify capabilities with the weakest environmental performance & associated CoAs

After the evaluation, the capabilities with the lowest environmental sustainability performance can be identified. By using Table 3: Linkage CoA and PCF and the artefact (presented in the later section *'The Artefact'*), the associated CoAs and actions can be identified. Companies can then invest in those actions for a targeted ES improvement.

4. Impact of CoA on business capabilities

The implementation of the ten strategic Courses of Action (CoAs) does not necessarily lead to the creation of entirely new business capabilities. Instead, their impact is primarily observed

in the transformation and greening of existing capabilities as defined in the APQC Process Classification Framework.

Across the 13 first level domains, the CoAs provide guidance for integrating sustainability considerations. For instance, lifecycle assessment (LCA) can be embedded in “Develop and Manage Products and Services”, particularly in product design and development processes. ESG reporting aligns with “Manage Financial Resources”, as part of enhanced reporting and compliance functions. Similarly, digital product passport initiatives can be positioned under “Deliver and Support Products and Services” or “Manage Information Technology”, depending on the technological and operational scope.

Rather than creating entirely new capabilities, the CoAs encourage organisations to extend and adapt existing ones. Through this approach, sustainability becomes a cross-functional theme that shapes how existing capabilities are executed, measured and improved. The strength of the GREAN framework lies in this integration: it starts from what is already in place within the organisation and re-aligns it with green objectives. This ensures a consistent and scalable way to embed sustainability into the daily reality of the business.

5. Important note

It is important to highlight that this thesis links the ten Courses of Action (CoAs) to business capabilities derived from the APQC Process Classification Framework (PCF). According to Jonas Van Riel, organisations are encouraged to structure their capability maps based on Porter’s Value Chain (Jonas Van Riel, 2025). The PCF shares many structural similarities and domains with Porter’s Value Chain, such as operations, marketing and support functions.

This alignment offers a significant advantage: for companies that have indeed based their capability structure on Porter’s Value Chain, the translation of the CoAs into their own organisational context becomes straightforward. The coherence between the APQC framework and Porter’s model allows for a seamless mapping of sustainability-oriented actions to existing business processes. Consequently, such organisations will be able to quickly and efficiently implement the CoAs proposed in this thesis.

However, for organisations that do not work with capabilities or that have defined their capabilities independently of Porter’s Value Chain, additional effort will be required. These

companies will need to translate or align their CoA to their internal structures in order to fully benefit from the proposed model.

The Artefact

The artefact presented in this section is the practical outcome of the Design Science Research (DSR) approach applied in this thesis. It translates the ten strategic Courses of Action (CoAs), proposed in the original GREAN framework, into concrete and actionable guidelines that organisations can adopt to integrate environmental sustainability into their strategy.

Each CoA is structured in a standardised table consisting of five consistent columns:

- **Action:** the overarching action within the CoA
- **Concrete Actions:** specific, practical steps or recommendations
- **Tools/Methods**: instruments or techniques that support implementation
- **KPIs/KEIs**: performance indicators that can be used for monitoring and evaluation
- **Impacted Capabilities:** the relevant impacted business capabilities based on the APQC Process Classification Framework (PCF)

The 'Impacted Capabilities' column identifies which business capabilities, based on the APQC Process Classification Framework (PCF), are affected by each concrete action. These links are provided at the first-level process category. If organisations wish to further explore the specific domains or activities impacted by a particular action, they can use this first-level category as a starting point and use to the full APQC documentation to identify the corresponding second-level process groups. In this way, the artefact not only offers practical implementation guidance but also serves as a basis for deeper analysis, internal alignment and performance evaluation.

This uniform structure facilitates comparison, prioritization and practical application of the CoAs across various organisational contexts. The artefact not only serves as a guide for implementation, but also as a framework for ongoing monitoring, evaluation and continuous improvement of environmental sustainability within enterprise architecture.

CoA1: Embed environmental sustainability into vision and strategy

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Establish a sustainability board committee	1.1. Guide and monitor the company's sustainability strategy at the highest level	• Board-level governance • ESG integration tools	• # of ESG items on board agenda • % of board members with sustainability expertise	1, 11 , 13
2. Integrate sustainability into mission and vision	2.1. Align mission with strategic sustainability goals and stakeholder values 2.2. Specify your ambition level 2.3 Align vision with long-term sustainability ambition	• Sustainability Ambition Ladder • Stakeholder mapping	• Presence of sustainability in mission/vision (yes/no) • Ambition level (1–5)	1
3. Align OKRs with sustainability	3.1. Define clear sustainability OKRs across departments 3.2 Start at company level and then work out to departmental	• OKR framework • Alignment workshops	• % of sustainability-linked OKRs completed • Avg. OKR progress (%)	1
4. Define sustainability KPIs	4.1. Set up and monitor KPIs on ESG themes 4.2. Apply OKRs collaboratively across teams	• KPI development guide • ESG indicators • Sustainability Balanced Scorecard (SBSC)	• # of sustainability KPIs defined • % of sustainability objective with corresponding KPI	1, 11 , 13

CoA2: Implement ESG reporting tools and processes

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Enhance transparency through ESG reporting	1.1. Implement CSRD requirements 1.2. Conduct double materiality assessment 1.3. Apply GRI and/or SASB frameworks 1.4. Tailor reports to stakeholders and investors	• CSRD • ESRS (12 standards) • Double Materiality • GRI • SASB (sector-specific)	• % compliance with CSRD • Quality of disclosures of frameworks adopted • Stakeholder trust indices	9,11,12
2. Integrate GenAI in ESG reporting	2.1. Use AI to assist in data gathering and verification 2.2. Use AI to draft narrative ESG content 2.3. Ensure human oversight	• Generative AI • Human-machine interaction model • Human validation	• Time saved in reporting • Error reduction rate • AI-aided accuracy metrics	8

CoA3: Embed sustainability into the company culture

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Embed sustainability through OKRs	1.1. Set company-wide sustainability-related OKRs	• OKR framework	• # of sustainability-related OKRs • % of departments with active OKRs • OKR achievement rate	1, 7
2. Empower a green workforce through GHRM	2.1. Use green recruitment and selection criteria 2.2. Include sustainability in job descriptions 2.3. Conduct sustainability-focused onboarding and training 2.4. Provide continuous, role-relevant sustainability training 2.5. Implement eco-conscious reward systems	• Value-based recruitment • Personality tests • Green job descriptions • Sustainability induction • Collaborative training • Green incentive schemes	• % of new hires meeting green criteria • Training completion rate • Behaviour change indicators • # of rewards for green behaviour • Employee engagement and satisfaction scores	7, 13

CoA4: Be transparent to customers about ES

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Communicate clearly and accessibly about sustainability	1.1. Share initiatives via website, social media and campaigns 1.2. Use accessible formats and visuals 1.3. Share sustainability mission and vision 1.4. Share both positive and negative results 1.5. Tailor channels to target audience	• Social media • Websites • ESG dashboards • Storytelling • Interactive platforms	• Customer trust index • # of communication channels used • Engagement rate • # of transparency-related complaints	3, 12
2. Publish clear ESG reports	2.1. Use GRI and CSRD standards 2.2. Integrate ESG data into annual reports 2.3. Ensure verifiability and structure of information	• GRI • CSRD • ESG reporting software	• % compliance with reporting standards • # of ESG reports published annually • Stakeholder satisfaction with ESG reporting	9, 11, 12
3. Provide product-level transparency	3.1. Use product labels and third-party certifications 3.2. Apply ISO standards (e.g., ISO 59000 family) 3.3. Add QR codes for traceability and product info 3.4. Implement Digital Product Passport (DPP) to meet EU ESPR requirements	• Life Cycle Assessment (LCA) • ISO standards • Eco-labels (FSC, Fairtrade, EU Ecolabel) • QR codes • Digital Product Passport (DPP) • ESP regulation	• # of certified products • % of products with traceability info • DPP coverage • QR scan rate • Product transparency score • Regulatory compliance rate	3, 12

CoA5: Include planet Earth as company stakeholder

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Embrace circularity	1.1. Design for durability, repairability, reusability and recyclability 1.2. Extend product lifetimes through maintenance, refurbishment and reuse 1.3. Recover materials post-use 1.4. Use renewable/biodegradable inputs 1.5. Use LCA to assess environmental impact 1.6. Identify hotspots 1.7. Compare material and design options for eco-efficiency	• Ellen MacArthur Foundation models • Butterfly diagram • Circular design tools • Take-back schemes • LCA software • Material Flow Analysis	• % circular material input • % product designed for recyclability • % renewable/biodegradable inputs • Average product lifetime • % of products refurbished/reused • Waste reduction per product • CO_2 reduction from circular practices	4
2. Adopt and align with sustainability standards	2.1. Ensure compliance with ESPR 2.2. Implement ISO series 2.3. Prevent destruction of unsold goods 2.4. Encourage supplier adherence to circular standards 2.5. Implement Digital Product Passport (DPP)	• ESPR • ISO 59000 and 14000 families • Digital Product Passport tools • Product audits	• % of compliant products • # of circular audits performed • % of suppliers meeting ISO standards • Unsold goods reporting rate • ISO certification rate	4
3. Use KPIs to measure circularity	3.1. Measure circular inputs, operational waste, circular outputs and circular revenues 3.2. Track enablers: circular design, waste production and transparency, product life extension and output collection	• KPI development guide • Circularity indicators • Circularity standards	• # of circularity KPIs defined • % of circular objective with corresponding KPI	1, 11, 13

CoA6: Identify architecture principles for green strategy

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Apply 5 general architecture principles for green strategy	1.1. Use the 5 general architecture principles for green strategy	• N.A.	• # of green principles adopted • % of projects assessed for alignment with green principles	13
2. Develop business-specific architecture principles	2.1. Define custom principles for your sector or company	• TOGAF • EA governance frameworks	• # of business-specific green principles defined	13

CoA7: Raise awareness of environmental consequences

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Provide targeted training and workshops	1.1. Conduct sustainability-focused onboarding and training 1.2. Implement general and job-specific induction 1.3. Provide continuous, role-relevant sustainability training	• E-learning platforms (e.g., Coursera, LinkedIn Learning) • Sustainability induction • Collaborative training	• # of employees trained • Training completion rate • Behaviour change indicators • Awareness level (pre/post survey scores)	7, 13
2. Implement information campaigns	2.1. Use internal communication tools	• Internal communication tools	• % of workforce reached by campaigns • Change in environmentally responsible behaviour • Awareness level (pre/post survey scores)	7, 13
3. Use digital visualisation tools	3.1. Apply digital dashboards 3.2. Use infographics and visualisation software 3.3. Provide environmental awareness toolkits	• Digital dashboards • Infographics and visualisation software (e.g., Power BI, Tableau) • Environmental awareness toolkits	• Engagement rate with digital tools • Awareness level (pre/post survey scores)	7, 13

CoA8: Include environmental sustainability in the hiring process

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. N.A.	1.1. Use green recruitment and selection criteria 1.2. Attract environmentally conscious talent 1.3. Include sustainability in job descriptions	• Value-based recruitment • Green job descriptions	• % of new hires meeting green criteria	7, 13

CoA9: Invest in green IS/ICT capabilities

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Green IS	1.1. Develop and implement systems that assist environmental management processes 1.2. Track real-time emissions 1.3. Use digital twin for product design and development 1.4. Use SPMS	• IoT devices • Cloud monitoring • Digital twin platforms • SPMS platforms • ERP systems	• # of processes modelled using digital twins • % of sustainability goals achieved (via SPMS) • % of route optimisation • # of real-time data integrations (IoT/ERP)	8
2. Green ICT	2.1. Invest in energy-efficient hardware and software 2.2. Manage e-waste 2.3. Dematerialise business processes	• Energy-efficient hardware • Take-back and recycling programs • Digital platforms • Modular product design	• Energy consumption per user • % of e-waste recycled or reused • % e-waste reduction • # of physical processes digitised • Average lifespan of ICT equipment	8
3. Deploy AI wisely for sustainable outcomes	3.1. Deploy AI for energy optimization 3.2. Use AI for predictive maintenance to reduce waste 3.3. Use innovative cooling systems and renewable energy 3.4. Evaluate full lifecycle of AI applications	• Energy-efficient data centres • Heat reuse systems in data centres	• % improvement in energy efficiency due to AI • # of defects predicted/prevented • % of waste heat reused • % of AI systems hosted on green infrastructure	8

CoA10: Adopt the practice of CBM and the use of ES-aware business capabilities

Action	Concrete Actions	Tools / Methods	KPIs / KEIs	Impacted Capabilities
1. Evaluate Capabilities on ES performance	1.1. Evaluate capabilities based on 4 dimensions 1.2. Conduct RAG assessment of capabilities 1.3. Assign weights to different capabilities	• RAG Assessment Framework • KEI dashboards • Capability impact scoring tools	• Number of red/amber capabilities • Change in improvements over time	13
2. Identify capabilities with weakest environmental performance & associated CoA	2.1. Select weakest capabilities 2.2. Use Table 2 to find associated CoA	• Linkage CoA and PCF (Table 2)	• Number of targeted improvements initiated • ES improvement per Capability • ROI of ES interventions	13

Case study

This case study corresponds to phases 4 (Demonstration) and 5 (Evaluation) of the Design Science Research (DSR) methodology, as it demonstrates the application of the GREAN framework and assesses its effectiveness in a realistic organisational context. It builds on the fictional scenario from the GREAN paper, in which Company Z, a retail organisation, implemented a large-scale digital transformation (DT). As part of this transformation, the GREAN framework was applied to structurally integrate environmental sustainability (ES) into the organisation. Ten strategic Courses of Action (CoAs) were used to launch initiatives ranging from ESG reporting to sustainable process design, to embed sustainability in all layers of the enterprise architecture (Vandevenne et al., 2023).

One year after the initial implementation, the Enterprise Architect carried out an evaluation based on CoA10: Adopt the practice of Capability-Based Management and use ES-aware business capability modelling. This assesses which business capabilities are performing weakly in terms of sustainability and what strategic actions can be taken to improve them. To support this evaluation, the RAG assessment proposed by (Vandevenne et al., 2023), was used.

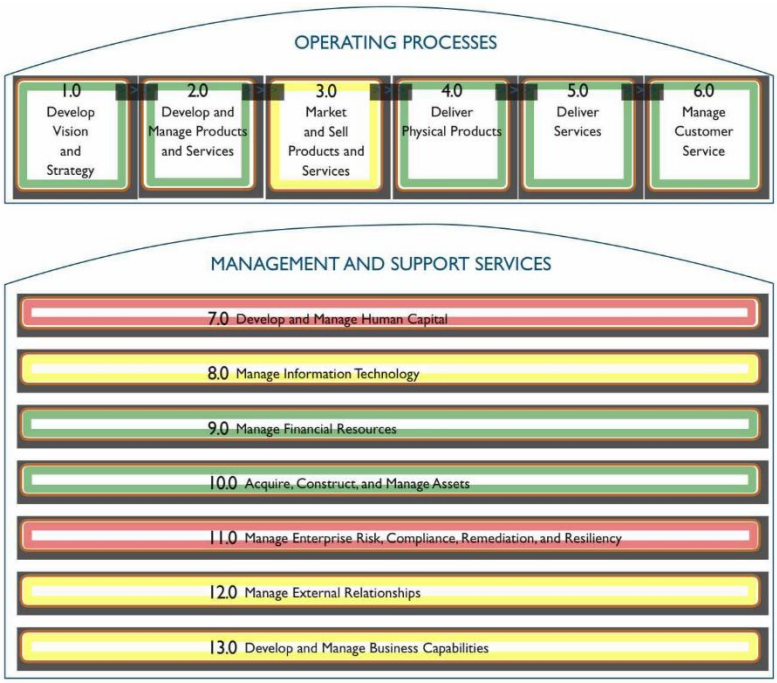

Figure 5: RAG assessment of Company Z's capabilities

Figure 5 represents the RAG assessment done by the Enterprise Architect. Company Z has two underperforming capabilities (Cap 7 and 11) as well as four intermediate performing capabilities (Cap 3, 8, 12 and 13). In the following sections, the Enterprise Architect's recommendations for improving these capabilities are outlined. To identify appropriate improvement actions, she consulted the artefact developed in this thesis, which maps specific strategic actions to each capability.

Addressing underperforming capabilities

Capability 7: Empower a green workforce

To improve this capability, Company Z should focus on several strategic actions linked to CoA3, CoA7, and CoA8. The company can establish a green workforce by actively investing in employee training and development through Green Human Resource Management (GHRM). This includes implementing green recruitment and selection criteria, as well as offering targeted training sessions (CoA3 – Concrete Actions 2.1 & 2.2; CoA7 – Action 1; CoA8 – Concrete Actions 1.1 & 1.3). In addition, by setting company-wide sustainability-focused Objectives and Key Results (CoA3 – Concrete Action 1.1), environmental responsibility becomes a shared goal across all teams. To assess the effectiveness of these initiatives, the Enterprise Architect recommends tracking key metrics such as training completion rates, employee engagement levels, and OKR achievement rates (CoA3 – KPIs/KEIs).

Further support is provided by CoA7, which aims to raise awareness of environmental consequences. Many employees still feel disconnected from sustainability issues, so Company Z is encouraged to increase internal engagement through consistent communication, interactive workshops, and storytelling techniques that make sustainability tangible and relevant (CoA7 – Actions 1, 2 & 3). Regular monitoring of awareness and engagement levels can help fine-tune these interventions over time.

Capability 11: Manage enterprise risk, compliance, remediation and resiliency

To improve Capability 11, Company Z should concentrate on strategic actions linked to CoA1, CoA2, CoA4, and CoA5. Under CoA1, the sustainability team must adopt a more proactive role in monitoring and guiding the company's sustainability strategies (CoA1 – Concrete Action 1.1). This includes critically reviewing the current Key Environmental Indicators (KEIs) to

ensure alignment with strategic objectives, and clearly defining roles and responsibilities within the team to enhance accountability. In addition, all KPIs should be precise, measurable, and strategically relevant to enable effective progress tracking and timely adjustments.

CoA2 recommends improving ESG reporting practices. While Company Z currently reports using SASB standards (CoA2 – Concrete Action 1.3), the Enterprise Architect advises proactively aligning with the upcoming CSRD requirements (CoA2 – Concrete Actions 1.1 & 1.2). Doing so will not only ensure future compliance, but also strengthen stakeholder trust among customers, suppliers, and partners. To support this effort, the company could implement a voluntary CSRD-aligned reporting system, backed by structured data collection and internal audits.

In line with CoA4 – Action 2, Company Z is also encouraged to publish ESG reports on a quarterly basis and make them accessible to both internal and external stakeholders. These reports should be clear, consistent, and transparent in order to reinforce the company's credibility and accountability.

Finally, Company Z should focus on defining and monitoring sustainability KPIs (CoA5 – Action 3) related to circularity and supplier compliance. For example, the company could track the percentage of suppliers that meet circularity criteria or comply with standards such as the ISO 59000 family. These metrics help extend circular practices across the supply chain, thereby supporting regulatory compliance, reducing operational risks, and enhancing overall supply chain resilience.

Addressing intermediate performing capabilities

The actions proposed to improve underperforming capabilities also positively impact the intermediate performing capabilities. In addition to these shared effects, the Enterprise Architect also suggested several targeted actions specifically aimed at further enhancing the intermediate performing capabilities. Conversely, implementing these additional actions will not only improve the intermediate capabilities, but also lead to further improvements in the originally underperforming ones. This mutual reinforcement is due to the holistic nature of business capabilities and the ten CoA: improvements in one area often generate positive spillover effects in others.

Capability 3: Market and Sell Products and Services

The Enterprise Architect has observed that Company Z still communicates too little about its sustainability initiatives. In her view, it is essential to align with CoA4: 'Communicate accessibly and clearly' & 'Provide product-level transparency' (CoA4 - Action 1 & 3) by making sustainability information much more visible and understandable to customers. This includes clear and consistent communication via the company's website, newsletters and social media (CoA4 - Concrete Action 1.1 & 1.4).

She also recommends that Company Z prepares for the introduction of a digital product passport (CoA4 - Concrete Action 3.4). These passports, which will soon be mandatory within the EU, provide customers with near-complete transparency about a product's origin, composition and environmental impact. By taking this step early, Company Z not only ensures compliance but also strengthens customer trust and contributes to a more transparent and sustainable future.

Capability 8: Manage Information Technology

Company Z currently does not use AI in its operations. Therefore, the Enterprise Architect suggests that exploring the use of AI could be beneficial (CoA2 - Action 2; CoA9 - Action 3). It can for example be used to improve their ESG reporting. On the one hand, it would enhance the company's ability to manage information technology, on the other hand, it could significantly improve the efficiency, accuracy, and credibility of its sustainability disclosures.

She also suggests investing in all actions of CoA9, as this will significantly improve the management of information technology. As mentioned earlier, Company Z could adopt AI to enhance ESG reporting, but the potential of AI extends far beyond that. The Enterprise Architect recommends exploring additional applications across the business.

For example, she proposes tracking live CO_2 emissions from Company Z's deliveries using IoT technologies and subsequently optimising delivery routes through AI-powered route planning (CoA9 - Concrete Action 1.1 & 1.2). This would not only reduce emissions but also improve operational efficiency.

In addition, she advises the implementation of a sustainability performance management system (CoA9 - Action 1.4), allowing the company to monitor key environmental indicators in real-time and align them with strategic goals.

Finally, she suggests assessing opportunities for business dematerialisation, such as digitising documentation and offering digital services in place of physical products (CoA9 – Concrete Action 2.3).

Capability 12: Manage External Relationships

The enterprise architect acknowledges that this capability will naturally improve, as actions related to managing external relationships are already being suggested within the previously mentioned capabilities.

Capability 13: Develop and Manage Business Capabilities

This capability is also automatically enhanced by the improvement of the previously mentioned capabilities. The only Course of Action (CoA) not yet addressed, but which will contribute to this capability, is CoA6: '*Identify Architecture Principles for Green Strategy*'. Company Z already applies the principle "*Always include Environmental Sustainability (ES) in future transformation projects*" but should also adopt the following four general principles (CoA6- Concrete Action 1.1):

- ES is everyone's responsibility
- ES is a core strategic concern
- Embed sustainability in Enterprise Architecture (EA)
- Include lifecycle thinking in design

In addition to these, the enterprise architect will collaborate with Company Z to define a set of business-specific architecture principles tailored to their sustainability goals (CoA6 - Concrete Action 2.1).

The Holistic Impact of CoAs on Capability-Based Management

The actions proposed within the GREAN framework are highly interconnected. Improvements in underperforming capabilities often generate positive effects on intermediate ones, as many strategic Courses of Action (CoAs) are mutually reinforcing across different layers of the enterprise.

For example, Capability 11 is an underperforming capability. To improve this capability, the Enterprise Architect recommended aligning with CSRD regulations. However, when

consulting the artefact, it becomes clear that this same action (CoA2 – Concrete Actions 1.1 & 1.2) is also linked to Capabilities 9 and 12.

Another example is Capability 12, which performed at an intermediate level. The Enterprise Architect recognised that several improvement actions already initiated under other CoAs, such as CoA2 (Action 1) and CoA4 (Actions 1, 2 & 3) also contribute to strengthening this capability.

These examples illustrate that investing in one CoA to address a specific capability can simultaneously enhance several others. This chain reaction underscores the importance of a holistic approach. Rather than viewing CoAs in isolation, they should be seen as part of an integrated strategy that accelerates sustainability transformation across the entire organisation.

Discussion

This thesis provides actionable guidelines, actions, KPIs and architecture principles for organisations to improve their sustainability performance. This section discusses the academic and practical contributions, limitations and directions for future research.

1. Contribution and practical implications

This thesis addresses the gap between conceptual models and real-world application by operationalising the GREAN framework into a practical and actionable tool for organisations. Through the development of concrete guidelines, strategic actions, KPIs and architecture principles, it successfully achieves research objective 1: translating the ten Strategy Courses of Action (CoAs) into practical implementation guidance.

By systematically linking these CoAs to the APQC Process Classification Framework (PCF), the thesis also fulfils research objective 2, creating a clear and structured path to embed sustainability across all organisational functions. This linkage makes it easier for companies to integrate sustainability into existing processes and responsibilities, enhancing alignment and coherence between strategic sustainability goals and day-to-day operations. As previously discussed, the proposed CoAs are especially easy to implement for organisations that have structured their capabilities based on Porter's Value Chain, due to the alignment with the APQC framework. For others, a translation to their own internal structure will be necessary to apply the model effectively.

Finally, these efforts culminated in the development of a hands-on artefact, a structured table for every CoA with its actions, concrete actions, tools/methods, KPIs/KEIs and impacted capabilities. This artefact was applied in a case study scenario, demonstrating its potential usability in practice. In doing so, the thesis addresses research objective 3: Develop a hands-on artefact that organisations can use to implement, monitor and maintain long-term strategic alignment of sustainability initiatives

Overall, this work makes a meaningful contribution to the ongoing development of the GREAN framework by strengthening its practical relevance and providing organisations with the tools to take action on sustainability in a structured, measurable and strategically aligned manner.

2. Limitations and future research

This research has several limitations, which also offer opportunities for future work.

To begin with, due to the broad scope and the large amount of relevant literature, it was not possible to incorporate all insights into this thesis. As a result, some potentially valuable perspectives may have been missed. Future research could adopt a more targeted or systematic approach to explore additional concepts that may further strengthen the framework.

In addition, this thesis builds strongly on existing literature and the GREAN framework. Any limitations or blind spots in these sources may have influenced the final outcome. A possible direction for future research is to further refine or integrate the GREAN framework with other approaches to enhance the robustness of the framework. Another recommendation for future research could be to conduct structured interviews with C-level managers and senior managers, focusing on the CoA and relevant practices, as part of a qualitative study. This could provide deeper insights into the practical applicability and contextual nuances of the GREAN framework in real-world organizational settings.

Furthermore, this thesis takes a general, non-sector-specific approach. Since sustainability challenges and enterprise architecture practices may differ per industry, it would be useful to test the framework in specific sectors, for example, in manufacturing, government or IT, to see how it performs in different contexts.

Another limitation is that the concretised Courses of Action (CoAs) and the developed artefact have not yet been tested in real-world organisational settings over an extended period. Future research could apply the framework in actual organisations and monitor the outcomes over time, in order to evaluate how effectively the strategic CoAs contribute to achieving sustainability goals in practice.

Finally, the framework was demonstrated and evaluated in only one fictitious case study. Although this provided useful initial insights, generalising the findings is difficult. Future research could implement the framework in multiple real-world case studies to more effectively assess its practical relevance, usability and applicability across different organisational contexts.

Conclusion

This thesis investigated how the GREAN framework, as introduced in (Vandevenne et al, 2023) can be further operationalised and concretised to better support organisations in integrating environmental sustainability into their enterprise architecture (EA). The central research question was: How can the ten strategic “Courses of Action” (CoAs) of the GREAN model be translated into concrete, applicable guidelines within the strategy layer of EA, so that organisations can actually take steps towards sustainable transformation?

Using a Design Science Research (DSR) methodology, this research produced an artefact that translates the ten CoAs into actionable guidance. These CoAs were substantiated through a structured literature review and linked to business capabilities that were derived from the APQC Process Classification Framework (PCF), creating a practical and comprehensive tool for organisations aiming to align their digital and sustainability agendas. Additionally, the tenth CoA introduced an ES-aware business capability modelling approach, offering a novel method to map and evaluate environmental performance across business functions.

A case study was conducted to demonstrate the applicability of the artefact and allowed for a small-scale evaluation of its potential value. This confirmed that the CoAs can serve as a useful reference point for organisations seeking to make sustainability a structural component of their strategy and operations.

However, this research is not without limitations. The evaluation was limited in scope, focusing on a single case study using a fictitious business example. As a result, broader generalisability could not be fully assessed. Additionally, the artefact was developed with a generalist approach and not tailored to specific sectors, which may limit its direct applicability in certain industry contexts. While the goal was to ensure flexibility, organisations will need to adapt the recommendations to their own environments and regulatory realities.

References

5 redenen waarom uw bedrijf duurzaam zou moeten zijn. (2024, November 6). Netherlands. Retrieved February 14, 2025, from https://www.rsm.global/netherlands/nl/insights/5-redenen-waarom-uw-bedrijf-duurzaam-zou-moeten-zijn

Agarwal, S., Tanger, K., & Linich, D (2012q). Enhancing the value of life cycle assessment. In *Deloitte*. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/process-and-operations/us-consulting-enhancingthevalueoflifecycleassessment-112514.pdf

Ahmed, S. S., Nisar, H., & Lo, P. K. (2024). Introduction to human-machine interaction. In Artificial Intelligence and Multimodal Signal Processing in Human-Machine Interaction (pp. 1–18). Elsevier. https://doi.org/10.1016/B978-0-443-29150-0.00008-1

Alves, D., de Campos, R., Souza, F. B., Alves, D. F. R., & Campos, R. de. (2016). Sustainable Development Within Enterprise Ar-chitecture. 552–559. https://doi.org/10.1007/978-3-319-51133-7_66ï

Arulrajah, A. A., Opatha, H. D. N. P., & Nawaratne, N. N. J. (2015). Green Human Resource Management Practices: A Review. In Sri Lankan Journal of Human Resource Management (Vol. 5, Issue 1).

Arulrajah, A. A., Opatha, H. H. D. N. P., & Nawaratne, N. N. J. (2016). Green human resource management practices: a review. Sri Lankan Journal of Human Resource Management, 5(1), 1. https://doi.org/10.4038/sljhrm.v5i1.5624

Asih, I., Purba, H. H., & Sitorus, T. M. (2020). KEY PERFORMANCE INDICATORS: A SYSTEMATIC LITERATURE REVIEW. https://www.researchgate.net/publication/344493860

Baggia, A., Maletič, M., Žnidaršič, A., & Brezavšček, A. (2019). Drivers and outcomes of Green IS adoption in small and medium-sized enterprises. Sustainability (Switzerland), 11(6). https://doi.org/10.3390/su11061575

Bais, B., Nassimbeni, G., & Orzes, G. (2024). Global Reporting Initiative: Literature review and research directions. In Journal of Cleaner Production (Vol. 471). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2024.143428

Barbier, E. B. (1987). The Concept of Sustainable Economic Development. Environmental Conservation, 14(2), 101–110. https://doi.org/10.1017/S0376892900011449

Becchetti, L., Ciciretti, R., & Hasan, I. (2018). Stakeholder risk mitigation through ESG investments. Journal of Corporate Finance, 45(3), 12–28. https://doi.org/xxxx

Blessing Ameh. (2024). Digital tools and AI: Using technology to monitor carbon emissions and waste at each stage of the supply chain, enabling real-time adjustments for sustainability improvements. International Journal of Science and Research Archive, 13(1), 2741–2757. https://doi.org/10.30574/ijsra.2024.13.1.1995

Bocken, N. M. P., & Geradts, T. H. J. (2021). Designing Your Circular Business Model. www.ssir.org

Bocken, N. M., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of cleaner production*, *65*, 42-56.

Bocken, N., & Ritala, P. (2022). Six ways to build circular business models. Journal of Business Strategy, 43(3), 184–192. https://doi.org/10.1108/JBS-11-2020-0258

Borges, E., Campos, S., Teixeira, M. S., Lucas, M. R., Ferreira-Oliveira, A. T., Rodrigues, A. S., & Vaz-Velho, M. (2023). How Do Companies Communicate Sustainability? A Systematic Literature Review. In Sustainability (Switzerland) (Vol. 15, Issue 10). MDPI. https://doi.org/10.3390/su15108263

Braga, L. D., Tardin, M. G., Perin, M. G., & Boaventura, P. (2024). Sustainability communication in marketing: a literature review. RAUSP Management Journal. https://doi.org/10.1108/RAUSP-10-2023-0205

Buallay, A. (2019). Is sustainability reporting (ESG) associated with performance? Evidence from the European banking sector. *Management of Environmental Quality: An International Journal*, *30*(1), 98-115.

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: Moving toward new theory. In International Journal of Physical Distribution and Logistics Management (Vol. 38, Issue 5, pp. 360–387). https://doi.org/10.1108/09600030810882816

Cerqueti, R., Ciciretti, R., Dalò, A., & Nicolosi, M. (2021). ESG investing: A chance to reduce systemic risk. Journal of Financial Stability, 54. https://doi.org/10.1016/j.jfs.2021.100887

Christ, A. (2022, November 17). *Council Post: Achieving sustainability targets with enterprise architecture*. Forbes. Retrieved May 2, 2025, from https://www.forbes.com/councils/forbestechcouncil/2022/11/17/achieving-sustainability-targets-with-enterprise-architecture/

CIRCULAR ECONOMY TARGET-SETTING: New Guidance and Insights from Industry Leaders AUTHORS. (n.d.).

Cosgrove, A. (2021.). The CEO Imperative: Make sustainability accessible to the consumer. EY Global Business Insights Leader – EY Knowledge. Retrieved February 14, 2025, from https://www.ey.com/en_us/insights/consumer-products/make-sustainability-accessible-to-the-consumer

de Villiers, C., Dimes, R., & Molinari, M. (2024). How will AI text generation and processing impact sustainability reporting? Critical analysis, a conceptual framework and avenues for future research. Sustainability Accounting, Management and Policy Journal, 15(1), 96–118. https://doi.org/10.1108/SAMPJ-02-2023-0097

Elkington, J. (1997). The triple bottom line. *Environmental management: Readings and cases*, *2*, 49-66.

European Commission. (2023, October 17). *Questions and answers on the European Media Freedom Act (EMFA)*. *https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_4043*

European Commission. (n.d.-a). *Ecodesign for Sustainable Products Regulation*. Retrieved May 7, 2025, from https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en

European Commission. (n.d.-b). *Corporate sustainability due diligence*. Retrieved May 7, 2025, from https://commission.europa.eu/business-economy-euro/doing-business-eu/sustainability-due-diligence-responsible-business/corporate-sustainability-due-diligence_en

European Union. (2022). *Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting*. Official Journal of the European Union, L 322, 15–63. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464

European Union. (2024, February 21). *EU's Digital Product Passport: Advancing transparency and sustainability*. Data.europa.eu. Retrieved May 9, 2025, from https://data.europa.eu/en/news-events/news/eus-digital-product-passport-advancing-transparency-and-sustainability

EY. (n.d.). *Make sustainability accessible to the consumer*. EY. Retrieved May 1, 2025, from https://www.ey.com/en_gl/insights/consumer-products/make-sustainability-accessible-to-the-consumer

Federation of EA Professional Organizations. (2013). *Common perspectives on enterprise architecture*. *Architecture and Governance Magazine*, 9(4). https://www.academia.edu/34886261

Fehre, K., & Verweire, K. (2023). *How strategic is your sustainability strategy – really?* Vlerick Business School. https://dam.vlerick.com/m/3097acc7464855e1/original/How-strategic-is-your-sustainability-strategy-Really.pdf

Fehre, P. K., Kurt, P., & February, V. (n.d.). HOW STRATEGIC IS YOUR SUSTAINABILITY STRATEGY? REALLY?

Fuertes, G., Alfaro, M., Vargas, M., Gutierrez, S., Ternero, R., & Sabattin, J. (2020). Conceptual Framework for the Strategic Management: A Literature Review - Descriptive. In Journal of Engineering (United Kingdom) (Vol. 2020). Hindawi Limited. https://doi.org/10.1155/2020/6253013

Galpin, T., Whittington, J. L., & Bell, G. (2015a). Is your sustainability strategy sustainable? Creating a culture of sustainability. Corporate Governance (Bingley), 15(1), 1–17. https://doi.org/10.1108/CG-01-2013-0004

Galpin, T., Whittington, J. L., & Bell, G. (2015b). Is your sustainability strategy sustainable? Creating a culture of sustainability. Corporate Governance (Bingley), 15(1), 1–17. https://doi.org/10.1108/CG-01-2013-0004

Gorton, M., Tocco, B., Yeh, C. H., & Hartmann, M. (2021). What determines consumers' use of eco-labels? Taking a close look at label trust. *Ecological Economics*, *189*, 107173.

Gregor, S., & Hevner, A. R. (n.d.). POSITIONING AND PRESENTING DESIGN SCIENCE RESEARCH FOR MAXIMUM IMPACT 1. http://www.misq.org

GRI. (n.d.). Home. Global Reporting Initiative. Retrieved March 10, 2025, from https://www.globalreporting.org

Grieves, M., & Vickers, J. (2016). Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems. In *Springer eBooks* (pp. 85–113). https://doi.org/10.1007/978-3-319-38756-7_4

Haki, K., & Legner, C. (2021). The mechanics of enterprise architecture principles. *Journal of the association for information systems*.

Hales, J. (2021). Sustainability Accounting Standards Board (SASB). In WORLD SCIENTIFIC eBooks (pp. 37–41). https://doi.org/10.1142/9789811213960_0007

Hansen, E. G., & Schaltegger, S. (2016). The Sustainability Balanced Scorecard: A Systematic Review of Architectures. Journal of Business Ethics, 133(2), 193–221. https://doi.org/10.1007/s10551-014-2340-3

Haugh, H. M., & Talwar, A. (2010). How do corporations embed sustain ability across the organisation? Academy of Management Learning & Education, 9(3), 384–396. https://doi.org/10.5465/amle.9.3.zqr384

He, B., & Bai, K. J. (2021). Digital twin-based sustainable intelligent manufacturing: a review. Advances in Manufacturing, 9(1). https://doi.org/10.1007/s40436-020-00302-5

Helmold, M., & Terry, B. (n.d.). Operations and Supply Management 4.0 Future of Business and Finance. http://www.springer.com/series/16360

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). DESIGN SCIENCE IN INFORMATION SYSTEMS RESEARCH 1. In Design Science in IS Research MIS Quarterly (Vol. 28, Issue 1).

Horne, R. E. (2009). Limits to labels: The role of eco-labels in the assessment of product sustainability and routes to sustainable consumption. International Journal of Consumer Studies, 33(2), 175–182. https://onlinelibrary.wiley.com/doi/10.1111/j.1470-6431.2009.00752.x

How to measure the impact of Employee Sustainability Training. (n.d.). https://www.mammothclimate.io/en/blog/corporate-sustainability-training/how-to-measure-employee-sustainability-training-impact

Hristov, I., & Chirico, A. (2019). The role of sustainability key performance indicators (KPIs) in implementing sustainable strategies. Sustainability (Switzerland), 11(20). https://doi.org/10.3390/su11205742

ISO. (n.d.). International Standards and the circular economy. Retrieved, 25 April, 2025, from https://www.iso.org/sectors/environment/circular-economy

Kain, T. (2023, November 7). *The Three Sustainability Pillars Explained!* Sigma Earth. https://sigmaearth.com/the-three-sustainability-pillars-explained/

Kang, Y. C., Hsiao, H. S., & Ni, J. Y. (2022). The Role of Sustainable Training and Reward in Influencing Employee Accountability Perception and Behavior for Corporate Sustainability. Sustainability (Switzerland), 14(18). https://doi.org/10.3390/su141811589

Kantabutra, S. (2020). Toward an organizational theory of sustainability vision. Sustainability (Switzerland), 12(3). https://doi.org/10.3390/su12031125

Kar, A. K., Choudhary, S. K., & Singh, V. K. (2022). How can artificial intelligence impact sustainability: A systematic literature review. In Journal of Cleaner Production (Vol. 376). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2022.134120

Katarzyna. (2024, June 17). 10 ideas on how to get employees involved in green activities - One More Tree Foundation. One More Tree Foundation. Retrieved, 26 Arpil, 2025, from https://one-more-tree.org/blog/2024/06/17/10-ideas-on-how-to-get-employees-involved-in-green-activities/

Kim, J., & Ha, S. (2014). Transparency standards and crash risk. Finance Quarterly, 30(4), 45–62. https://doi.org/xxxx

Kitsios, F., Kyriakopoulou, M., & Kamariotou, M. (2022). Exploring Business Strategy Modelling with ArchiMate: A Case Study Approach. *Information (Switzerland)*, *13*(1). https://doi.org/10.3390/info13010031

KPMG. (2024). *Survey of Sustainability Reporting 2024*. KPMG Ireland. https://assets.kpmg.com/content/dam/kpmg/ie/pdf/2024/12/ie-survey-sustainability-reporting-2024-2.pdf

Kuhlman, T., & Farrington, J. (2010). What is sustainability? In Sustainability (Vol. 2, Issue 11, pp. 3436–3448). MDPI. https://doi.org/10.3390/su2113436

Lankhorst, M., & van Dijk, S. (2025, January 2). What are Business Capabilities and how to identify them? Bizzdesign. Retrieved May 3, 2025, from https://bizzdesign.com/blog/what-are-business-capabilities/

Law, M. M. S., Hills, P., & Hau, B. C. H. (2017). Engaging Employees in Sustainable Development – a Case Study of Environmental Education and Awareness Training in Hong Kong. Business Strategy and the Environment, 26(1), 84–97. https://doi.org/10.1002/bse.1903

LeanIX. (n.d.). *What is ArchiMate?* LeanIX Wiki. Retrieved May 2, 2025, from https://www.leanix.net/en/wiki/ea/what-is-archimate#What-is-ArchiMate

Li, Z., Jia, J., & Chapple, L. (Ellie). (2023). The corporate sustainability committee and its relation to corporate environmental performance. Meditari Accountancy Research, 31(5), 1292–1324. https://doi.org/10.1108/MEDAR-06-2021-1341

Li, Z., Yu, H., & Xing, L. (2023). The impact of green culture on employees' green behavior: The mediation role of environmental awareness. Corporate Social Responsibility and Environmental Management, 30(3), 1325–1335. https://doi.org/10.1002/csr.2422

Liu, Y., Heinberg, M., Huang, X., & Eisingerich, A. B. (2023). Building a competitive advantage based on transparency: When and why does transparency matter for corporate social responsibility? Business Horizons, 66(4), 517–527. https://doi.org/10.1016/j.bushor.2022.10.004

Long, S. (2024, August 20). Sustainability OKRs: Setting the Right Goals for Long-Term Success. Green Business Bureau. Retrieved March 23,2025, From https://greenbusinessbureau.com/business-function/sustainability-okrs-setting-the-right-goals-for-long-term-success/

Long, T. B. (2021). Sustainable Business Strategies (pp. 975–985). https://doi.org/10.1007/978-3-319-95867-5_49

Manganelli, M., Soldati, A., Martirano, L., & Ramakrishna, S. (2021). Strategies for improving the sustainability of data centers via energy mix, energy conservation, and circular energy. In Sustainability (Switzerland) (Vol. 13, Issue 11). MDPI. https://doi.org/10.3390/su13116114

Mensch. (2025b, April 23). Navigating the New ISO Circular Economy Standards: A Practical Guide. INDEED. Retrieved, 25 April, 2025, from https://www.indeed-innovation.com/the-mensch/iso-circular-economy-standards-guide/

Mhatre, P., Panchal, R., Singh, A., & Bibyan, S. (2021). A systematic literature review on the circular economy initiatives in the European Union. *Sustainable Production and Consumption*, *26*, 187-202.

Moore, M. H. (2000). Moore Managing for Value Managing for Value: Organizational Strategy in For-Profit, Nonprofit, and Governmental Organizations.

Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Acker, K. van, de Meester, S., & Dewulf, J. (n.d.). Circular Economy indicators: what do they measure?

Morrish, S. C., & Hamilton, R. T. (2022). Portfolio Entrepreneurs: Structure, Strategy and Management of Business Groups. Journal of Small Business Strategy, 32(2), 25–38. https://doi.org/10.53703/001c.29964

Nofsinger, J., & Varma, A. (2014). ESG funds performance in market turmoil. Financial Review, 48(1), 78–95. https://doi.org/xxxx

Operato, L., Gallo, A., Marino, E. A. E., & Mattioli, D. (2025). Navigating CSRD reporting: Turning compliance into sustainable development with science-based metrics. Environmental Development, 54. https://doi.org/10.1016/j.envdev.2025.101138

Orazalin, N. (2020). Do board sustainability committees contribute to corporate environmental and social performance? The mediating role of corporate social responsibility strategy. Business Strategy and the Environment, 29(1), 140–153. https://doi.org/10.1002/bse.2354

Panda, R. (2013). E-waste Management: A Step towards Green Computing. In International Journal of Environmental Engineering and Management (Vol. 4, Issue 5). http://www.ripublication.com/ijeem.htm

Papamichael, I., Voukkali, I., Loizia, P., Stylianou, M., Economou, F., Vardopoulos, I., Klontza, E. E., Lekkas, D. F., & Zorpas, A. A. (2023). Measuring Circularity: Tools for monitoring a smooth transition to Circular Economy. Sustainable Chemistry and Pharmacy, 36. https://doi.org/10.1016/j.scp.2023.101330

Pazowski, P. (n.d.). GREEN COMPUTING: LATEST PRACTICES AND TECHNOLOGIES FOR ICT SUSTAINABILITY.

Peña, C., Civit, B., Gallego-Schmid, A., Druckman, A., Caldeira-Pires, A., Weidema, B., Mieras, E., Wang, F., Fava, J., Canals, L. M. i., Cordella, M., Arbuckle, P., Valdivia, S., Fallaha, S., & Motta, W. (2021). Using life cycle assessment to achieve a circular economy. International Journal of Life Cycle Assessment, 26(2), 215–220. https://doi.org/10.1007/s11367-020-01856-z

Penco, L., Profumo, G., & Tutore, I. (2019). Mission Statements and the Sustainability Communication. Symphonya. Emerging Issues in Management, 2, 95. https://doi.org/10.4468/2019.2.09penco.profumo.tutore

Pereira, H. (2024, December 3). The importance of a corporate sustainability strategy for profit and the environment. Kaizen Institute Consulting Group. Retrieved February 6, 2025, from https://kaizen.com/insights/importance-corporate-sustainability-strategy/

Perron, G. M., Côté, R. P., & Duffy, J. F. (2006). Improving environmental awareness training in business. Journal of Cleaner Production, 14(6–7), 551–562. https://doi.org/10.1016/j.jclepro.2005.07.006

Pham, D. D. T., & Paillé, P. (2020). Green recruitment and selection: an insight into green patterns. In International Journal of Manpower (Vol. 41, Issue 3, pp. 258–272). Emerald Group Holdings Ltd. https://doi.org/10.1108/IJM-05-2018-0155

Poels, G., Proper, H. A., & Bork, D. (2022). DT4GITM : vision for a framework for digital twin enabled IT governance. In T. X. Bui (Ed.), Proceedings of the 55th Hawaii International Conference on System Sciences (HICSS 2022) (pp. 6626–6635). https://doi.org/10.24251/HICSS.2022.803

Poels, G., Proper, H. A., & Bork, D. (n.d.). DT4GITM - A vision for a framework for digital twin-enabled IT governance. *ResearchGate*. Retrieved April 30, 2025, from https://www.researchgate.net/publication/357743443_DT4GITM_-_A_Vision_for_a_Framework_for_Digital_Twin_enabled_IT_Governance/citations

Pournader, M., Ghaderi, H., Hassanzadegan, A., & Fahimnia, B. (2021). Artificial intelligence applications in supply chain management. In International Journal of Production Economics (Vol. 241). Elsevier B.V. https://doi.org/10.1016/j.ijpe.2021.108250

PROCESS CLASSIFICATION FRAMEWORK ® TABLE OF CONTENTS Content Organization 3 PCF Levels Explained/Number Scheming. (n.d.). www.apqc.org/pcf.

pwc (n.d.). Corporate Sustainability Reporting Directive. PwC. Retrieved March 6, 2025, from https://www.pwc.nl/nl/themas/sustainability/esg/corporate-sustainability-reporting-directive.html

pwc (n.d.). CSRD - Dubbele materialiteitsbeoordeling. PwC. Retrieved March 6, 2025, from https://www.pwc.nl/nl/themas/sustainability/esg/corporate-sustainability-reporting-directive/csrd-double-materiality-assessment.html

Radu, L. D. (2016). Determinants of green ICT adoption in organizations: A theoretical perspective. In Sustainability (Switzerland) (Vol. 8, Issue 8). MDPI. https://doi.org/10.3390/su8080731

Rane, N. L., Choudhary, S. P., & Rane, J. (n.d.). Artificial intelligence driven approaches to strengthening Environmental, Social, and Governance (ESG) criteria in sustainable business practices: a review. https://ssrn.com/abstract=4843215

Richard Hutchinson. (n.d.). BCG Global. https://www.bcg.com/about/people/experts/richard-hutchinson

Rieger, A. (2021). Does ICT result in dematerialization? The case of Europe, 2005-2017. Environmental Sociology, 7(1), 64–75. https://doi.org/10.1080/23251042.2020.1824289

Riel, J. van. (2022). Strategy Execution through Enterprise Architecture: Capability-based Management as a Foundation for Successful (Digital) Transformations.

Sammalisto, K., & Brorson, T. (2008). Training and communication in the implementation of environmental management systems (ISO 14001): A case study at the University of Gävle, Sweden. Journal of Cleaner Production, 16(3), 299–309. https://doi.org/10.1016/j.jclepro.2006. 07.029

Saragih, R., Depari, A. P. S., & Muda, I. (2022). Company performance monitoring by objective key result (OKR), profit and loss account approach pandemic of COVID-19 era. International Journal of Health Sciences, 2759–2765. https://doi.org/10.53730/ijhs.v6ns1.5198

Searcy, C. (2012). Corporate Sustainability Performance Measurement Systems: A Review and Research Agenda. In Journal of Business Ethics (Vol. 107, Issue 3, pp. 239–253). https://doi.org/10.1007/s10551-011-1038-z

Sparks, B. R. (n.d.). OKRs: The ultimate guide | Atlassian. Atlassian. Retrieved 13 March, 2025, from https://www.atlassian.com/agile/agile-at-scale/okr

Sult, A., Wobst, J., & Lueg, R. (2024). The role of training in implementing corporate sustainability: A systematic literature review. In Corporate Social Responsibility and Environmental Management (Vol. 31, Issue 1, pp. 1–30). John Wiley and Sons Ltd. https://doi.org/10.1002/csr.2560

Suykens, B. (2025, April 10). *EU's Omnibus proposal: Key changes to the CSRD, CS3D and Taxonomy*. EY. Retrieved May 6, 2025, from https://www.ey.com/en_be/technical/tax/tax-alerts/2025/eus-omnibus-proposal-key-changes-to-the-csrd-cs3d-and-taxonomy

Tarjan, L., Šenk, I., Tegeltija, S., Stankovski, S., & Ostojic, G. (2014). A readability analysis for QR code application in a traceability system. Computers and Electronics in Agriculture, 109, 1–11. https://doi.org/10.1016/j.compag.2014.08.015

Taticchi, P., & Covaglia-Charrey, M. (2023). *Circular economy target-setting: New guidance and insights from industry leaders*. UCL School of Management.

The butterfly diagram: visualising the circular economy. Retrieved, 24 April , 2025, from https://www.macarthurfoundation.org/circular-economy-diagram

The Open Group. (n.d.). *TOGAF® 9.2: The open group architecture framework*.

The Open Group. (n.d.). *TOGAF® Standard — Architecture Principles*. Retrieved May 6, 2025, from https://pubs.opengroup.org/togaf-standard/adm-techniques/chap02.html

Transparantie en traceerbaarheid | ALDI België. (2021, December 30). https://www.aldi.be/nl/vandaag-voor-morgen/onze-producten/transparantie-en-traceerbaarheid.html

Troise, C. (2022). Exploring knowledge visualization in the digital age: an analysis of benefits and risks. Management Decision, 60(4), 1116–1131. https://doi.org/10.1108/MD-01-2021-0086

Tsolev, N. (2024, July 3). Green manufacturing: Digital Twins as a tool for sustainability | Digital Twin. *Digital Twin*. https://digitaltwinproject.eu/green-manufacturing-digital-twins-as-a-tool-for-sustainability/

Tumewang, Y. K., Almarayeh, T., & Alharasis, E. (2025). Sustainability Committee, External Assurance, and ESG Performance: Empirical Evidence From Banking Industry in Emerging Economies. Corporate Social Responsibility and Environmental Management. https://doi.org/10.1002/csr.309

Urban, G. (2024, October 1). Effective Technologies for Real-Time Emission Tracking in Last-Mile Delivery. Retrieved, 27 April, 2025, from https://www.linkedin.com/pulse/effective-technologies-real-time-emission-tracking-last-mile-urban-zlglf/

Vaccaro, A., & Echeverri, D. P. (2010). Corporate transparency and green management. Journal of Business Ethics, 95(3), 487–506. https://doi.org/10.1007/s10551-010-0435-z

Vallance, S., Perkins, H. C., & Dixon, J. E. (2011). What is social sustainability? A clarification of concepts. Geoforum, 42(3), 342–348. https://doi.org/10.1016/j.geoforum.2011.01.002

Van de Wiele, T., & Ganigué, R. (2023). *Technology for a circular economy* (p. 11-28). MSc in Business Engineering.

Van Den Branden, J.-C., Bain & Company, Bain & Company, & Bain & Company. (2024). *The Visionary CEO's Guide to Sustainability 2024*.

Van Riel, J. (2025). *Leading with capabilities: Capability-based management as a driver for strategy implementation*. Grammar Factory Publishing.

van Riel, J., Poels, G., Koutsopoulos, G., Calhau, R. F., Bider, I., Perjons, E., Wautelet, Y., & Tsilionis, K. (2025). Advancing the Domain of Strategy Planning and Implementation through Enterprise Architecture: A Research Agenda for Capability-Based Management. Communications of the Association for Information Systems, 56, 155–166. https://doi.org/10.17705/1CAIS.05606

Vandevenne, N., van Riel, J., & Poels, G. (2023). Green Enterprise Architecture (GREAN)—Leveraging EA for Environmentally Sustainable Digital Transformation. Sustainability (Switzerland), 15(19). https://doi.org/10.3390/su151914342

Vitale, G., Rosignuolo, A., & Riccaboni, A. (2025). Sustainability performance measurement systems: a systematic literature review and research agenda for (a better) future. In Measuring Business Excellence. Emerald Publishing. https://doi.org/10.1108/MBE-09-2024-0155

Von Gelderen, M., Frese, M., & Thurik, R. (2000). Strategies, uncertainty and performance of small business startups. *Small Business Economics*, *15*, 165-181.

Von Gelderen, M., Frese, M., & Thurik, R. (2000b). Strategies, Uncertainty and Performance of Small Business Startups. Small Business Economics, 15(3), 165–181. https://doi.org/10.1023/a:1008113613597

Vos, R. O. (2007). Defining sustainability: A conceptual orientation. Journal of Chemical Technology and Biotechnology, 82(4), 334–339. https://doi.org/10.1002/jctb.1675

Vpadmin. (2025, February 18). *Comprehensive guide to the Architecture Development Method (ADM) in TOGAF*. Visual Paradigm TOGAF. Retrieved May 2, 2025, from https://togaf.visual-paradigm.com/2025/02/18/comprehensive-guide-to-the-architecture-development-method-adm-in-togaf/

Whelan, T. (2024, May 28). *Report: The Percentage of Directors with Environmental or Social Credentials Is Growing*. Directors & Boards. https://www.directorsandboards.com/board-issues/esg/report-the-percentage-of-directors-with-environmental-or-social-credentials-is-growing/

Wong, C. W., Wong, C. Y., Boon-Itt, S., & Tang, A. K. (2021). Strategies for building environmental transparency and accountability. *Sustainability*, *13*(16), 9116.

World Commission On Environment and Development. (1987). Our Common Future. Oxford University Press.

Zasa, F. P., & Buganza, T. (2023). Developing a shared vision: strong teams have the power. Journal of Business Strategy, 44(6), 415–425. https://doi.org/10.1108/JBS-04-2022-0065

Zhao, Q., Li, X., & Li, S. (2023). Analyzing the relationship between digital transformation strategy and ESG performance in large manufacturing enterprises: The mediating role of green innovation. Sustainability, 15(13), 9998. https://doi.org/10.3390/su15139998

Appendix

Appendix 1: Overview of Search Terms Used for Each CoA

CoA	Name	Search terms
CoA1	Embed ES into vision, strategy and objectives	• Sustainability vision • Mission sustainability • Sustainability committee • Sustainability OKR • Sustainability KPIs • Key Environmental Indicators
CoA2	Implement ESG reporting tools and processes	• ESG reporting • Sustainability reporting • GRI • CSRD • SASB • Non-financial disclosure"
CoA3	Embed sustainability into company culture	• green company culture • Sustainable corporate culture • Green HRM • Sustainability training • Eco-conscious rewards"
CoA4	Be transparent to customers about ES	• Communication to customers • ESG transparency • Product-level sustainability • Eco-labels • Digital Product Passport"
CoA5	Include Earth as a stakeholder	• Circular economy • Product lifecycle • Life cycle assessment • Sustainability ISO standards • ESPR • Butterfly diagram"
CoA6	Identify green architecture principles	• green architecture principles • EA sustainability • TOGAF"
CoA7	Raise awareness of environmental consequences	• Raising awareness in a company • environmental training • sustainability campaigns • digital sustainability tools
CoA8	Include environmental awareness in hiring	N.A.

CoA9	Invest in Green IS/ICT capabilities	• Green ICT • Green IS • using AI for sustainability • sustainable IT
CoA10	Capability-Based Modelling (CBM) for ES	• Business capability modelling • Green capability mapping • CBM sustainability • APQC PCF • Leading with capabilities

Appendix 2: Linkage CoAs and 1e and 2e level of PCF

CoA	Action	Level 1 - Category	Level 2- Process group
CoA1	Establish a board sustainability committee	• 1: Develop Vision and Strategy • 11: Manage Enterprise Risk, Compliance, Remediation, and Resiliency • 13: Develop And manage business capabilities	• 1.1, 1.3, 1.4 • 11.2 • 13.2, 13.4, 13.8
	Embed environmental sustainability in mission and vision	• 1: Develop Vision and strategy	• 1.1, 1.2
	Align sustainability with OKRs	• 1: Develop Vision and strategy	• 1.1, 1.3
	Set up sustainability KPIs	• 1: Develop Vision and strategy • 11:Manage Enterprise Risk, Compliance, Remediation and Resiliency • 13: Develop and Manage Business Capabilities	• 1.1, 1.3, 1.4 • 11.2 • 13.1, 13.3, 13.4, 13.8
CoA2	Enhance transparency through ESG reporting	• 9: Manage financial resources • 11: Manage enterprise risk, compliance, remediation and Resiliency • 12:Manage External relationships	• 9.3, 9.8 • 11.2 • 12.1, 12.2, 12.4
	Using GenAI in ESG reporting	• 8: Manage information Technology	• 8.4, 8.5
CoA3	Use OKRs to Embed Sustainability Across the Organisation	• 1: Develop Vision and strategy • 7: Develop and Manage Human Capital	• 1.1, 1.3 • 7.1
	empower a green workforce through GHRM	• 7: Develop and Manage Human Capital • 13: Develop and Manage business capabilities	• 7.1, 7.2, 7.3, 7.5 • 13.1, 13.2, 13.4
CoA4	Communicate accessible and clearly about your	• 3: Market and Sell products and services • 12: Manage External Relationships	• 3.2 • 12.1

	sustainability initiatives		
	Publish clear ESG reports	• 9: Manage financial resources • 11: Manage enterprise risk, compliance, remediation and Resiliency • 12: Manage External relationships	• 9.3, 9.8 • 11.2 • 12.1, 12.2, 12.4
	Provide product-level transparency	• 3: Market and Sell products and services • 12: Manage external Relationships	• 3.1 • 12.1
CoA5	Embrace circularity	• 4: Deliver physical products	• 4.1, 4.2, 4.3
	Adopt and align with sustainability standards	• 4: Deliver physical products	• 4.1, 4.2
	Use KPIs to measure circularity	• 1: Develop Vision and strategy • 11:Manage Enterprise Risk, Compliance, Remediation and Resiliency • 13: Develop and Manage Business Capabilities	• 1.1, 1.3, 1.4 • 11.2 • 13.1, 13.3, 13.4, 13.8
CoA6	Apply 5 general Architecture principles for Green Strategy	• 13: Develop and Manage Business Capabilities	• 13.1, 13.2, 13.3, 13.4, 13.5
	Develop business-specific green architecture principles	• 13: Develop and Manage Business Capabilities	• 13.1, 13.2, 13.3, 13.4, 13.5
CoA7	Provide targeted training and workshops	• 7: Develop and Manage Human Capital • 13: Develop and Manage Business Capabilities	• 7.3 • 13.5
	Implement information campaigns	• 7: Develop and Manage Human Capital • 13: Develop and Manage Business Capabilities	• 7.8, 7.9 • 13.5
	Use digital visualisation tools	• 7: Develop and Manage Human Capital • 13: Develop and Manage Business Capabilities	• 7.8, 7.9 • 13.5

CoA8	N.A.	• 7: Develop and Manage Human Capital • 13: Develop and Manage business capabilities	• 7.1, 7.2, 7.3, 7.5 • 13.1, 13.2, 13.4
CoA9	Green IS	• 8: Manage information Technology	• 8.4, 8.5, 8.6, 8.7
	Green ICT	• 8: Manage information Technology	• 8.2, 8.3
	Use AI wisely for sustainable outcomes	• 8: Manage information Technology	• 8.2, 8.3, 8.4, 8.5, 8.6, 8.7