Improving EcoDesign implementation at Philips: from compliance to innovation

Master thesis
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TU Delft PHILIPS

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Throughout this project, artificial intelligence (AI) is used. A more detailed description of AI use in the project can be found in Appendix A.

The design solutions presented in this report are proposed and validated concepts, and have not necessarily been fully implemented within the organization.

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Preface

This thesis marks the end of my master's in Strategic Product Design and five years of studying at the Faculty of Industrial Design Engineering. It felt like a fitting final project: applying strategic design in a product design context, focusing on organizational complexity and environmental sustainability in a practical setting at Philips.

Looking back, this has been one of the most challenging projects I have worked on during my studies. It asked me to understand how EcoDesign is implemented in a large organization, while finding my way through technical topics, organizational structures, and many different perspectives. What made the project difficult was also what made it valuable in terms of learning: moving between engineering details, abstraction levels, strategic discussions, and organizational questions, and gradually bringing these together into something useful.

I would like to thank Conny and Shahrokh for their guidance throughout the project. Thank you for challenging my thinking, pointing me back to the literature when needed, and helping me sharpen the academic and practical side of the work. Daniel, thank you for your close involvement at Philips, your trust, and your critical reflections. You helped me make sure that the outcomes were not only interesting on paper, but also relevant in practice.

I am also grateful to all colleagues across Philips who made time for interviews, feedback sessions, workshops, and informal conversations. I am proud that the project does not end with this report, but also contributes to Philips' EcoDesign program for the coming years.

Finally, I want to thank the people around me who supported me during these months. Thank you for listening, thinking along, distracting me, and reminding me to have fun and learn.

Enjoy reading!

Tobias Rumphorst
Amsterdam, June 2026

Abstract

EcoDesign is widely adopted by large manufacturing organizations to reduce the environmental impact of their products, yet its impact often remains limited. Despite formal programs and a growing body of tools and methods, EcoDesign frequently struggles to be properly integrated on the organizational side. This thesis investigates how the implementation of EcoDesign within product development processes can be improved, using Philips as a case study.

The project started with a structured literature review to identify the success factors and barriers for internal EcoDesign implementation. Building on the framework of Dekoninck et al. (2016), insights from 39 academic papers were integrated into a conceptual model that organizes EcoDesign implementation across six themes: leadership and strategy, organizational structure and collaboration, integration into the product development process, environmental and sustainability knowledge, tools and methods, and requirements. A complementary external analysis, including a competitor benchmark and trend analysis, positioned Philips within the wider industry context.

The empirical research consisted of 22 semi-structured interviews with different stakeholders within Philips, supplemented by four interviews with external organizations. The main issues identified were late process integration, limited cross-functional collaboration, and ambiguous requirements without rationale. The interviews also indicated that EcoDesign in practice takes different forms, ranging from baseline approaches to incremental improvement to radical innovation. It is argued that these different forms require different implementation approaches.

Based on these findings, a revised two-track EcoDesign framework for Philips is proposed. The first track, EcoDesign in PDLM, focuses on baseline and incremental EcoDesign for new product introductions. It ensures auditability and supports Business Units in meeting mandatory requirements. The track is operationalized through the EcoDesign in PDLM handbook, which provides a structured process, updated requirements, and guidelines written in engineering-oriented terminology. The second track, Eco-Innovation, aims to steer EcoDesign into product roadmaps. It targets product management and aims to strengthen cross-functional collaboration. It is supported by the Eco-Innovation starter package, consisting of a tool and workshop that enable teams to see EcoDesign as an opportunity.

Validation sessions with stakeholders endorsed the overall framework, with the handbook seen as a clear improvement over the current standard and the Eco-Innovation starter package successfully piloted within a Business Unit. Further iteration is needed to solve practical concerns and refine the solutions before wider rollout.

The main contribution of this project is the insight that different forms of EcoDesign require different implementation approaches, which can be complementary. The proposed framework operationalizes this insight. By translating the framework into concrete design deliverables, the project also offers a practical example for other organizations facing EcoDesign implementation challenges.

List of abbreviations

General

AI	Artificial Intelligence
BoM	Bill of Materials
CDP	Carbon Disclosure Project
COCIR	European Coordination Committee of the Radiological, Electromedical, and Healthcare Information Technology Industry
CSA	Corporate Sustainability Assessment
CSRD	Corporate Sustainability Reporting Directive
DfE	Design for Environment
DPP	Digital Product Passport
ESG	Environmental, Social and Governance
ESPR	Ecodesign for Sustainable Products Regulation
FAQ	Frequently Asked Questions
FSC	Forest Stewardship Council
GPP	Green Public Procurement
ISO	International Organization for Standardization
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MEPA	Medical Equipment Proactive Alliance
MR(I)	Magnetic Resonance (Imaging)
NPD	New Product Development
NPI	New Product Introduction
PDP	Product Development Process
PLM	Product Lifecycle Management
PPWR	Packaging and Packaging Waste Regulation
R&D	Research & Development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances
SBTi	Science Based Targets Initiative
SPD	Sustainable Product Design
TBL	Triple Bottom Line

Philips specific

AD	Advanced Development
BP	Business Partner
BU	Business Unit
GSO	Group Sustainability (Organization/Office)
I2M	Idea to Market
PDLM	Product Development Launch and Maintenance
RSL	Regulated Substances List
SME	Subject Matter Expert
VPC	Value Proposition Creation

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1. Introduction

This chapter introduces the research context, objective, and questions that guide this project. It describes the methodological approach and the scope of the research. The chapter closes with an overview of how the rest of the report is structured.

1.1 Research context

The world is facing a growing environmental crisis. Human activities have already caused the global average temperature to rise by about 1.1°C compared to pre-industrial levels. This contributes to more extreme weather, biodiversity loss, and damage to ecosystems (IPCC, 2023). At the same time, scientific studies show that seven out of nine planetary boundaries have already been transgressed. These boundaries describe the natural systems that keep the Earth stable and resilient (Rockström et al., 2009; Sakschewski et al., 2025). These developments show the urgent need to change how societies produce and consume goods and services (IPCC, 2023).

A central response to these challenges is the concept of sustainable development, defined by the Brundtland Commission as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED, 1987). Within this context, companies are increasingly taking responsibility for reducing their environmental impact, for example by setting science-based emission reduction targets (SBTi, 2025), switching to renewable energy, increasing circularity approaches, and integrating sustainability in core strategies and leadership remuneration (UNGC, 2025). For product-focused companies, design is one of the strongest leverage points available: decisions made in product development largely determine what materials are used, how much energy a product needs, how long it lasts, and what happens at end-of-life. Research suggests that around 80% of a product's environmental impact is determined during design (Ahmad et al., 2018). In response to this, the concept of EcoDesign has emerged, which focuses on integrating environmental considerations into product design.

The meta-review of Schäfer & Löwer (2021) did not find a universally accepted definition of EcoDesign in the literature, but highlights the most important characteristics: (1) a primary focus on product development activities, (2) the explicit aim of reducing environmental impacts, and (3) the consideration of environmental effects across the full product life cycle, from raw material extraction to end-of-life treatment (Schäfer & Löwer, 2021). This aligns with the International Organization for Standardization (ISO) definition: *"a systematic approach, which considers environmental aspects in design and development with the aim to reduce adverse environmental impacts throughout the life cycle of a product"* (ISO, 2020). EcoDesign is often used interchangeably with related terms such as Design for Environment (DfE), sustainable product design (SPD), life cycle engineering, and, in certain contexts, sustainable innovation (Schäfer & Löwer, 2021). EcoDesign focuses explicitly on environmental sustainability, while an approach such as SPD often considers the full Triple Bottom Line, including additional economic and social dimensions (Diaz et al., 2021; Elkington, 2007).

Organizations increasingly adopt EcoDesign practices in their products and operations. Key drivers include stricter regulations and external standards, such as emission caps and recyclability rates, which also push organizations to anticipate future requirements (Poulikidou et al., 2014). Customer demand is another important driver, as customers across sectors

increasingly request environmental performance documentation to compare products (Poulikidou et al., 2014). This also makes market competition a relevant factor in EcoDesign adoption. In addition, internal factors, such as company commitments, values, business opportunities, and resilience, can motivate companies to adopt EcoDesign (Kara et al., 2014; Poulikidou et al., 2014). External drivers are considered the strongest drivers for adoption (Bey et al., 2013). Figure 1.1 visualizes the full set of EcoDesign adoption drivers.

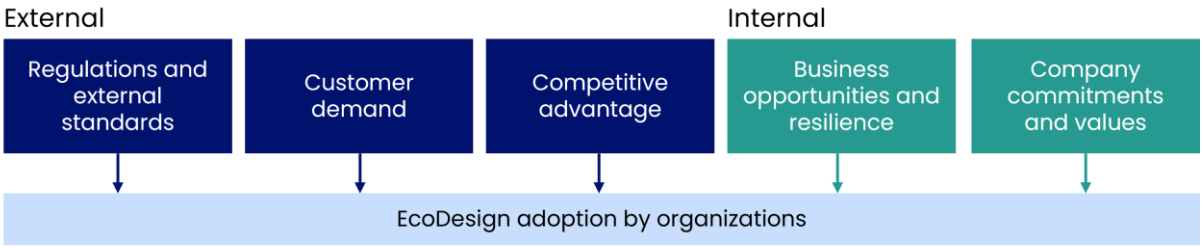


Figure 1.1: Factors that influence the adoption of EcoDesign practices by organizations (Poulikidou et al., 2014).

EcoDesign is widely seen as a useful way to reduce the environmental impact of products, but implementing it in industry remains a challenge (Dekoninck et al., 2016; Vilochani et al., 2024b). In response, researchers have developed many methods and tools to help practitioners include environmental considerations in product development (Faludi et al., 2020; Hallstedt et al., 2023). However, despite the number of tools available, they are still not widely used in regular industry practice (Pigosso et al., 2013). It is emphasized that advancing EcoDesign requires moving beyond tool creation toward understanding how such methods can be effectively integrated into industry workflows, organizational structures, and decision-making processes (Faludi et al., 2020; Vilochani et al., 2024b).

Integrating EcoDesign across these workflows, structures, and processes is considered difficult because the challenges often appear at the translation between strategic, tactical, and operational levels (Watz & Hallstedt, 2022). This thesis therefore approaches EcoDesign implementation as an organizational challenge and explores how it can be improved by better aligning organizational levels and initiatives. This is done in the context of a large organization with a mature EcoDesign program, directly addressing the gap between EcoDesign in theory and practical embedding (Thelemann et al., 2026).

1.2 Research objective

Instead of treating EcoDesign as a purely conceptual or technical topic, this research investigates how EcoDesign is implemented within the complexity of real organizational contexts. Philips serves as the case-study context for this. As a large multinational health-technology company with a longstanding EcoDesign program and formally embedded sustainability requirements, it provides a relevant setting to study EcoDesign implementation in complex product development processes. The original project brief can be found in Appendix B.

Overall, the objective of this research is twofold: to contribute to academic understanding of EcoDesign implementation across organizational levels, and to develop practical design solutions that support the implementation of EcoDesign within Philips.

1.3 Research and design questions

This research is guided by the following main research question:

How can the implementation of EcoDesign within product development processes be improved in the context of a large organization like Philips?

To answer this question, the following sub-questions will be answered, of which the first two questions are research questions, while questions three and four are design questions:

1. What success factors and barriers influence the implementation of EcoDesign within product development processes in organizations?
2. How do the success factors and barriers identified in the literature manifest themselves in the context of Philips?
3. How can the identified organizational barriers and success factors be translated into an improved EcoDesign implementation framework for Philips?
4. What types of design interventions can support the operational integration of this EcoDesign implementation framework?

1.4 Project approach & methodology

This graduation project follows a qualitative case-study approach, combined with an iterative design phase. This allows for an in-depth understanding of EcoDesign implementation challenges in a real organizational context, while developing and testing design solutions to address them. The study is structured into four phases, shown in Figure 1.2, which also links the phases to the sub-questions and report structure.

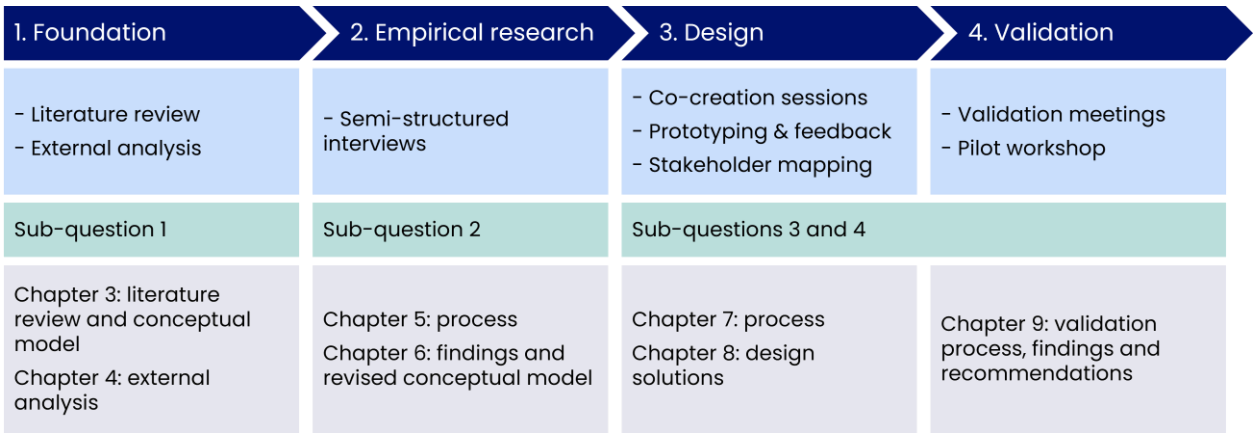


Figure 1.2: Four phased project approach with link to sub-questions and report structure.

The first phase combines a semi-systematic literature review with an external analysis consisting of a trend analysis and a competitor benchmark. The literature findings are thematically organized into a conceptual model that serves as a theory-informed analytical framework for the empirical research phase.

The second phase examines how the success factors and barriers identified in the literature manifest within Philips. The primary method is semi-structured interviewing, with participants selected through purposive sampling across four internal stakeholder groups and external organizations. The data is analyzed through theory-informed thematic analysis, using the conceptual model as the initial coding framework while remaining open to inductive insights.

Third, the design phase uses iterative prototyping and stakeholder feedback to develop solutions and generate further insights. Included methods in this phase are a workshop with Group Sustainability (GSO), stakeholder mapping, prototyping, and continuous feedback sessions.

The fourth phase aims to validate the developed framework and design interventions through structured feedback and pilot sessions with GSO and Business Units (BUs).

1.5 Scope

On an academic level, this project studies EcoDesign implementation within product development processes in large, established manufacturing organizations. The focus is on the organizational and managerial factors that influence EcoDesign implementation, not on the technical barriers encountered to operationalize EcoDesign in products, such as the availability of low-carbon materials or technologies.

Within Philips, the project focuses on the Professional Health Systems segment. Personal Health BUs are excluded because of their different maturity in EcoDesign implementation and shorter innovation cycles. Validation of the designed solutions is further narrowed to one specific BU.

In terms of EcoDesign content, Philips works with four focal areas: energy, packaging, substances, and circularity. This project considers all four, but mainly focuses on energy, packaging, and circularity. Substances are included where relevant for completeness, but are not a primary focus, as they are managed through separate regulatory and chemical management processes within Philips, such as the Regulated Substances List (RSL).

Finally, several related topics are explicitly left out of scope. The project does not aim to redesign Philips' overall product development process or its broader sustainability strategy. Instead, it works within these existing structures. The project also does not include a quantitative environmental impact assessment of the proposed solutions.

1.6 Report structure

This report is structured similarly to the project approach. Chapter 1 introduces the research context, approach, and research questions, followed by relevant background on Philips as the case organization in Chapter 2.

The academic foundation is developed in Chapter 3 through a literature review on EcoDesign implementation, presenting insights in a conceptual model. This is complemented by an external analysis in Chapter 4, including a trend analysis and competitor benchmark.

The qualitative interview methodology is described in Chapter 5, with the empirical findings presented in Chapter 6. The report then moves into the design phase: Chapter 7 explains the design process, Chapter 8 presents the proposed solutions, and Chapter 9 describes the validation approach and findings.

Chapter 10 discusses the contributions, limitations, and recommendations. The report concludes in Chapter 11 by answering the research questions. A personal reflection on the project is included in Chapter 12.

2. Background

This chapter provides background information on the organizational and operational context of the project. It describes the case company on a high level, its current structure, and strategy towards 2030. To better understand the EcoDesign context, this chapter also discusses the innovation and product development processes and explains how EcoDesign is currently structured within Philips.

2.1 Company background

Philips (Koninklijke Philips N.V.) is a Dutch multinational company operating in the health technology sector. Philips' vision is to deliver better care for more people through meaningful innovation. Philips generates annual sales of approximately €17.8 billion and employs around 65,000 people, with sales and services in more than 100 countries (Philips, 2026a).

As a company, Philips develops and markets a wide range of products and services, broadly in two categories:

- Products for Personal Health (B2C): electric toothbrushes, grooming devices, and mother and childcare products.
- Professional Health Systems (B2B): imaging systems such as Magnetic Resonance (MR), Computed Tomography (CT) and X-ray scanners, patient monitoring systems, image-guided therapy systems, enterprise informatics solutions, etc. This segment is the focus of this project.

Over the past two decades, Philips has transformed from a diversified electronics company into a focused health-technology company. Historically, it was known for products ranging from lighting and household appliances to televisions and audio equipment. Since 2010, Philips has gradually divested its non-healthcare businesses. Some of these, including Signify and Versuni, still sell products under the Philips brand as licensees.

Within the Health Systems segment, Philips operates in a highly competitive market, with the specific competitive landscape varying considerably depending on the product category. Across most Health Systems segments, two players stand out as the most prominent competitors (Moody's Ratings, 2025):

- Siemens Healthineers is the largest competitor, with a broad portfolio of professional health-technology products.
- GE HealthCare, a spin-off from General Electric, is the second major competitor, also with a similar portfolio and company size.

As this research focuses on internal EcoDesign implementation, only GE HealthCare and Siemens Healthineers are considered as competitors in this report. More information on this topic is presented in Section 4.2.

2.2 Organizational structure

Philips has a decentralized organizational structure, with activities organized into different Business Units (BUs). In the current operating model, BUs are responsible for their own product portfolios, processes, and results. This means that strategic priorities, including EcoDesign, are

ultimately owned and executed at BU level. It should be noted that each BU is organized slightly differently, so roles, structures, and product development processes can vary across the organization.

Group Sustainability, also referred to as the Group Sustainability Office or Organization (GSO), is the case owner for this project. As a central function, GSO is not part of one specific BU, but works across the organization. It sets overarching targets and standards, including minimum EcoDesign requirements for products. Within GSO, Business Partners (BPs) support specific BUs and help connect central sustainability ambitions to BU-level execution. Figure 2.1 shows a simplified overview of Philips' organizational structure and main BUs.

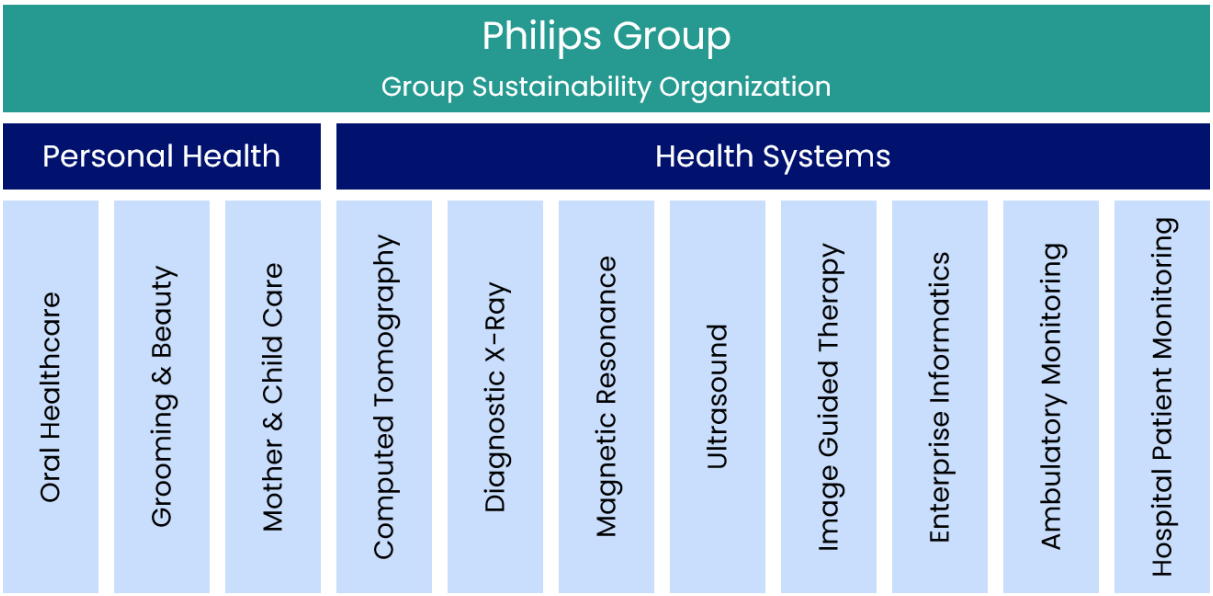


Figure 2.1: Organizational Structure of Philips with Business Units (simplified).

2.3 Strategy

In February 2026, Philips presented a new strategic plan at its Capital Markets Day. The plan focuses on three pillars: value through segment-specific strategies, platform-based innovation combining hardware, software, data and AI as a key differentiator, and disciplined execution (Philips, 2026b).

The 2030 Impact Ambitions are an important element of this new strategy, building on the strong achievement of the 2025 ESG commitments (Philips, 2026c). The new ambitions are structured around three dimensions: improving health and well-being, strengthening governance, and reducing the absolute environmental impact across the value chain. With respect to environmental impact, Philips measures progress in three areas (Philips, 2026c):

- Climate: reducing scope 1 and 2 (own operations) as well as scope 3 (value chain) emissions to achieve net-zero by 2045. There are in between reduction targets for 2030.
- Materials: reducing the absolute amount of virgin, non-renewable materials and increasing the amount of materials available for re-use.
- Nature: reducing pressure on nature, water withdrawal at Philips manufacturing sites and chemical usage in processes and products.

EcoDesign is specifically mentioned within these ambitions as a key enabler and governance mechanism for reaching Philips' environmental goals (Philips, 2026c). EcoDesign can support targets on climate, materials, and nature, as further explained in Figure 2.3.

2.4 Product development and innovation process

Within Philips, product development is organized through an end-to-end process called Idea to Market (I2M), which starts at the earliest stages of value creation and ends with bringing a product to the market. The I2M process consists of three sub-processes (see Figure 2.2):

- Value Proposition Creation (VPC): focuses on identifying customer needs, defining value propositions, creating new business models, and making strategic product choices. The expected outcome is a validated value proposition, such as a new product concept, feature, or business model.
- Advanced Development (AD): focuses on developing and validating new technologies, materials and platform solutions before full product development starts.
- Product Development Launch and Maintenance (PDLM): the execution-focused process focusing on new product introductions (NPIs), including design, engineering, verification, and launch. It also covers maintenance of the product in the market, such as small updates.

These sub-processes do not always follow a fixed sequential order. Depending on the project, only one sub-process may be needed, or multiple AD projects may inform a single PDLM project. Each sub-process contains stage-gates where progress is formally reviewed. More detailed information on the stage-gate structure of PDLM is provided in Confidential Appendix I.

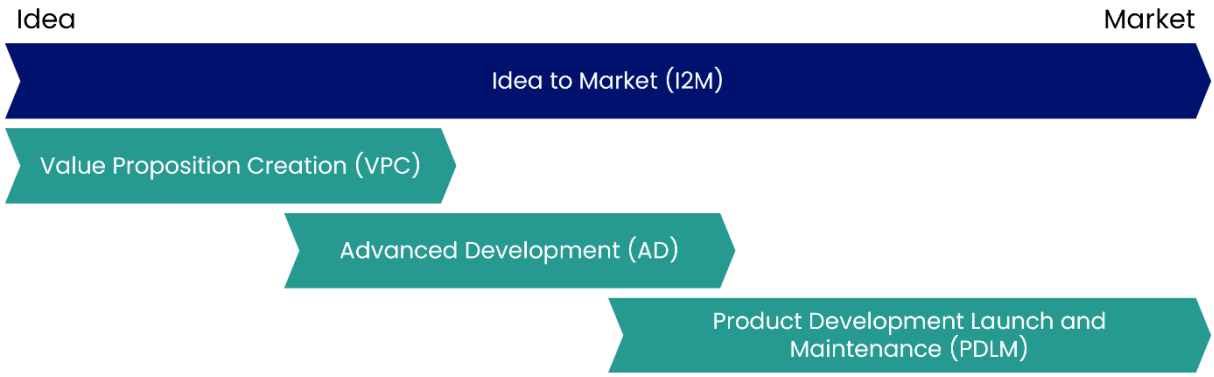


Figure 2.2: Philips I2M process with sub-processes.

2.5 EcoDesign at Philips

Philips has a long history of integrating environmental performance into its products. Around 1970, the company introduced its first environmental guidelines on chemical substance use in products and manufacturing. In 1994, EcoDesign was formally introduced, marking the start of life cycle thinking and the Regulated Substances List (RSL). Since then, EcoDesign has continued to evolve and become more and more embedded in Philips' innovation processes.

EcoDesign within Philips focuses on four focal areas, as shown in Figure 2.3 with examples:

- Energy: reducing product energy consumption during the use phase, for example by improving system efficiency and optimizing power modes such as eco-modes.
- Packaging: reducing the material impact of packaging by lowering volume and weight, and increasing the use of recycled, renewable, and recyclable materials.
- Substances: eliminating hazardous materials that may pose environmental or health risks, such as Halogenated Flame Retardants (HFRs), PVC, PFAS, and heavy metals.
- Circularity: reducing the use of virgin non-renewable materials and enabling reuse or recycling, for example through design for disassembly, recycled or biobased materials, and longer product lifetimes.

Energy

Reducing product's energy consumption and thereby use-phase CO2e emissions.

- Standby, low-power or eco-modes
- Increasing system efficiency

Contribute to 2030 Impact Ambitions on climate.



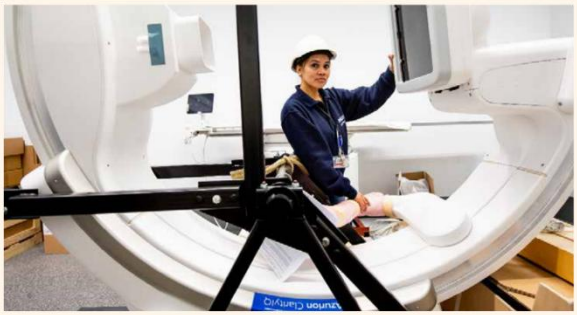
Powersave+ in Philips MR systems, reducing total energy consumption (Philips, n.d.-a)

Packaging

Reducing amount of virgin non-renewable packaging and increasing recyclability.

- Reducing packaging weight and volume
- More sustainable and recyclable materials

Contribute to 2030 Impact Ambitions on materials.



Using more recycled and reusable packaging frames for large health systems (Philips, n.d.-b)

Substances

Eliminating hazardous materials with risks for health or environment.

- Phasing out substances like HFRs, PVC, PFAS
- Phasing out heavy metals (e.g. lead)

Contribute to 2030 Impact Ambitions on nature



Philips Azurion is REACH and RoHS compliant and mercury free (Philips, n.d.-b)

Circularity

Reducing amount of virgin non-renewable materials in product and increasing recyclability.

- Use less and more recycled/renewable content
- Use products longer and increase recyclability

Contribute to 2030 Impact Ambitions on materials



Using recycled or biobased plastic materials where possible (Philips, n.d.-c)

Figure 2.3: Focal areas for EcoDesign within Philips (image sources are listed below each example).

Within Philips, EcoDesign is primarily implemented through formal requirements embedded in PDLM projects that focus on launching new systems to the market, ensuring that all new product introductions (NPIs) meet Philips' EcoDesign standards. BUs are required to demonstrate compliance with these requirements at two specific stage-gates within PDLM, verified by GSO. More specific information about the integration of EcoDesign into the PDLM process and the current set of EcoDesign requirements can be found in Confidential Appendix I.

3. Development of a conceptual model through literature review

To answer the first sub-question, this chapter reviews academic literature on EcoDesign implementation in organizations. It describes the database search, discusses key success factors and barriers, and synthesizes the findings into a first conceptual model that guides the empirical phase of the project.

3.1 Database search

This literature review followed a semi-systematic review approach, which is considered well-suited for synthesizing diverse literature into a conceptual or theoretical model (Snyder, 2019). The approach combined a database search with some citation-based expansion ("*snowballing*") to balance systematic coverage with theoretical completeness.

3.1.1 Search strategy

A systematic search was conducted in Web of Science, as it provides broad coverage of peer-reviewed journals and supports transparent, reproducible querying. The search strategy was directly derived from the research question and aimed to capture literature on organizational EcoDesign implementation. The database search, with papers published after 2012 returned 384 records. The full search string is provided in Appendix C.

3.1.2 Screening

Eligibility criteria were defined to keep the review focused on organizational implementation rather than general sustainability strategy or purely technical design optimization. The inclusion and exclusion criteria used in the screening are shown in Table 3.1. Exclusion criteria are set up to already focus on Philips' context, excluding papers on very different product types (e.g. buildings) or small organizations.

Table 3.1: Inclusion and exclusion criteria in literature screening process.

Inclusion criteria	Exclusion criteria
• Peer-reviewed journal articles or conference output • Available in English • Published after 2012	• Not accessible (n=1) • Only a strategic EcoDesign adoption focus (why organizations are adopting EcoDesign) • Pure technical EcoDesign focus • Focus on public policy • Only focus on small organizations • Focus on different product types

Screening occurred in two stages. First, all 384 records were screened based on title, resulting in the exclusion of 344 records when following the inclusion and exclusion criteria. Second, the remaining 40 records were screened on abstract (-7) and accessibility (-1), resulting in 32 articles included for full-text analysis.

3.1.3 Snowballing

To complement the database search and reduce the risk of missing influential work, snowballing was conducted using ResearchRabbit AI. This tool suggests relevant and similar papers based on the existing article selection (ResearchRabbit™, n.d.). All suggested articles were manually screened using the same inclusion and exclusion criteria, resulting in the inclusion of seven additional papers. The full article selection process is shown in Figure 3.1.

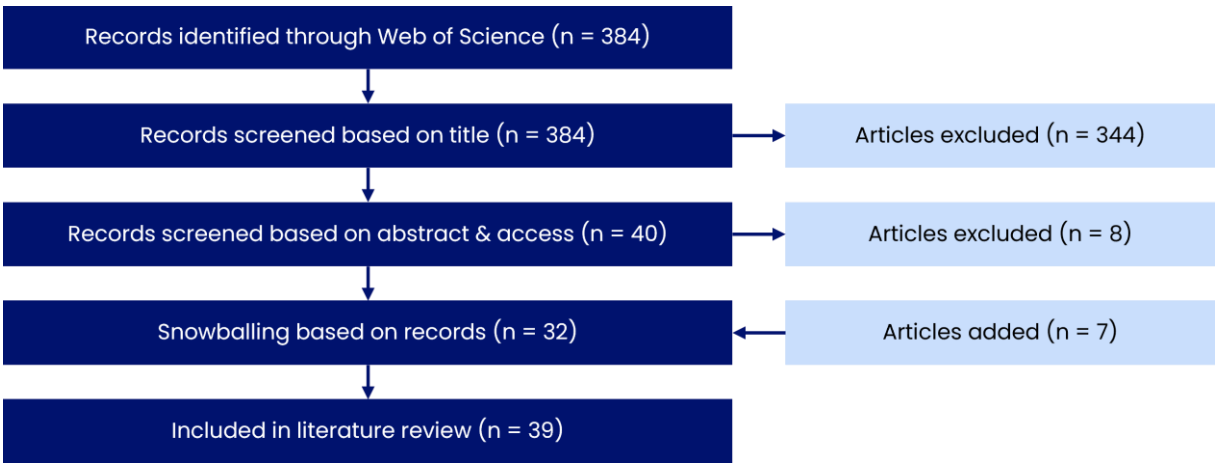


Figure 3.1: Overview of database search and snowballing process.

3.1.4 Analysis and synthesis

In total, 39 papers were included in the final sample. The included papers were read and analyzed to identify success factors and barriers related to EcoDesign implementation. These factors were tracked in an Excel file, eventually leading to more than 150 identified success factors or barriers for EcoDesign implementation. These extracted factors were then clustered into themes and used as the basis for the conceptual model presented in Section 3.5.

3.2 Findings

The findings of this literature review are structured into six themes that cover the organizational and managerial factors influencing EcoDesign implementation in product development processes. The model builds on and adapts the framework developed by Dekoninck et al. (2016), which identifies five categories with several sub-categories that influence EcoDesign implementation: strategy, management, collaboration, knowledge, and tools. Dekoninck et al. (2016) explicitly recommend their framework as a suitable foundation for future research, including in-depth qualitative studies in specific organizational contexts.

The developed conceptual model presented here differs in five ways compared to the framework of Dekoninck et al. (2016). First, the model focuses specifically on internal organizational factors, and therefore does not consider external collaborations with, for instance, suppliers. Second, the categories "management" and "collaboration" from Dekoninck et al. (2016) are reorganized into two distinct themes: organizational structure and collaboration, and EcoDesign integration into the product development process, better separating people and process related factors. Third, a sixth theme on requirement-specific factors is added, given that EcoDesign at Philips is primarily driven through formal requirements, making it particularly relevant to understand how these influence implementation. Fourth, by drawing on more recent literature, the model identifies additional sub-factors within each theme, allowing for a more granular understanding of what enables or hinders implementation. Finally, this review further organizes the themes across three organizational levels: strategic, tactical, and operational. A visual overview of the full conceptual model is presented at the end of this chapter.

3.2.1 Leadership and strategy

The literature consistently emphasizes the importance of leadership support and the alignment of EcoDesign activities with the broader organizational strategy, with clear KPIs, to successfully implement EcoDesign (Ali et al., 2019; Delaney & Liu, 2024; Rodrigues et al., 2017; Rossi et al., 2016; Schöggl et al., 2023; Vilochani et al., 2025). Strong leadership commitment and a connection to the broader company strategy help legitimize EcoDesign and create internal awareness, motivating product developers towards sustainability action (Rodrigues et al., 2019; Vilochani et al., 2025). Petersen (2019) adds that an internal push, i.e. top-management support for EcoDesign, can help to translate broader sustainability strategy to tactical and operational levels, such as integrating EcoDesign into product development processes (PDPs).

Upper Echelons Theory (Hambrick & Mason, 1984) provides a theoretical explanation for why leadership commitment is central to EcoDesign implementation. The theory argues that organizational outcomes reflect the values, priorities, and cognitions of top managers, meaning that sustainability or EcoDesign ambitions are more likely to be translated into concrete organizational action when they are genuinely supported at the leadership level.

3.2.2 Organizational structure and collaboration

Literature consistently identifies organizational and structural conditions as important factors for successful EcoDesign integration. Schäfer and Löwer (2021) emphasize the importance of clear roles and responsibilities for EcoDesign. Ambiguity around ownership of EcoDesign activities often results in weaker implementation. Vilochani et al. (2024b) add to these factors that it is important to have a clear structure between a sustainability function and the innovation function, and that these could have different roles or be involved in different activities when it comes to implementing EcoDesign in the PDP. Moreover, literature highlights the role of multidisciplinary collaboration. EcoDesign typically requires collaboration between design, engineering, sustainability, and business functions (Dekoninck et al., 2016; Schöggl et al., 2016). In addition to formal structures, the company culture, especially its resistance to change, can either be an enabler or barrier to implement EcoDesign (Aguiar et al., 2021; Ali et al., 2019).

From a theoretical perspective, the classical organizational theory helps explain the importance of clear roles, responsibilities, and coordination structures for EcoDesign implementation. This aligns with literature showing that clear ownership positively influences implementation within organizations (Schäfer & Löwer, 2021). Systems theory adds a broader perspective by viewing organizations as interconnected systems, where structures, roles, incentives, culture, and processes influence each other. This fits with findings that EcoDesign implementation is also shaped by organizational culture and employee motivation. It also supports the need for multidisciplinary collaboration, as EcoDesign involves trade-offs across different functions and parts of the product development process.

3.2.3 EcoDesign integration into the Product Development Process

Third, the literature suggests that formal integration of EcoDesign within the product development process is important for successful implementation. This is especially relevant in the early phases, where EcoDesign requirements can still influence key design decisions, such as in the conceptual or fuzzy front-end design phases (Hallstedt, 2015; Ross et al., 2021; Watz & Hallstedt, 2020). Additionally, formal stage-gate reviews focused on EcoDesign positively impact its implementation (Brones et al., 2014; Pigosso et al., 2014; Vilochani et al., 2024b), as this will help to make EcoDesign "*become part of standard work processes*" (Schäfer & Löwer, 2021). The importance of properly integrating EcoDesign in the PDP is also emphasized by Rodrigues et al. (2016), who argue for process-related KPIs to measure EcoDesign implementation instead of only focusing on product-related KPIs.

The EcoDesign Maturity Model (Pigosso et al., 2013) shows why process integration matters. The model describes how organizations move from ad-hoc product sustainability initiatives towards more systematic and institutionalized EcoDesign practices. At higher maturity levels, EcoDesign is formally embedded in product development, including early-phase involvement and structured stage-gate checkpoints. From this perspective, integrating EcoDesign in early innovation phases and review moments is not just a best practice, but a step towards making EcoDesign part of standard procedures rather than an optional add-on (Pigosso et al., 2013).

3.2.4 Environmental sustainability knowledge

The fourth theme concerns knowledge-related factors within design teams and organizations. Several studies identify EcoDesign knowledge as an important condition for implementation, particularly because product development teams may not always have detailed knowledge of environmental impacts, product life cycles, or sustainability trade-offs (Dekoninck et al., 2016; Horn et al., 2023; Vilochani et al., 2024a). Formal training can therefore support implementation, especially when it goes beyond simply providing teams with materials (Rossi et al., 2019a). Knowledge-related factors can be closely linked to organizational factors. Brones et al. (2014) argue that project managers need to bridge the technical knowledge of engineers and developers with management knowledge from strategy, operations and/or communications.

In addition to knowledge, the literature indicates the need for a shared understanding and terminology, especially for sustainability concepts (Schulte & Hallstedt, 2017). It should be clear how concepts as EcoDesign are understood and what its scope is.

From a theoretical standpoint, the distinction between tacit and explicit knowledge (Smith, 2001) helps explain why knowledge-related factors are important for EcoDesign implementation. Explicit knowledge refers to described knowledge, such as guidelines, checklists, or metrics. However, EcoDesign implementation and new product development also rely on tacit knowledge: practical experience with life cycle thinking, environmental impacts, and conflicting priorities (Brones et al., 2021; Rossi et al., 2019b). Training and cross-functional collaboration can help to develop this tacit knowledge and therefore support EcoDesign implementation. Smith (2001) also argues that organizations should find the right balance in dealing with the tension between tacit and explicit knowledge and can consequently create competitive advantages.

3.2.5 Tools and methods

A substantial body of literature addresses the role of EcoDesign tools, revealing both enabling and constraining effects. EcoDesign tools must be tailored to specific businesses or sectors to be useful in practice, as generic tools often fail to align with organizational decision-making practices and PDPs (Faludi et al., 2020; Horn et al., 2023). In addition, digital tools that are integrated with existing workflows can improve their uptake (Delaney & Liu, 2024).

At the same time, EcoDesign tool adoption can be hindered for several reasons, as identified by Vicente and Camocho (2024). Tools are often not aligned with the design culture, as they are perceived to limit the creativity of product designers. Other EcoDesign tools are not aligned with knowledge levels and skills of designers, or the benefits of these methods are not clearly perceived by their users (Vicente & Camocho, 2024). For more data-intensive tools, such as Life Cycle Assessments (LCAs), the main barriers are the time, expertise, and resources needed to evaluate a product's environmental impact across its life cycle (Delaney & Liu, 2024; Hjellvik, 2025). This creates a tension in early design phases: sustainability checklists can be used early but are often seen as too generic, while LCAs require data that is usually not yet available (Buchert et al., 2015). The literature also describes a paradox of choice, where too many available tools can overwhelm designers and reduce actual use (Vicente & Camocho, 2024).

More recent studies suggest that tools are more useful when they support comparison between alternatives, rather than only providing absolute environmental scores (Rossi et al., 2019b; Hallstedt et al., 2023). Several studies also emphasize that tools should guide reflection and learning instead of fully automating decisions, for example through early-phase quizzes or prompts that raise awareness (Ross et al., 2021; Rossi et al., 2019a). One example is the Sustainability Fingerprint (Hallstedt et al., 2023), which helps product engineers and designers use qualitative data to visually compare EcoDesign decisions. Another example is to work with decision trees, allowing teams to easily compare alternatives (Buchert et al., 2015).

Ullman's design process paradox (2010, Figure 3.2) helps explain some of the earlier mentioned factors and tensions. In early design phases, design freedom is high, but reliable data is limited. Later in the process, more data becomes available, but the ability to make major changes decreases. This explains why early-phase tools such as checklists can be criticized for being too generic, while tools such as LCAs are difficult to use early in the process (Diaz et al., 2021; Hjellvik & Kirkels, 2025). As a result, tools that support relative comparison or structured reflection may better fit early-phase decision-making under uncertainty. This shows that EcoDesign tool use depends not only on the tool itself, but also on its fit with specific phases in the PDP.

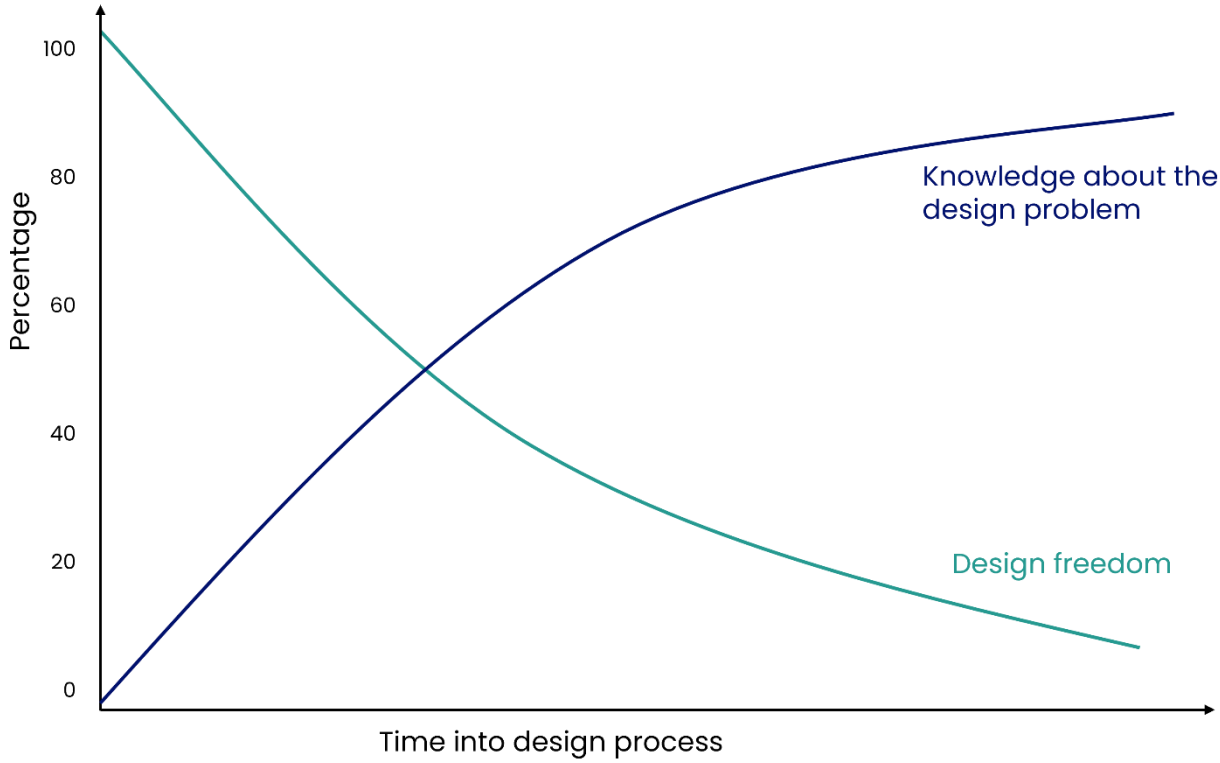


Figure 3.2: Design Process Paradox (figure adapted from Ali et al., 2021; based on Ullman, 2010).

3.2.6 Requirements

The final theme relates to EcoDesign requirements. The literature highlights traceability of requirements as a critical success factor, as sustainability requirements that are not clearly linked to design decisions or performance criteria tend to lose priority during development processes (Schöggl et al., 2023; Watz & Hallstedt, 2022). Product development teams need to understand why EcoDesign requirements are relevant and how they link to product benefits, otherwise sustainability criteria are often deprioritized compared to elements such as performance, cost, and aesthetics (Rossi et al., 2019b). Several studies therefore emphasize the importance of explicit trade-off logic. When trade-offs are kept implicit or poorly articulated, EcoDesign is often deprioritized (Horn et al., 2023; Rossi et al., 2019b; Vilochani et al., 2025; Watz & Hallstedt, 2022).

In addition to specific requirements, Baldassarre et al. (2020) highlight the importance of terminology. Following this logic, EcoDesign requirements should be written for engineers in "factory language": clearly defined and measurable (Baldassarre et al., 2020). On the other hand, it is argued that sustainability requirements should be phrased in business language to clearly link EcoDesign approaches to business strategy (Monticelli & Vezzoli, 2025).

The design process paradox, as described in Section 3.2.5, also helps explain challenges related to EcoDesign requirements. Requirements are expected to influence decisions early in the PDP when information is limited, while also remaining precise, traceable, and verifiable in later phases. This helps explain why it is difficult to formulate requirements that retain relevance and clarity throughout the entire process.

3.3 Tensions in EcoDesign implementation

In addition to the identification of success factors and barriers, the literature reveals several underlying tensions when it comes to EcoDesign implementation. Understanding these tensions helps to explain the complexity of the research topic. Figure 3.3 provides an overview of the identified tensions.

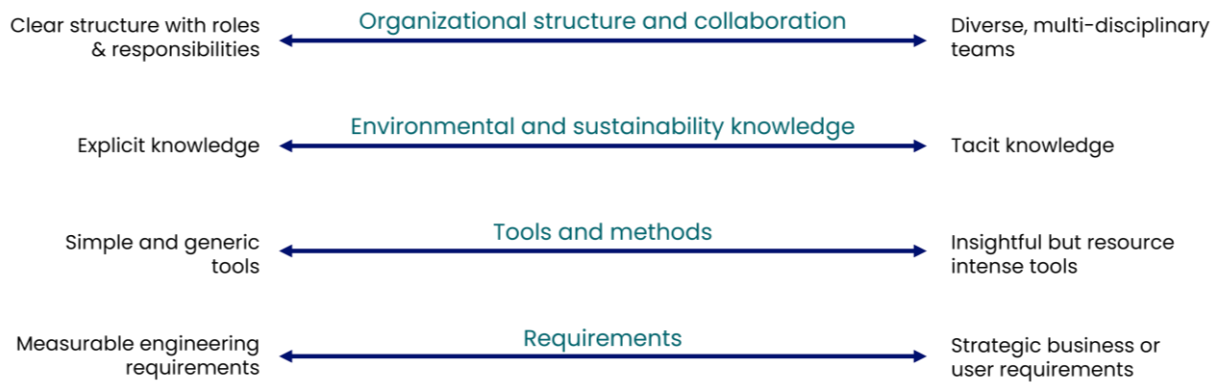


Figure 3.3: Tensions in EcoDesign implementation derived from the literature review.

First, as highlighted in Section 3.2.2, EcoDesign implementation requires a clear organizational setup with clear roles and responsibilities (Schäfer & Löwer, 2021), an idea that aligns with more classical organizational theory. At the same time, EcoDesign is often framed as a systems-level challenge, where multidisciplinary collaboration is considered crucial (Dekoninck et al., 2016). These two logics can pull in different directions: a strong division of tasks and clear role boundaries may make cross-functional collaboration harder to organize and sustain. A similar tension is visible within the knowledge theme: tacit knowledge is often created through cross-

functional collaboration, while explicit knowledge tends to fit better with reductionist approaches and formalized role divisions.

Second, there is a tension around tool usage. On one hand, EcoDesign benefits from insightful tools such as LCAs. However, these tools are often resource-intensive and require data or knowledge that is typically not available in the early stages of the PDP (Hjellvik & Kirkels, 2025). On the other hand, tools such as environmental checklists that require less input are often too generic to actually support decision-making in EcoDesign implementation (Buchert et al., 2015).

The final tension concerns how EcoDesign requirements are formulated. On one hand, requirements should be traceable to higher-level sustainability ambitions (Watz & Hallstedt, 2022) and leave room for interpretation and creativity (Vicente & Camocho, 2024). On the other hand, requirements should be concrete, measurable, and phrased in engineering terminology so they can be verified during development (Baldassarre et al., 2020). This creates a tension: requirements set at a strategic level tend to be abstract, while measurable engineering requirements risk becoming too prescriptive.

A larger, overarching tension in embedding EcoDesign within product development lies in the shift from linear or reductionist approaches toward a systems thinking perspective. Most organizations and PDPs are structured in a relatively fixed and sequential way, with clearly defined roles, responsibilities, and decision moments. This structure supports efficiency and control, but it also encourages the decomposition of complex problems into isolated tasks and requirements. Sustainability integration, however, often demands a systems-level perspective, in which environmental impacts are understood as the result of interrelated design choices across materials, manufacturing, use, and end-of-life phases (Schäfer & Löwer, 2021). Decisions made in one phase of the product development process can strongly influence options and impacts in later stages, requiring iterative feedback, cross-functional collaboration, and trade-off thinking. As a result, sustainability challenges do not always align well with linear development processes or reductionist structures. This tension between reductionist approaches and systems-oriented sustainability thinking underlies and connects the previously discussed tensions around organizational structure, knowledge, tool usage, and requirements.

3.4 Discussion

Two limitations of the literature base are worth acknowledging. First, many studies rely on relatively small samples and were conducted in specific geographical contexts, particularly the Nordics and Western Europe. These regions tend to have a high sustainability maturity and strong regulatory frameworks, which may have shaped both organizational practices and respondents' perspectives (Strand, 2024). Second, and more relevant for this research, several studies focus mainly on the initial adoption of EcoDesign or on organizations with lower EcoDesign maturity levels (Pigosso et al., 2013). Philips, by contrast, has a long-standing EcoDesign program and would likely be positioned at a higher maturity level according to the EcoDesign Maturity Model (Pigosso et al., 2013). As a result, this case is more concerned with advanced implementation than with adoption. This points to a need for more research on advanced EcoDesign implementation, a gap this thesis partially addresses.

The six themes can be organized across three levels: strategic, tactical and operational. At the strategic level, leadership and strategy form the foundational enabling condition: without commitment and clear direction from leadership, EcoDesign lacks the legitimacy and priority needed to drive action throughout the rest of the organization. At the tactical level, the organizational structure, collaboration, and PDP integration determine whether strategic intent is translated into organizational resources, structures and processes. At the operational level,

knowledge, tools and methods, and requirement-specific factors shape the practical reality of EcoDesign within product development teams. Even though the conceptual model is descriptive, this three-level structure implies a priority order: strategic factors function as enabling conditions for what follows, meaning that weaknesses at the strategic level tend to undermine the effectiveness of tactical and consequently operational factors.

Across and within these three levels, the themes and their underlying factors are strongly interconnected and should not be read as independent. For example, lack of EcoDesign knowledge can directly undermine the effective use of tools, as teams cannot apply methods they do not sufficiently understand. Additionally, requirements lose their effectiveness when introduced too late in the process, meaning that process integration is a precondition for requirements to have any real impact on design decisions. These examples show that EcoDesign implementation challenges are rarely caused by a single theme in isolation. It is argued that evaluating or improving EcoDesign implementation in an organization therefore requires a broad perspective considering the full range of themes.

3.5 Conceptual model

The six themes, organized across strategic, tactical, and operational levels, are synthesized into the conceptual model presented in Figure 3.4. For each theme, the model includes the relevant supporting scientific theories alongside the success factors and barriers. This model will serve as the theory-informed analytical lens for the empirical phase of this research, after which it will be updated based on additional findings (see Chapter 6).

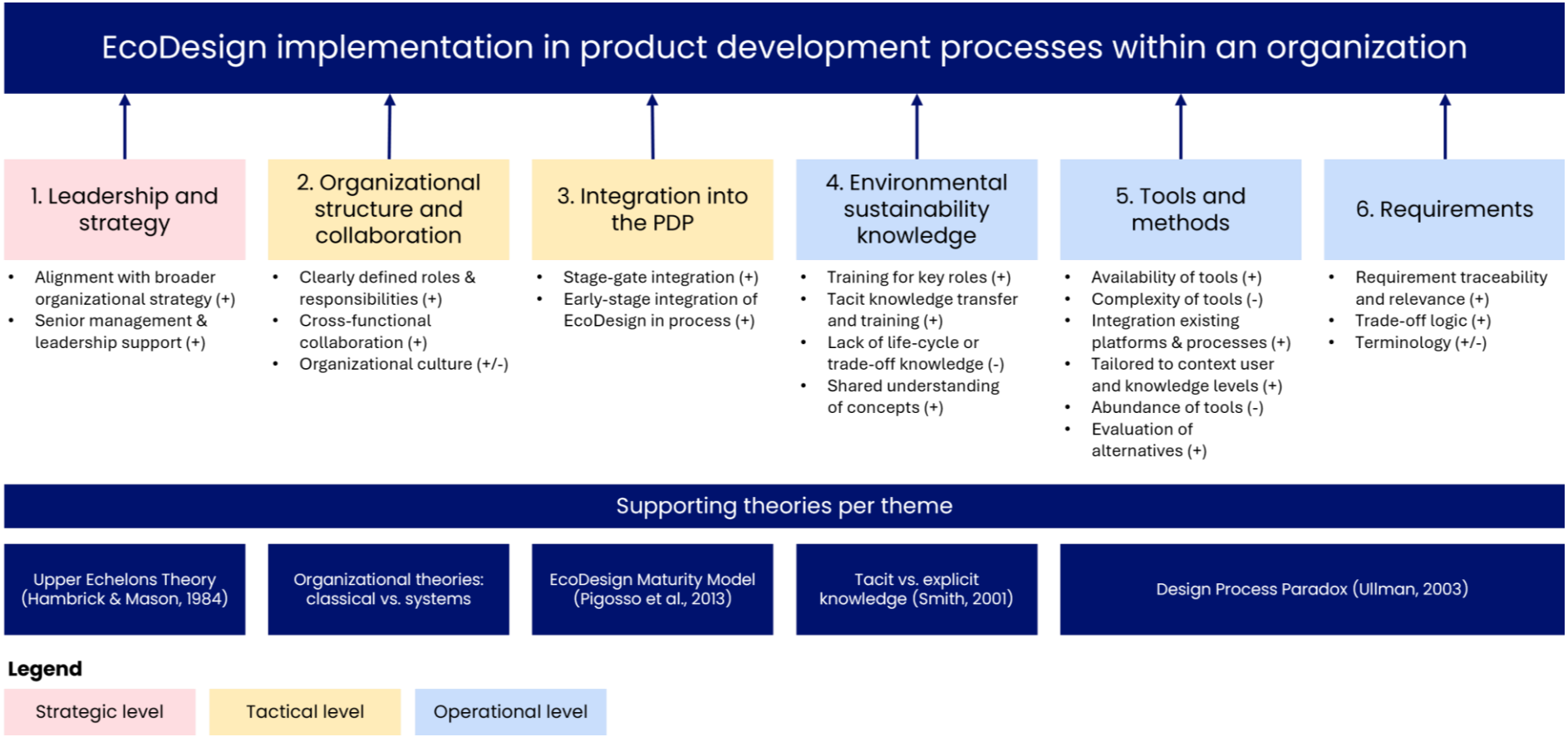


Figure 3.4: Conceptual model on EcoDesign implementation adapted and extended from Dekoninck et al. (2016) based on the literature review.

4. External research

In addition to academic literature, relevant external developments were explored to understand the broader context in which Philips operates. The external research was conducted before the empirical interviews to have the right contextual knowledge before engaging with stakeholders. The chapter discusses key trends and a sustainability-focused competitor analysis.

4.1 Trend analysis

To structure the analysis of relevant external developments, a PESTEL framework with input from various sources of grey literature was used as a starting point. From this, three trends were identified as most relevant for EcoDesign at Philips, which are presented below.

4.1.1 Market and procurement shift towards sustainability

Across industries, sustainability is increasingly embedded in procurement practices, driven by both public and private actors. An increasing number of national governments and large corporations are adopting sustainable procurement criteria and supplier requirements (Ecovadis & Accenture, 2026). Governments increasingly position Green Public Procurement as a key instrument within national environmental strategies and climate commitments (OECD, 2022).

Within the healthcare sector, this trend is particularly visible. The sector is estimated to be responsible for approximately 4.4% of global greenhouse gas emissions, rising to around 10% in high-income countries (Health Care Without Harm, 2019; Kouwenberg et al., 2024). Around 71% of these emissions originate from the value chain (scope 3), which includes medical equipment manufacturers, while an additional 12% is attributed to purchased energy (scope 2), closely linked to the energy consumption of medical devices (Health Care Without Harm, 2019).

In response, hospitals and healthcare providers are using procurement as a lever to reduce their environmental impact. Sustainability criteria, such as energy efficiency, circular service models, and environmental transparency, are being integrated into tender processes and supplier evaluations. A clear example is the National Health Service (NHS) in the United Kingdom, which has committed to achieving net-zero emissions by 2045 and is embedding sustainability criteria into its procurement processes, requiring suppliers to report emissions and have decarbonization plans (NHS, 2025). This means that EcoDesign is becoming increasingly relevant for market competitiveness.

At the industry level, a relevant initiative is the Medical Equipment Proactive Alliance for Sustainable Healthcare (MEPA), which is developing standardized sustainability criteria for medical equipment. MEPA is a collaborative initiative led by three organizations: COCIR, the European trade association representing the medical imaging and health technology industry (including Philips, Siemens Healthineers and GE HealthCare), Vizient, one of the largest healthcare procurement bodies in the United States, and HealthTrust Performance Group, a group purchasing organization focused on healthcare supply chain management. The Global Electronics Council and Kaiser Permanente (a large hospital group in the US) were additionally consulted (MEPA, 2026a).

The MEPA criteria cover both company-level and product-level sustainability performance, and are structured across three levels: basic, intermediate, and advanced. The criteria are organized into four categories, also visible in Figure 4.1 (MEPA, 2026b):

- **Life Cycle Assessment (LCA)**: focused on disclosing and communicating the environmental performance of the product.
- **Climate change mitigation**: covering energy consumption, power saving modes, and product-specific features and services to reduce climate impact.
- **Responsible use of resources**: addressing packaging and product materials, such as recyclability, recycled/biobased content, and refurbishment options.
- **Chemicals of concern**: relating to the use of hazardous substances, closely aligned with Philips' existing substances focal area.

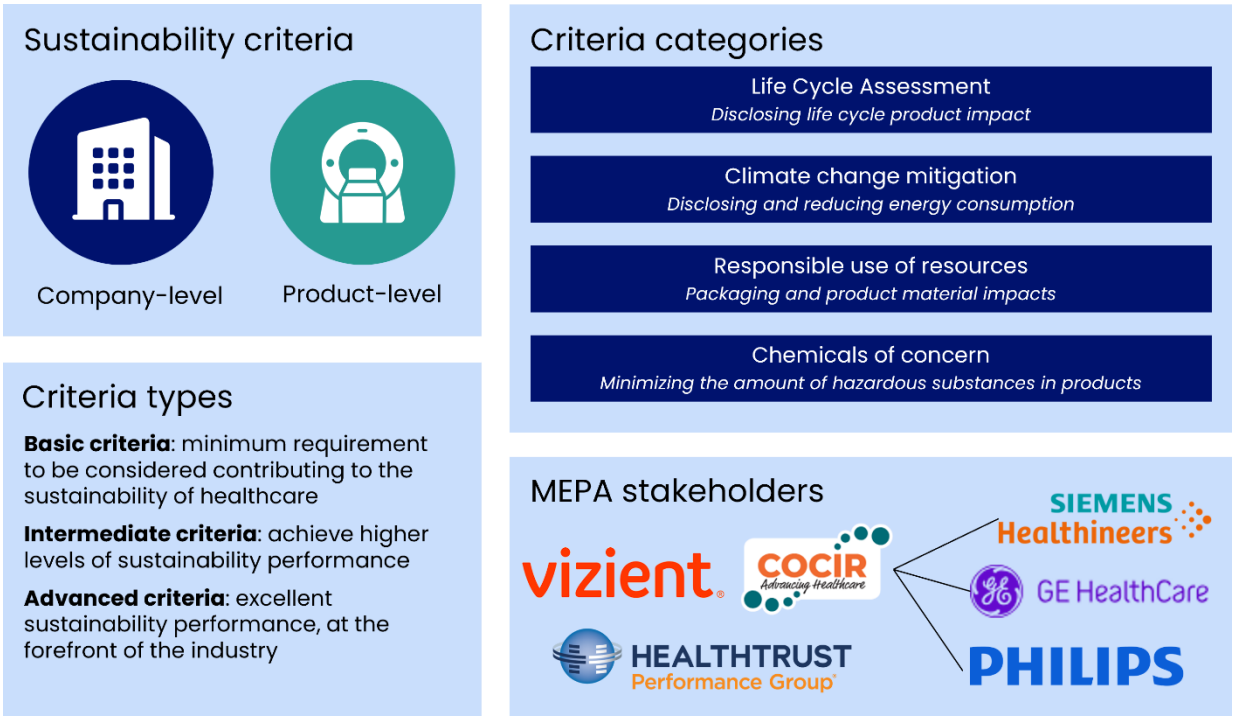


Figure 4.1: Overview of Medical Equipment Proactive Alliance (MEPA).

In parallel, COCIR is working with its members to standardize energy consumption measurements for medical devices (COCIR, n.d.). Device manufacturers are expected to report on their product's energy consumption in defined use scenarios, allowing hospitals to better compare the energy performance of different devices across manufacturers. The MEPA criteria also use these COCIR energy scenarios.

Given the broad coalition of industry players and procurement organizations behind MEPA, it has strong potential to become a leading standard for sustainable procurement of medical devices in the coming years. Therefore, Philips' EcoDesign requirements should be closely aligned.

4.1.2 Expanding regulations and product transparency

The regulatory landscape surrounding sustainable products is rapidly expanding, especially within the European Union. Sustainability is increasingly formalized through mandatory reporting, product regulations, and transparency obligations, previously often driven by voluntary initiatives.

At the organizational level, the Corporate Sustainability Reporting Directive (CSRD) introduces stricter requirements for sustainability disclosure (European Parliament and Council of the European Union, 2022). Although CSRD focuses on company-level reporting, it also creates pressure on product development to provide clear and measurable sustainability information. Product-level information, such as energy consumption, material composition, and recycled content, becomes essential input for these disclosures.

At the product level, more regulations are emerging that directly influence how products are designed. A direct example is the Ecodesign for Sustainable Products Regulation (ESPR), which provides a framework for the European Commission to set both performance and information requirements for products through delegated acts (European Commission, n.d.). An example of a performance requirement is a guaranteed minimum product lifetime or the mandatory availability of spare parts. Information requirements typically cover disclosure of substances of concern, energy consumption data, or end-of-life treatment instructions (see Table 4.1). Spiliotopoulos & Gonzalez Torres (2025) note that information requirements are generally better suited to be set horizontally, applying across a wide range of products and categories, while performance requirements tend to be more product specific.

Table 4.1: Distinction between performance and information requirements under ESPR.

	Performance requirements	Information requirements
Meaning	Rules about how the product must perform.	Rules about what information must be provided on environmental performance.
Purpose	Reduce environmental impact of the product	Enable transparency and informed choices
Examples	- Maximum power of 1 kW - Minimum 50% recycled content - Product must be repairable	- Digital Product Passport - Material composition information - Repair instructions in manual

Other regulations, such as REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals), RoHS (Restriction of Hazardous Substances), the Packaging and Packaging Waste Regulation (PPWR), and the Right to Repair, further expand sustainability requirements across different aspects of the product life cycle. However, many regulations are not in force yet (PwC, n.d), or medical devices and equipment may not yet fall within the scope of these regulations. However, these developments indicate the direction in which product regulation is evolving. For a company like Philips, with long innovation timelines, it is important to anticipate these regulations early. This helps to build organizational resilience and avoid costly redesigns once regulations come into force.

4.1.3 Platform innovation and digitization

The third relevant trend is the shift from primarily hardware-based products toward digital and platform-based solutions. This shift is visible across the health technology industry and is also a core element of Philips' new 2030 strategy, which explicitly emphasizes platform-based solutions integrating hardware, software, data, and artificial intelligence (Philips, 2026b).

This shift has important implications for EcoDesign. Traditionally, EcoDesign has focused on the environmental impact of physical hardware products, such as materials, energy use, and end-of-life. However, digital technologies also have environmental impacts, for example through the energy use of digital infrastructure. In 2024, data centers already accounted for around 1.5% of global electricity consumption, with this share projected to double by 2030 (IEA, 2025). For

companies moving toward platform-based solutions, a growing share of their environmental footprint will come from outside the physical product itself.

At the same time, digitalization can contribute to more sustainable healthcare delivery. Smart digital solutions can reduce hospital visits, improve operational efficiency, and optimize resource use, lowering emissions across the healthcare system (Nissinen et al., 2025). This creates a key tension: digital technologies both introduce new environmental impacts and enable reductions elsewhere. As a result, product development teams and EcoDesign practitioners increasingly need to look beyond the physical boundaries of the product and consider the broader system (Nissinen et al., 2025).

4.2 Competitor analysis

This section presents a competitor analysis focusing on environmental sustainability and EcoDesign-relevant aspects, based on publicly available sustainability reports, annual reports, third-party ESG ratings, and product documentation. The analysis is structured across two levels: corporate-level commitments and reporting, and product-level performance, with an specific health system used as example. Detailed Philips product information referenced in this section is available in Confidential Appendix II.

4.2.1 Corporate Sustainability and reporting

At the corporate level, Philips appears to have the strongest sustainability positioning among the three considered companies, both in terms of ambition and reporting transparency. Table 4.2 at the end of this chapter provides a comparative overview of key corporate sustainability indicators.

Philips performs strongest across most ESG indicators. For SBTi, Philips has committed to net-zero by 2045, five years ahead of Siemens Healthineers and GE HealthCare, which both target 2050. Philips also performs well on the Dow Jones CSA/ESG ratings, EcoVadis rankings, and CDP reporting, while Siemens Healthineers and GE HealthCare either score lower or do not report on some of these metrics.

Taken together, these results suggest that Philips has a stronger corporate sustainability position than the two competitors included in this analysis. It sets more ambitious targets, engages with more external rating bodies, and reports more transparently at the corporate level.

4.2.2 EcoDesign and product-level sustainability

While corporate sustainability commitments provide an important baseline, EcoDesign requires a closer look at the product level. All three companies reference EcoDesign or equivalent approaches in their annual reports. Philips reports that 100% of its products are EcoDesigned and that EcoDesign has been fully embedded into its innovation process since 2024 (Philips, 2026a). Siemens Healthineers describes its Sustainable by Design program, structured around waste reduction, responsible material use, lifetime optimization, and energy efficiency (Siemens Healthineers, 2026a). Interestingly, Siemens' four pillars have a clear link to the needs of hospitals, while Philips' four focal EcoDesign areas are more generic. In its annual report, Siemens Healthineers (2026a) also highlights specific examples of sustainable product innovations, including reduced energy consumption in MR systems and packaging innovations in diagnostics. GE Healthcare states a commitment to integrating environmental design considerations across the product development cycle using a life cycle approach. In 2024, GE Healthcare focused on energy reductions and anesthetic gas optimization, planning to extend the focus to other areas as well (GE HealthCare, 2025).

To assess actual product-level sustainability performance beyond annual report claims, a case-study competitor analysis was conducted for a specific health system. The detailed results are available in Confidential Appendix II.

This analysis shows an important nuance: while Philips leads in corporate sustainability, this does not automatically mean it leads across all product categories and sustainability dimensions. At the product level, competitors such as Siemens Healthineers and GE HealthCare perform strongly in specific areas and have well-developed sustainability materials for customers.

Table 4.2: Sustainability focused competitor analysis between Philips, Siemens Healthineers, and GE HealthCare (GE HealthCare, 2025; GE HealthCare, 2026; Philips, 2026a; Siemens Healthineers, 2026a; Siemens Healthineers, 2026b; S&P Global, 2026).

		PHILIPS	SIEMENS Healthineers	GE HealthCare
Company size	**Sales**	€18.0 bn	€23.4 bn	€17.6 bn ($20.6 bn)
	Employees	64,800	74,000	54,000
Corporate level	**SBTi net-zero target***	Net-zero across value chain by 2045	Net-zero across value chain by 2050	Net-zero across value chain by 2050
	Dow Jones Sustainability World Index**	CSA: 59/100 ESG: 59/100	CSA: 37/100 ESG: 44/100	CSA: 44/100 ESG: 50/100
	Ecovadis***	76/100	No score available	74/100
	CDP******	Climate: A Water: A	Siemens AG (parent company): Climate: A Water: B	Did not disclose
Product level	**EcoDesign in annual report**	100% EcoDesigned products, EcoDesign formally embedded into innovation processes since 2024	Embedding EcoDesign into its processes. Sustainable by Design program.	Progress in building Environmentally conscious design considerations into product development cycle. Formally incorporated environmental factors into design inputs for new products.
	EcoDesign areas	Energy, Substances, Packaging & Circularity	Waste reduction, energy efficiency, Lifetime optimization & responsible material use.	In 2024 focus on energy and anaesthetic gas optimization. Planning to expand in next years.

**SBTi (Science Based Targets initiative): an initiative that validates corporate climate targets against climate science. Considered the leading standard for corporate net-zero commitments.*

***Dow Jones Sustainability World Index: tracks the sustainability performance of the world's largest companies. The CSA (Corporate Sustainability Assessment) score reflects S&P Global's evaluation of company ESG practices on a scale of 0 to 100, where higher scores reflect better performance.*

****EcoVadis: a third-party platform that assesses and rates companies on sustainability performance across four areas: environment, labour, ethics, and sustainable procurement. Scores range from 0 to 100, where higher scores reflect better performance.*

*****CDP (Carbon Disclosure Project): a global disclosure platform that scores companies on environmental transparency and action, on a scale from D (disclosure) to A (leadership). An A rating is achieved by less than 2% of disclosing companies.*

5. Research approach

This chapter describes the empirical research approach used to answer the second sub-question. Section 5.1 outlines the research design, participant sampling, data collection, and analysis. Section 5.2 covers the ethical considerations.

5.1 Methodology

5.1.1 Research design

To explore the organizational practices and experiences around EcoDesign implementation in depth, a qualitative research approach was chosen. Semi-structured interviews were used as the main data collection method, as these provide a clear structure while allowing flexibility to explore relevant topics in more depth. This made it possible to evaluate Philips based on the themes from the conceptual model and get new insights from participants' experiences.

5.1.2 Participants and sampling

Participants were selected using a purposive sampling strategy, which is commonly applied in qualitative research to identify individuals with relevant knowledge or experience related to the research topic (Creswell & Poth, 2018). In this study, participants were selected based on their involvement with EcoDesign or sustainability in product development (for external organizations that might not use the term EcoDesign). External participants were selected from organizations that do not compete with Philips or Philips brand licensees, allowing them to speak openly about their experiences. These interviews serve as a complementary source of insight, helping to compare Philips' situation with practices in other organizations and inform the design phase.

To ensure a comprehensive understanding of EcoDesign implementation, participants were selected across multiple roles that reflect different types of involvement in EcoDesign:

1. **Sustainability experts within GSO**: responsible for developing and coordinating EcoDesign at the corporate level.
2. **Sustainability engineers within BUs**: responsible for driving sustainability and EcoDesign within their specific BU.
3. **R&D or System engineers within BUs**: directly involved in product development and responsible for making explicit design decisions.
4. **Product (marketing) managers within BUs**: responsible for product strategy, positioning, and alignment with market and customer needs.
5. **External organizations**: representatives from non-competing companies with experience in EcoDesign or similar sustainability approaches at the product level.

As mentioned in Section 2.2, different BUs have different ways of working and therefore also different phrasing for exact roles. The roles above are simplified versions, which group participants with broadly similar responsibilities into one category for analytical purposes.

Across the different groups, participants had varying levels of experience with EcoDesign topics, ranging from approximately one year to over thirty years in sustainability or product development roles. In total, twenty-six interviews were conducted. This sample size was chosen to ensure comparable group sizes across the internal stakeholder groups, enabling comparison between roles, while remaining feasible within the project timeline. Tables 5.1 and 5.2 provide additional information on participant sample sizes and the sectors and roles of external participants.

Table 5.1: Roles and sectors of external interviewees.

Role	Sector
Head of Design	Consumer Goods
Manager Sustainable Design	Consumer Goods
Design Researcher	Aerospace
Head of Sustainable Innovation and Design	Consumer Goods

Table 5.2: Overview internal interviewees.

Role in Philips	#interviewees
GSO – Sustainability expert	6 (including pilot)
BU – Sustainability engineer	6
BU – R&D or System engineer	5
BU – Product (marketing) manager	5

5.1.3 Data collection procedure

The semi-structured interviews were conducted in March and April 2026 and lasted approximately 45 minutes to 1 hour. Depending on availability and logistical considerations, interviews were conducted either in person or online via Microsoft Teams.

Interview protocols were developed to guide data collection, informed by the six themes of the conceptual model. Questions were slightly adapted to the participant group (GSO, BU, and external organizations) to allow for role-specific depth while maintaining consistency across interviews. One pilot interview was conducted to test and refine the protocols. The complete protocols can be found in Appendix D1-D3.

All interviews were audio recorded with the consent of the participants. Notes were taken during the interviews to support follow-up questions and capture initial observations. Interview recordings were transcribed verbatim using Microsoft Copilot, approved by Philips. Transcripts were then anonymized, meaning that names or specific personal identifiers were removed. The roles of interview participants were simplified to the roles in Table 5.2.

5.1.4 Data analysis

The interview data were analyzed using thematic analysis, a widely used method for identifying and interpreting patterns in qualitative data (Braun & Clarke, 2006). The analysis was theory-informed and consisted of a deductive and inductive round. This combination allowed the research to both evaluate Philips against the conceptual model and identify insights not captured in the literature. All coding was tracked in Excel. The full process is shown in Figure 5.1.

In the deductive round, the codebook was derived directly from the conceptual model, using the six themes as main codes and the success factors or barriers as subcodes. Each interview segment was matched to the main code and subcode it described. For example, a segment in which a participant described limited backing from senior management within the BU for EcoDesign was assigned the main code "Strategy and leadership," the subcode "Leadership support", and tagged as a negative effect.

The inductive round remained open to patterns not captured by this initial codebook. New patterns were added as standalone codes or as new subcodes within existing themes through iterative grouping and refinement. For example, several participants referred to the V-model when describing how EcoDesign activities aligned with development stages. As this pattern recurred across interviews but was not represented in the conceptual model, it was eventually grouped into a new subcode within the main code "PDP integration."

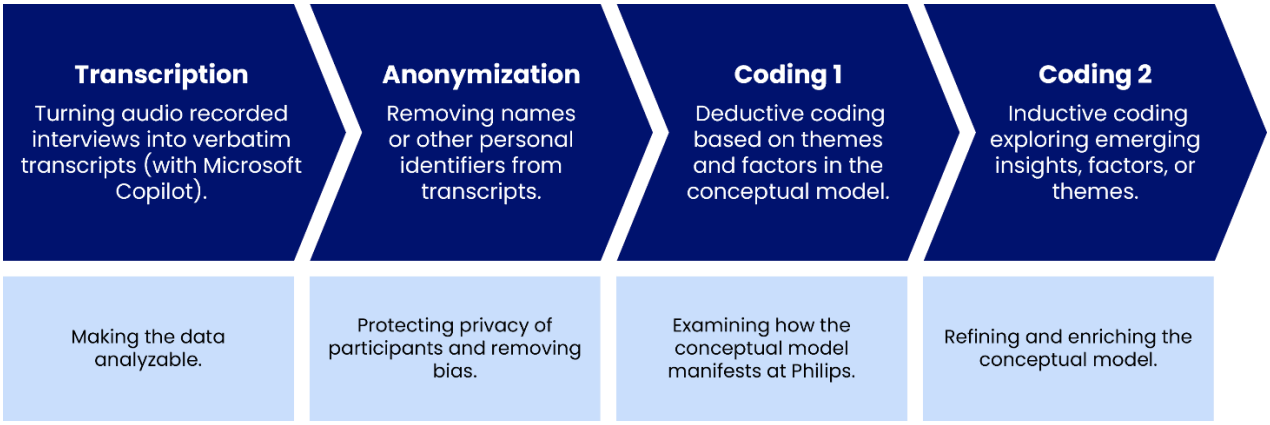


Figure 5.1: Overview of data collection and analysis method.

To support consistency, each coded segment was tagged with whether the participant described a positive or negative effect on EcoDesign implementation, and with the participant's role. This kept coding consistent and made data easy to analyze, showing per theme where implementation at Philips works well or is hindered and how perceptions differ across roles.

Finally, the researcher's insider position was taken into account throughout analysis. It was addressed by staying close to the descriptive findings during coding: exact passages from the transcripts were copied verbatim into the Excel file alongside their assigned codes, keeping a clear split between descriptive findings and interpretation. Interpretation formed a separate stage, to develop the insights presented in Chapter 6. Insights were also discussed regularly within Philips providing an additional check on the researcher's interpretation of the data.

5.2 Ethical considerations

Prior to conducting the interviews, a Human Research Ethics submission was made to TU Delft, which was approved. This process helped ensure that the research was designed and conducted ethically, in line with the university's research ethics standards.

Participation in the interviews was voluntary. Informed consent was obtained from all participants prior to the interviews through a standardized informed consent form, shown in Appendix E. Participants were informed about the purpose of the research, the intended use of data, and their right to withdraw from the study at any time without consequences.

To protect confidentiality, all interview data were anonymized during analysis. Interview recordings and transcripts were stored securely and used solely for the purposes described in the informed consent form. All tools and IT systems used for data collection, transcription, and storage were approved for use by Philips.

6. Results

This chapter presents the empirical findings from the semi-structured interviews conducted within Philips and with external organizations. The findings address the second sub-question of this project. The chapter presents company-wide and role-specific findings, external insights, and closes with the revised conceptual model.

6.1 Philips company-wide insights

The company-wide findings are structured along the six themes of the conceptual model. Within these themes, several additional inductive insights are included. Other inductive insights, which are not considered directly relevant for this thesis, are presented in Appendix F.

6.1.1 Leadership & Strategy

The interview findings indicate that leadership support for EcoDesign at Philips is strong at the corporate, group level of the organization. EcoDesign is explicitly positioned as an enabler and governance mechanism for achieving the 2030 Impact Ambitions. Therefore, there are also internal KPIs in place for EcoDesigned products. This suggests that this leadership support and anchoring helped to successfully implement EcoDesign in the organization and to standardize it within product development processes.

At BU level, however, leadership support appears to differ across the organization. Interviewees described the Personal Health BUs as mature in EcoDesign, with stronger leadership engagement and more established sustainability practices. Within Health Systems BUs, by contrast, EcoDesign maturity varied. These BUs do not always have detailed longer-term (product) sustainability roadmaps in place and are more focused on clinical aspects or costs in product development. This points to a mistranslation between strategy and execution: while the corporate ambition is explicit, its translation into BU-specific tactical and operational activities is not equally developed across the company.

6.1.2 Organization & Structure

The interviews suggest that organizational responsibilities for EcoDesign at Philips are clearly defined across most BUs. Sustainability or system engineers, together with R&D engineering teams, hold formal accountability for implementing EcoDesign and for showing adherence to the current set of EcoDesign requirements. GSO has a supporting role in this structure, providing expertise through dedicated Subject Matter Experts (SMEs) or through the BPs. Interviewees saw this clarity of ownership as a strength: engineers and sustainability experts know where to go for guidance and responsibilities are clear.

However, a recurring challenge identified across the interviews is the limited degree of cross-functional collaboration on EcoDesign. Because responsibility is concentrated within sustainability and R&D engineering functions, other roles tend to remain less involved in EcoDesign discussions. Interviewed product managers themselves mentioned that they are less involved, even though they often hold a crucial role in the earlier stages of product development. Trade-offs between sustainability, cost, performance, and clinical requirements are therefore not consistently discussed in multidisciplinary settings and decisions are made in a narrow

functional scope. Additionally, product managers hold a relatively senior position in product development teams, which makes them more important to involve.

6.1.3 EcoDesign integration into the Product Development Process

The findings show that Philips has mature formal integration of EcoDesign in its PDLM process. BUs are required to deliver EcoDesign deliverables at specific stage-gates, which are systematically reviewed. This suggests that EcoDesign is part of Philips' formal product development governance, a characteristic associated with advanced EcoDesign implementation in the literature (Pigosso et al., 2013).

At the same time, the interviewees consistently point to late-stage integration as a significant process-related challenge. This late integration appears at two levels. First, within PDLM projects themselves, EcoDesign risks being introduced when key design decisions have already been made or are difficult to change. By the time EcoDesign requirements are actively addressed, the Bill of Materials (BoM) of the system is sometimes already "frozen", leaving limited room for actual sustainability improvements. This is consistent with the design process paradox described in the literature review, where design freedom decreases as a project progresses (Ullman, 2010).

Second, PDLM itself is considered too late as a starting point within the broader I2M process. Respondents note that the large design decisions shaping environmental impact, such as system-level energy consumption or product weight, are typically made upstream in AD or VPC and are largely inherited by the time a project enters PDLM. Achieving more impact therefore requires EcoDesign to already be active in these earlier I2M phases.

An additional insight from the interviews relates to how EcoDesign requirements fit within the engineering workflows used in product development. Within Philips, product development teams commonly work with the V-model: a systems engineering process in which requirements are progressively decomposed from business or user level to system-level specifications, down to component-level requirements (Forsberg & Mooz, 1991; see Figure 6.1). Interviewees indicated that the current set of EcoDesign requirements is not always well-positioned within this hierarchy and process, both in terms of timing and terminology. How Philips integrates the V-model into its PDLM process can be found in Confidential Appendix I.

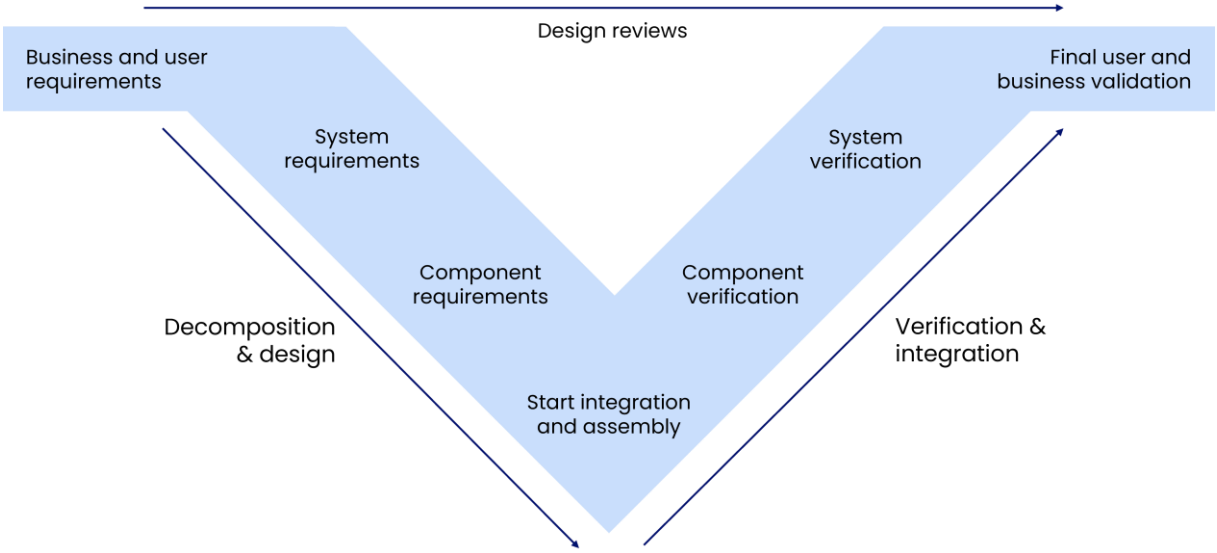


Figure 6.1: Systems engineering V-model (adapted and simplified from Forsberg & Mooz, 1991).

6.1.4 Environmental & Sustainability knowledge

Overall, the interviews point to a strong knowledge base on environmental and sustainability topics within Philips. R&D engineers and sustainability experts generally have sufficient technical understanding to implement EcoDesign in practice, including knowledge of EcoDesign principles, life cycle thinking, and the environmental impact of design decisions. Training materials on these topics are available within the organization, and engineers can consult SMEs when needed. This knowledge base appears to combine explicit knowledge, such as documented guidelines, requirements, and assessment methods, with tacit knowledge built through experience with complex medical products and their environmental trade-offs (Smith, 2001). At an operational level, knowledge is therefore not identified as a primary barrier to EcoDesign implementation at Philips.

At the same time, EcoDesign is not always understood in the same way across functions. Sustainability and R&D engineers often see it as a set of connected choices across the product life cycle. Product managers, however, view it more black-and-white: a product is either EcoDesigned or not. They are also not always familiar with what EcoDesign means in practice at Philips, which requirements apply, and how they can contribute.

6.1.5 Tools & methods

According to the interviewees, Philips provides a broad set of tools and methods to support EcoDesign implementation. Teams working on EcoDesign are generally able to access and use these tools. The BoMCheck tool supports substance management by allowing teams to verify material compliance, while LCA tools are available to evaluate the environmental impact of products across their full life cycle. The ESG Case is used to document and communicate sustainability performance, providing a structured way to evidence EcoDesign efforts. In addition, simple tools are available to evaluate product disassembly and recyclability. Overall, respondents did not identify a lack of tools as a significant barrier to EcoDesign implementation.

Beyond the existing toolset, Philips is actively working to improve its data infrastructure for sustainability reporting by better integrating different platforms and systems. The aim is to provide product development teams with more accessible and reliable information on the environmental performance of products. Interview participants suggested that Windchill, the Product Lifecycle Management (PLM) platform already used at Philips for other sustainability reporting purposes, could also integrate EcoDesign-related tools and data. This would reduce the reliance on standalone tools and separate documents.

6.1.6 Requirements

EcoDesign requirements are the main mechanism through which sustainability is operationalized in product development at Philips, with BUs demonstrating adherence at specific stage-gates. However, the interviews identified several operational challenges with the current requirements.

A first challenge concerns the clarity and formulation of requirements. Respondents describe the current requirements and their documentation as too ambiguous, with requirements not always written in terminology that fits how R&D teams work. For example, there is no clear guidance on how to measure elements such as product weight, including which system configuration should be used. A related issue is that the applicability of requirements is not systematically clear: it is not always evident when a requirement applies to a specific product or project. As discussed in Section 6.1.3, requirements also do not fit well within the V-model, as it is unclear whether they should be treated as business, user, system or component requirements.

A second, related challenge is the absence of a clear rationale behind individual requirements. Product development teams do not always understand why a specific requirement exists or why it should be prioritized alongside competing project objectives. If the reason behind these requirements is not clear, they are more likely to be set aside when priorities compete.

6.2 Role-specific insights

This section presents the empirical findings organized by internal stakeholder group. While some findings overlap with the company-wide analysis in Section 6.1, it is important to understand the challenges and needs of different stakeholders to tailor interventions in the design phase.

6.2.1 Sustainability engineers

The interview analysis indicates that sustainability engineers within the BUs possess substantial knowledge on sustainability and EcoDesign, both on a technical and regulatory level. In most BUs, they play an important bridging role between GSO and product development teams.

However, structural challenges limit their influence on product design. Sustainability capacity within certain BUs is limited to one or two individuals supporting multiple projects simultaneously, without formal decision-making power and without being structurally embedded in core project teams. As a result, sustainability engineers can be involved too late in the PDP. By the time they get actively engaged, key design decisions and BoMs could be frozen, shifting their work towards reporting and justifying decisions already made. This risks turning EcoDesign into a compliance-oriented exercise, rather than a proactive driver of sustainable product design. To address this, sustainability engineers emphasized the need for earlier and more formal involvement, also in upstream I2M phases such as VPC and AD (Section 6.1.3).

6.2.2 R&D and system engineers

R&D and system engineers recognize the value of having EcoDesign formally integrated into the PDLM process through stage gates, as this creates structure and ensures sustainability is addressed at defined moments in product development. However, engineers also experience EcoDesign as being introduced too late to meaningfully influence design decisions. As a result, EcoDesign activities shift towards documenting and justifying decisions that have already been made, making EcoDesign feel more like a reporting obligation than a design driver.

A second challenge concerns how EcoDesign requirements are communicated. Engineers experience current requirements as insufficiently precise and not formulated in engineering terminology. This creates a mismatch with the V-model approach, in which requirements should be clearly defined and verifiable. It is not always clear when requirements are applicable, forcing engineers to interpret them rather than directly use them. Additionally, requirements lack an explicit rationale, making them difficult to justify internally when they conflict with other priorities such as performance, cost, or time constraints.

6.2.3 Product managers

Interviewed product managers generally did not consider EcoDesign part of their own responsibility, viewing it primarily as a technical topic owned by R&D engineers or sustainability experts. They tended to associate EcoDesign with compliance, describing it as a box to tick instead of a design consideration. This framing oversimplifies EcoDesign, which in practice should involve making conscious decisions and trade-offs. This interpretation contributes to the limited engagement product managers show towards EcoDesign.

A second challenge raised in the interviews is that product managers did not see the full strategic relevance or business value of EcoDesign. Value drivers such as tender requirements, competitive positioning, or other opportunities were described as not clearly communicated to them. This likely helps explain why EcoDesign is easily deprioritized when it conflicts with other priorities, such as when a sustainability improvement would increase costs.

Taken together, these findings support the interpretation that limited ownership and understanding of EcoDesign among product managers contributes to its late integration in PDPs. In most BUs, product managers hold a relatively senior position and are involved in early decisions around scope, prioritization, and resource allocation. When EcoDesign is not part of their considerations at this stage, early product decisions are made without sustainability input.

6.2.4 Group Sustainability

From the perspective of GSO, which sets and oversees EcoDesign requirements across all BUs, two challenges limit the effectiveness of EcoDesign. The first challenge is that EcoDesign is positioned too late in product development to create substantial environmental impact. GSO interviewees mentioned that by the time projects enter PDLM, core decisions regarding system architecture, materials, and energy have largely been made, leaving limited design freedom. As a result, EcoDesign within PDLM is typically limited to incremental improvements.

The second challenge concerns the auditability of current EcoDesign requirements. Because requirements are formulated at a high level and lack clear applicability rules, BUs do not always have a clear view of what is expected from them. This leads to ambiguous evidence submissions, which GSO then needs to review and clarify. The process is inefficient for both sides, increasing workload without necessarily improving sustainability outcomes. Given GSO's limited capacity, this is not a sustainable way of working. Clearer and more measurable requirements are therefore seen as essential, clarifying expectations and reducing the administrative burden.

Table 6.1 provides an overview of the main challenges encountered and needs per stakeholder group interviewed within Philips.

Table 6.1: Overview of challenges and needs per internal stakeholder group based on interviews.

Business Unit			**Group level**
Sustainability engineer	R&D engineer	Product Manager	Group Sustainability
Challenges • Being the only one taking full responsibility on sustainability/EcoDesign topics • No formal role in product development teams and therefore involved too late to drive EcoDesign.	**Challenges** • Navigating ambiguous requirements and applicability rules, without a clear rationale in PDLM processes. • EcoDesign is introduced too late, when design decisions are frozen.	**Challenges** • EcoDesign is not seen as an internal compliance topic only. • Value drivers for EcoDesign are not communicated, making it easy to deprioritize EcoDesign.	**Challenges** • PDLM is too late in the process to create substantial impact with EcoDesign. • Requirements are too ambiguous to efficiently review, making it an inefficient process.
Needs • Leadership support and BU-level sustainability strategy to drive sustainability and EcoDesign in projects • Improved collaboration in cross-functional teams, early in product development processes.	**Needs** • Measurable requirements with clear applicability rules and rationales. • Earlier integration of EcoDesign into the product development process.	**Needs** • Clear communication of the business value and the main value drivers for EcoDesign. • Increased engagement and consequently more strategic and earlier integration in product development processes.	**Needs** • Earlier embedding of EcoDesign in the full product development process, leading to a more strategic EcoDesign approach. • Auditable requirements with an efficient evidencing process.

6.3 External insights

The external interviews primarily served as a comparison reference for the internal findings at Philips. Two themes from the conceptual model were strongly emphasized by external participants: the strategic alignment of EcoDesign with leadership support, and its early integration into product development. Participants stressed that EcoDesign only delivers larger impact when it is genuinely embedded in strategy and backed by leadership, and that decisions made late in development are limited in their impact. Both points reinforce the internal Philips findings discussed in Sections 6.1 and 6.2.

6.4 Different forms of EcoDesign

An emerging insight from both the internal and external interviews is that EcoDesign was understood differently across participants. Some, including product managers, mainly see EcoDesign as an internal compliance topic, similar to other interviewees who described EcoDesign as a "checkbox exercise" of meeting requirements and providing documentation. Others explained EcoDesign through concrete product improvements, such as reducing energy use or weight, or increasing the recyclability of products and packaging. Moreover, some interview participants referred to EcoDesign as a more fundamental innovation approach, referring for example to Philips' helium-free BlueSeal MR system or other innovative products from Philips and external organizations.

These findings suggest that EcoDesign can take different forms when implemented in an organization, depending on its level of ambition and the type of environmental improvement being pursued. Building on this interpretation, this research distinguishes three forms of EcoDesign, shown in Figure 6.2, including where they are generally integrated into the PDP.

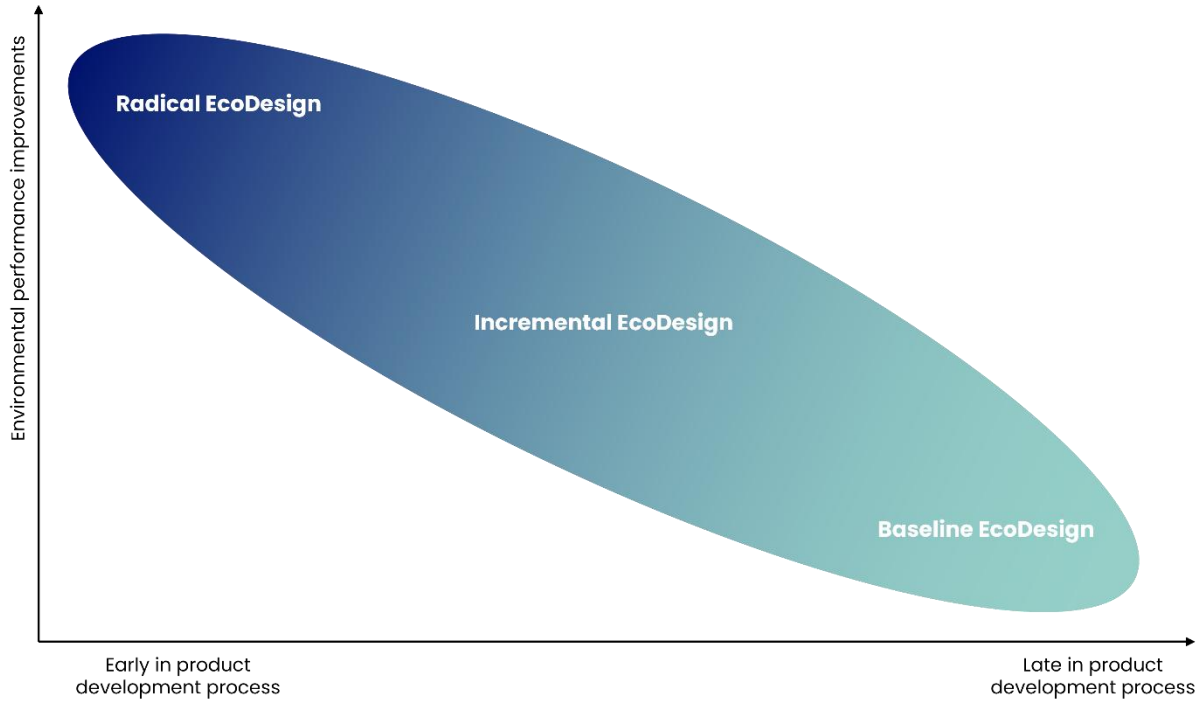


Figure 6.2: Different EcoDesign forms based on environmental performance improvement and position in the product development process.

The three identified forms of EcoDesign are, with examples in Figure 6.3:

- **Baseline EcoDesign**: ensuring that products meet a defined set of environmental standards and information requirements (see Section 4.1.2). This starts with compliance with

EcoDesign-related regulations, but it also includes basic environmental expectations related to a product's license to operate in the market. Examples are the ban of materials like expanded polystyrene (EPS) for packaging or measuring device energy consumption according to COCIR scenarios. The term baseline is used because this form defines the minimum level that needs to be in place for a product to be considered EcoDesigned, in this case within Philips. Since it usually does not require fundamental design changes, baseline EcoDesign often takes place later in the PDP.

- **Incremental EcoDesign**: making useful but targeted improvements within existing product development projects. Examples include reducing total product weight, improving energy efficiency through software updates, or increasing the use of recycled materials in packaging. Compared to baseline EcoDesign, this form requires more deliberate design effort and focuses on improving environmental performance within the existing product architecture.
- **Radical EcoDesign:** making fundamental product, material, platform or system changes that significantly reduce environmental impact. Participants pointed to Philips' BlueSeal as a clear example, but also described radical EcoDesign more broadly, for example through completely new materials, technologies or value propositions. Interviewees noted that sustainability is not always the primary driver of such projects, but it can strengthen the argument for prioritizing them.

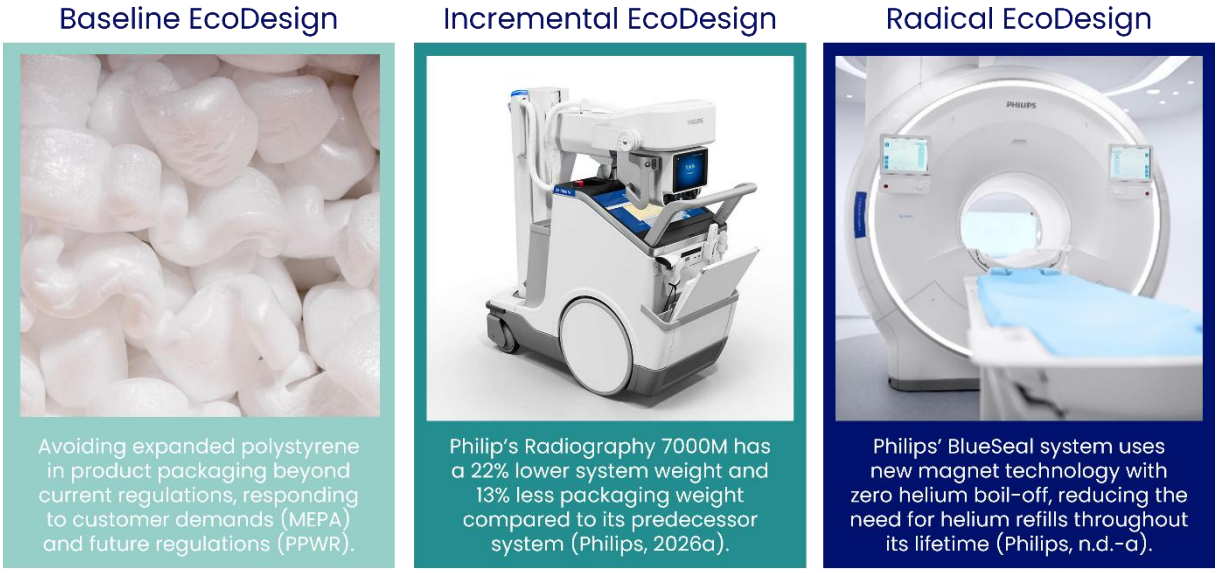


Figure 6.3: Philips examples of the three forms of EcoDesign (images sourced from Philips internal sources or royalty-free from Pexels).

This distinction can also be recognized in the innovation literature. Christensen (1997), among others, distinguishes between sustaining or incremental innovation, which improves existing products along established performance dimensions, and disruptive innovation, which introduces fundamentally different solutions. A similar distinction between incremental and more radical approaches is recognized in the EcoDesign literature (Pigosso et al., 2013; Watz & Hallstedt, 2022). The meta-review of Schäfer and Löwer (2021) argues that most EcoDesign efforts in organizations only achieve incremental improvements, and that more innovative and radical tools are often lacking. Organizations should pursue pro-active design strategies to combine radical innovation with sustainability (Maccioni & Borgianni, 2019). Research even suggests that new EcoDesign implementation approaches should make a more explicit split between incremental and radical EcoDesign (Dangelico, 2015). Moreover, the split between incremental and radical innovation is also acknowledged on policy level. The OECD (2009) calls the concept of making radical environmental improvements "eco-innovation".

The framework in Figure 6.2 adds the concept of baseline EcoDesign to the incremental and radical approach. This type of EcoDesign emerged from the interviews, mentioning that EcoDesign is not always linked to innovation, and can be focused on getting the right documentation at the end of a process. Literature also highlights that EcoDesign in practice often becomes an afterthought (Sheldrick & Rahimifard, 2013).

6.5 Discussion and revised conceptual model

The empirical findings from the interviews confirm the relevance of the six themes identified in the conceptual model developed in the literature review. The model proved to be a helpful analytical lens for identifying and structuring the challenges encountered at Philips, with the different themes being clearly recognizable in practice. Three challenges stand out as the most prominent across stakeholder groups: the late integration of EcoDesign in the product development process, the limited cross-functional collaboration on EcoDesign topics, and the missing rationale and engineering-oriented terminology of EcoDesign requirements. The themes about knowledge, tools and methods, by contrast, were less prominent as barriers.

At the same time, the interviews revealed an important nuance that the original model does not capture: EcoDesign can take fundamentally different forms. However, these three forms should not be seen as strictly separate categories. For example, using a new component or material in a system can be seen as a radical innovation on component level, while only leading to incremental improvements on the level of the full system. The distinction between baseline, incremental and radical EcoDesign has practical implications for how it should be implemented. Henderson and Clark (1990) already argue that different types of innovation require different organizational capabilities, and it can be argued that the same logic applies to EcoDesign. The relative weight of the six themes and the way they manifest in practice are likely to depend on the form of EcoDesign being pursued.

This interpretation can be illustrated across the six themes. More radical forms of EcoDesign require earlier process integration, stronger leadership support, and broader cross-functional collaboration, as fundamental product decisions must be shaped in the earlier design phases and often require long-term commitment across product management, R&D, and sustainability functions. Baseline EcoDesign, by contrast, can often be managed later in the process and within a narrower functional scope, supported by operational tooling and clear requirements. The required knowledge and tools also differ: baseline EcoDesign depends more on specific standards, labels, measurements, and evidence requirements, while radical EcoDesign requires more strategic thinking about value propositions and future product directions. Finally, formal requirements are more suitable for baseline EcoDesign than for radical innovation, where the solution space is still open and difficult to prescribe in advance. Implementation of incremental EcoDesign can be positioned in between these two forms.

These observations suggest that EcoDesign cannot be implemented through a one-size-fits-all approach. The importance of the six themes is likely to differ depending on whether baseline, incremental, or radical EcoDesign is being addressed. While the three forms of EcoDesign emerged directly from the empirical findings, their specific relationship with the six themes is an interpretation rather than a directly tested result. Further research could therefore validate the revised conceptual model (Figure 6.4) and explore what each form of EcoDesign exactly requires in practice (Section 10.4).

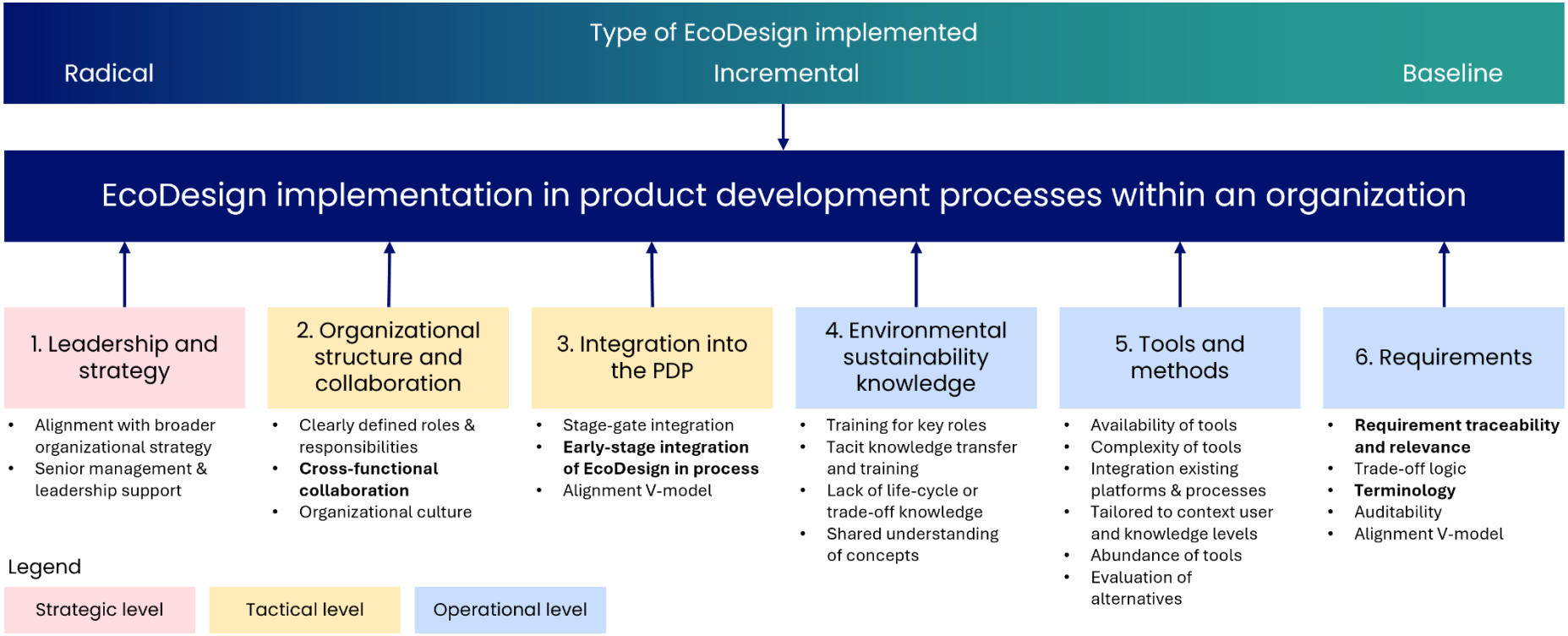


Figure 6.4: Revised conceptual model on EcoDesign implementation with insights from empirical research and focus factors in bold.

7. Design phase

This chapter describes how empirical findings from Chapter 6 were translated into the design solutions of Chapter 8. It describes the overall two-phase design process (Section 7.1), and some key design activities that shaped the outcomes (Section 7.2). Throughout the chapter, only the most important lessons from the design phase are presented.

7.1 Design process

The design process consisted of two main sub-phases, presented in Figure 7.1. The first focused on developing the overall framework for organizing EcoDesign within Philips, presented in Section 8.1. The second focused on iteratively developing separate interventions to operationalize the framework. Throughout the process, a set of design principles and constraints were developed and iteratively updated as new findings arose. These are included in Appendix G.

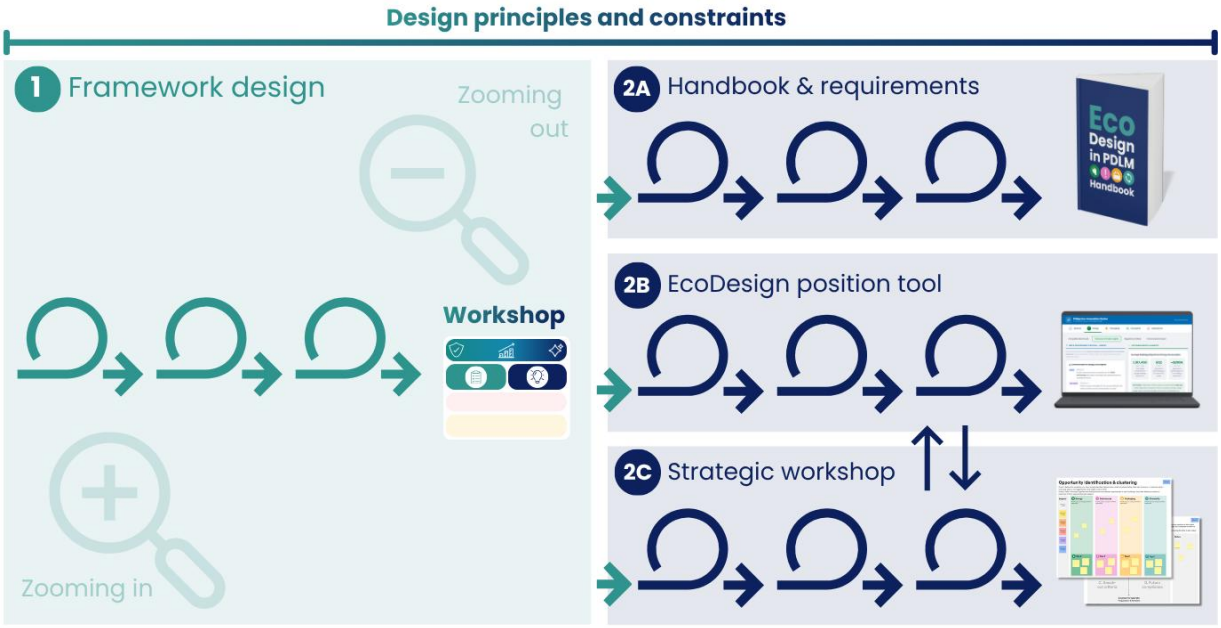


Figure 7.1: Design process.

The first sub-phase started directly after the interviews and built on the insights from Chapter 6. The design question here was still broad and open. The work involved zooming in on specific elements, such as PDLM or individual requirements, and zooming out to understand how those elements fit within the larger organization. Several directions were explored, including a level-based framework and a scoring system, but eventually not taken forward (see Appendix H). The phase concluded with an initial version of the EcoDesign implementation framework, with two complementary tracks.

During the design of the framework, it became clear that solutions had to avoid unnecessary complexity and protect a clear EcoDesign standard for Philips, needed for internal and external KPI reporting. At the same time, Philips proved to be very roadmap-driven: for changes to receive resources, they need to be embedded in BU roadmaps. These two needs informed the two-track

structure of the framework: one track safeguards the EcoDesign baseline, while the other connects EcoDesign to strategic roadmap development.

The two sub-phases of the design process were bridged by a structured workshop with EcoDesign experts from GSO (Section 7.2.1). The workshop validated the two-track framework with a wider group and generated initial ideas for the design solutions developed in the second sub-phase.

The second sub-phase was more focused and tangible. First, the format of the designed solutions was determined based on insights from design activities and earlier interviews. Alternatives were considered for both tracks, after which the work shifted towards prototyping and stakeholder feedback to improve the interventions. The main learnings from this phase are presented throughout Section 7.2.

Although this chapter presents the design process in a structured way, it was less linear in practice. Activities often overlapped and were revisited over time. For example, stakeholder mapping was refined several times and feedback sessions often ran in parallel with ideation. A more personal reflection on this process can be found in Chapter 12.

7.2 Key design activities

This section describes the most relevant design activities and findings shaping the final solutions.

7.2.1 Validation and brainstorming workshop

A structured workshop was held in Miro with eight colleagues from GSO. Participants were members of the core EcoDesign team and experts on other sustainability topics, with experience at Philips ranging from one to thirty years. A pre-read was shared beforehand, allowing the session to focus on discussion instead of explanation. The workshop consisted of two parts: validating the proposed framework and generating ideas for the interventions within its two tracks. Confidential Appendix III provides more detail on the findings and Figure 7.2 shows the structure of the workshop.

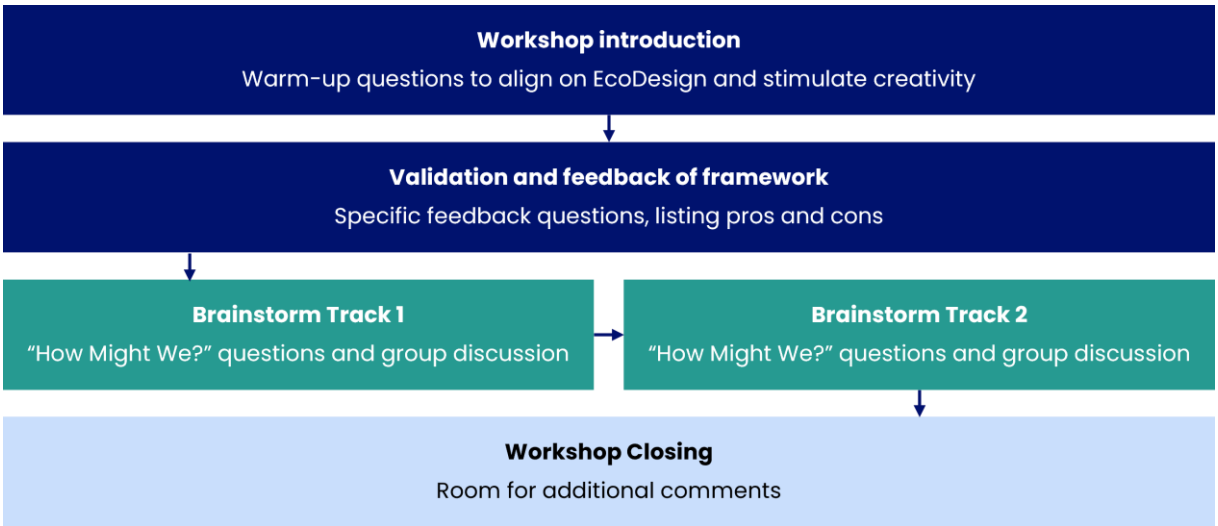


Figure 7.2: Structure of validation and brainstorming workshop.

The first part of the session aligned participants on a shared understanding of EcoDesign at Philips and tested the proposed two-track framework. The framework was validated: participants recognized the split between EcoDesign in PDLM and a more innovative track, noting that separation already occurs implicitly in some parts of Philips. The discussion also confirmed that

many EcoDesign efforts are currently directed into the wrong process, as PDLM leaves limited room for larger design changes. In addition, participants emphasized that any approach should be applicable across a wide range of BUs, given the limited capacity of GSO.

The second part of the workshop used “How Might we?” questions to generate ideas for each track. For Track 1, the discussion revolved around clarifying requirements, specifying applicability and how to evidence requirements. It was found that, given the varying EcoDesign maturity across BUs, exemptions backed by an improvement plan were considered acceptable. Also, participants suggested that many requirements could be evidenced through existing reporting in Windchill, already used for CSRD reporting. A point of debate was whether a formal control board should govern applicability decisions, which would bring clarity but also increase administrative burden. Another proposed suggestion was to make an assessment that determines which EcoDesign requirements would be applicable in PDLM projects.

For Track 2, questions explored how to motivate product managers, show the relevance of EcoDesign, and identify suitable formats to support this track. Suggested directions included better integration of EcoDesign into personal KPIs, stronger competitor analyses, and the use of lost tender data to show the business impact of EcoDesign. Proposed formats included one-pagers, a playbook, product-specific dashboards, and a new sustainability training program. Across these ideas, simplicity was a recurring theme: interventions should be focused, practical, and avoid overloading the audience with information.

7.2.2 Stakeholder mapping

Stakeholder mapping was used as a supporting design activity to better understand the internal stakeholder landscape and the interactions between different roles. It was conducted early in the process and revisited several times. The resulting map, included in Confidential Appendix IV, helped adapt the designed solutions to the practical reality within Philips.

One important finding was the role of design departments within the BUs. Designers were frequently mentioned as relevant stakeholders, as they are part of core product teams and have a strong influence in early PDLM phases and in processes such as AD and VPC. Finally, the activity highlighted the importance of GSO Business Partners. They often have a useful combination of BU portfolio knowledge and sustainability expertise, making them important stakeholders to involve more actively in EcoDesign discussions.

7.2.3 Requirements, MEPA mapping & rewriting

As part of Track 1, a key design activity was to further develop and improve the existing EcoDesign requirements. These requirements form the operational backbone of EcoDesign within PDLM, making their clarity, structure, and relevance essential for effective implementation. Examples of how requirements evolved are included in Confidential Appendix V. The requirements were improved through four main activities:

- **Reducing redundant requirements**. The existing requirements were reviewed for overlap with regulatory frameworks and other internal processes. One example is the substances category, where requirements that fully overlapped with the RSL were removed. This helped avoid redundant work for the BUs.
- **Adding rationale and context**. Many existing requirements described what should be done in product development, but did not clearly explain why. Rationale was therefore added to make the relevance of each requirement more explicit. This rationale was based on different sources, including the MEPA criteria introduced in Section 4.1.1 or expected regulatory developments. Suggestions were also added for how individual requirements could be evidenced, aligning them more closely with existing reporting needs.

- **Rewriting with AI support and critical review**. Requirements were rewritten using an internal AI tool that evaluates requirements against system engineering rules, flagging issues such as unclear sentence structures or the absence of measurement units. However, manual judgement remained essential, as the tool could not assess whether a requirement remained relevant across the diverse range of BUs and product contexts.
- **Finalizing through stakeholder feedback**. Through multiple feedback iterations, the requirements were finalized and structured into mandatory requirements and guidelines. Feedback helped to improve clarity and feasibility, ensuring that requirements used the right definitions, such as for power save modes, and would not become too ambitious for PDLM projects. The final requirements and guidelines were compiled into the handbook described in Section 8.2.

7.2.4 Iterative prototyping and feedback

Throughout the design process, prototypes of one-pagers, processes, dashboards, and workshop exercises were made (see Figure 7.3). These served as input for feedback sessions with GSO and BU stakeholders, including earlier interview participants. This section presents some of the most important insights from these iterations.

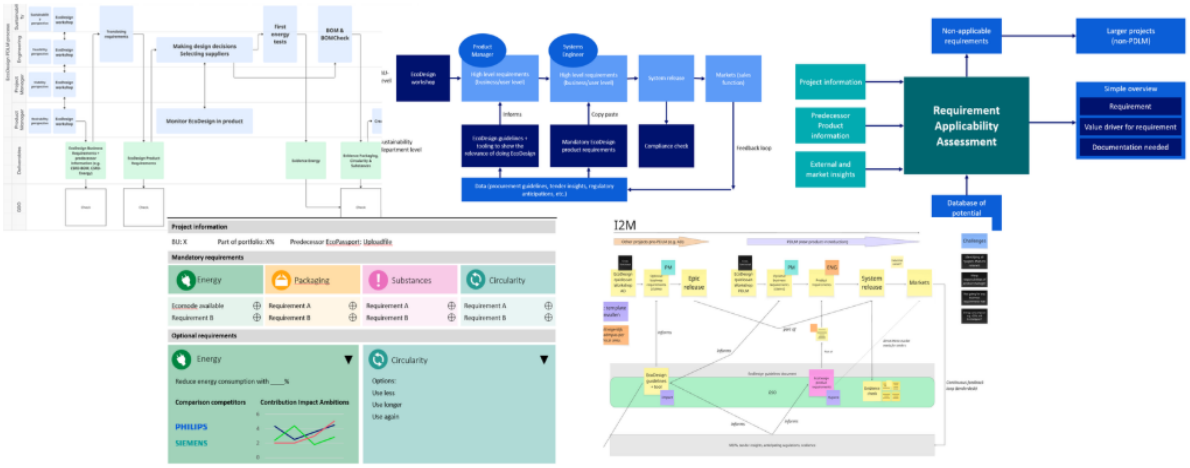


Figure 7.3: Impression of prototyped processes, tools, and structures.

For Track 1, feedback showed that improving EcoDesign in PDLM was not only about updating the requirements, but also about clarifying the process around them. Several practical mismatches caused confusion. For example, engineering teams often determine the predecessor product or measurement configuration relatively late, while some requirements depend on having these references available. This shifted part of the design effort towards explaining the process more clearly, which is reflected in the step-by-step structure of the handbook (Section 8.2).

A related learning concerned the type of requirements that work in practice. Philips' earlier EcoDesign standard included optional requirements that asked teams to make design improvements without a clear, verifiable outcome. These proved difficult to translate into product-specific requirements. As the interviews showed, product development teams work with the V-model, where design reviews are key moments for steering decisions. It was therefore more effective to support these reviews with clear guidelines, rather than adding optional requirements that could easily be overlooked. This insight informed the distinction between mandatory requirements, which must be verifiable, and guidelines, which support decision-making during design reviews (Section 8.2).

For EcoDesign within PDLM, it was also considered to create an assessment tool that would help BUs to determine which requirements are applicable for a product or project. While this idea

originated from the workshop (7.2.1), it was not selected as it would put too much control at GSO, while in Philips' operating model BUs should be in the lead to make important (non-regulatory) product decisions.

For Track 2, several possible processes were explored focusing on how BUs could start working on more innovative EcoDesign approaches. Eventually, the design direction shifted away from creating a complete process towards creating first momentum. Without initial motivation from BUs, a detailed process would risk being designed for something that might not yet be considered at all. This led to a simpler intervention aimed at building strategic and commercial awareness around the value of EcoDesign within BUs. In this way, the intervention functions as a first step towards the product sustainability roadmaps identified earlier as important within Philips.

Within this intervention, it became clear that BUs need specific and tangible input. General hospital purchasing guidelines led to limited responses, while a competitor benchmark was more concrete and sparked more interest. Testing different workshop exercises also showed the importance of comparing EcoDesign opportunities relative to each other, since BUs eventually need to prioritize which opportunities should be included in their sustainability roadmaps.

8. Design solutions

This chapter presents the solutions developed in this project. It first introduces the overall concept: a new EcoDesign framework with two complementary tracks. It then presents the three design interventions to operationalize the framework: the EcoDesign in PDLM handbook (Section 8.2), and the Eco-Innovation starter package, consisting of the EcoDesign Position Tool and the Eco-Innovation workshop (Section 8.3).

8.1 EcoDesign implementation framework

The main concept developed in this project is a revised EcoDesign framework that explicitly distinguishes between two complementary tracks. This builds on the insight that different forms of EcoDesign require different implementation approaches. As shown in Figure 8.1, the tracks are structured across three levels: strategic ("Why", closely linked to the three forms of EcoDesign), tactical ("How"), and operational ("What"). By making this structure explicit, the framework supports a clearer translation from strategy to tactical and operational levels.

The first track builds on Philips' current EcoDesign approach and is called EcoDesign in PDLM. At the strategic level, this track covers baseline and incremental EcoDesign within the PDLM process. Its purpose is to ensure proper auditability for reporting and KPIs, support BUs in answering important tender questions, and prepare products for relevant regulations, such as PPWR. These objectives are closely linked to the product's license to operate in the market. At the tactical level, the track primarily involves system and sustainability engineers, with GSO monitoring its execution. As the name suggests, this track is focused on PDLM: the process through which new products are introduced to the market and where limited design changes can be made. The main deliverable is the EcoDesign in PDLM handbook, an improvement of the current EcoDesign standard within Philips. This handbook is described in more detail in Section 8.2.

The second track is Eco-Innovation. At the strategic level, this track positions EcoDesign as a source of competitive differentiation and a driver of incremental and radical. At the tactical level, this track should be driven by a product-level sustainability or EcoDesign roadmap that links to different I2M projects. Therefore, it focuses on engaging product management and strengthening cross-functional collaboration. The track is operationalized through the Eco-Innovation starter package, consisting of the EcoDesign Position Tool and a standard workshop format. The starter package is deliberately designed as an initial trigger to create momentum for this new track (Section 8.3).

Although presented separately, the two tracks are connected in two ways. First, the product sustainability roadmaps developed in the Eco-Innovation track should ensure that VPC and AD projects eventually feed into concrete PDLM projects that launch products. Second, product-specific requirements in PDLM projects can be used to implement outcomes from earlier Eco-Innovation work. For example, a material explored in AD can later be translated into a concrete product-specific requirement in a PDLM project.

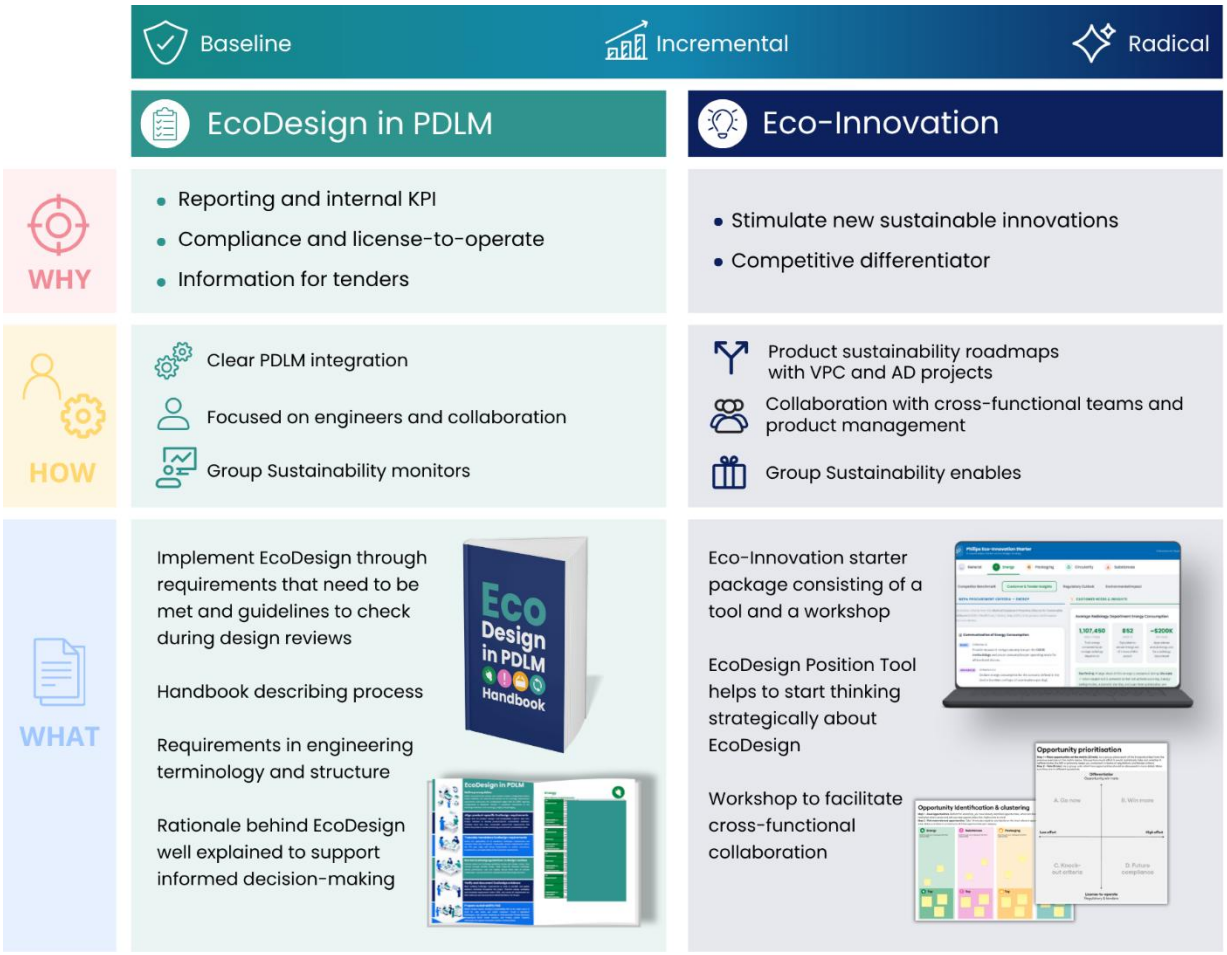


Figure 8.1: Two-track EcoDesign framework to improve implementation.

8.2 EcoDesign handbook for PDLM

The EcoDesign in PDLM handbook operationalizes the first track of the framework. It provides R&D teams with structured guidance for implementing EcoDesign within PDLM, focused on baseline and incremental EcoDesign.

A handbook was developed because it offered the simplest way to address the problems identified in the empirical research while building on the current EcoDesign standard, as explained in Confidential Appendix I. Alternative formats, such as explanatory one-pagers or point-based systems (Appendix H), would introduce new materials and additional complexity requiring more change management. The handbook format was therefore chosen because it builds on the existing standard while making it more practical and accessible for engineering teams. It also allows the EcoDesign requirements, the rationale behind them, and guidance to be brought together in one document.

The handbook is organized in three parts. It starts by explaining why EcoDesign matters, using three drivers: customer value, regulatory and cost resilience, and the 2030 Impact Ambitions, making sure that engineers see EcoDesign as something relevant rather than just another internal standard. The second part guides the reader through six steps that together cover the EcoDesign process in PDLM (Figure 8.3, Appendix J). These steps are linked to the relevant PDLM stage-gates to support earlier integration of EcoDesign, before key design decisions are fixed. Each step also includes a clear outcome, making the process easier to apply. The final part presents the mandatory EcoDesign requirements and guidelines.

Table 8.1: Overview of different levers to implement EcoDesign in PDLM.

	Product-specific requirement	Mandatory requirement	Guideline
Example	Integrating a material or part developed or explored in an earlier project.	The product packaging shall be free of expanded polystyrene (EPS).	Design for low weight Design with sustainable materials
V-model	Enter as user or business requirements	Enter as system/product requirements	Used during design reviews as in V-model
Ownership/ governance	Set, owned, and verified by the BU	Set and verified by GSO, BU determines applicability	Used by the product development team
Handbook appearance	Not listed, the handbook reminds BUs to incorporate them	Presented with rationale, applicability, and evidencing guidance	Presented with rationale

The handbook distinguishes three types of levers to implement EcoDesign in a project. These differ in where they enter Philips' V-model and in ownership (see Table 8.1):

- **Product-specific EcoDesign requirements** come from the BU and enter the project as user or business requirements. Since product managers are responsible for setting these, engineering teams should involve them early to align. After, the requirement is decomposed into system and component requirements. An example is integrating a specific part or material developed and validated in an earlier project, potentially originating from the Eco-Innovation track. These requirements are fully owned and verified by the BU. The handbook therefore does not prescribe product-specific requirements, but reminds BUs to define and include them where relevant.
- **Mandatory EcoDesign requirements** define the minimum baseline that applies across the organization and are set by GSO. They enter directly as system or product requirements, are measurable and are verified by GSO at the relevant stage-gate according to the V-model. Examples are eliminating specific materials from packaging in all products or measuring energy consumption according to defined scenarios (information requirements). As the mandatory EcoDesign requirements apply to all Health Systems BUs, they are presented in the handbook with their rationale, possible non-applicability, and recommendations for efficient evidencing.
- **EcoDesign guidelines** cover topics that are important but cannot be translated into measurable requirements across the wide range of products. An example is designing with sustainable materials, such as recycled or biobased plastics. Rather than being verified, guidelines are discussed during design reviews, where they support informed decision-making and make trade-offs explicit. Guidelines replace the previous "design effort requirements", which were optional and could get lost because they did not enter the actual requirement structure. Guidelines are included in the handbook with their rationale.

Moreover, the handbook is designed to provide actionable steps without overloading the reader with information, which was seen as a problem of the previous EcoDesign standard. The requirements are rewritten to better fit the terminology and phrasing used by engineers, as explained in Section 7.2.3 and shown in Confidential Appendix V. Evidence suggestions were added to align EcoDesign evidencing better with existing reporting practices (e.g. CSRD reporting through Windchill BoMs). Finally, each requirement has its own non-applicability criteria, for some requirements referring to an improvement plan when requirements are not met (as suggested in the workshop, Section 7.2.1). This allows BUs to evaluate the applicability of requirements themselves and fits Philips' decentralized operating model with BUs in the lead.



Figure 8.2: Impression of the EcoDesign in PDLM handbook

EcoDesign in PDLM



Define prerequisites

Define the predecessor product and standard product configuration early in Project Initiation. Use these as the baseline for all EcoDesign improvement assessments and ensure the configuration aligns with the CSRD reporting configuration in Windchill. Conduct a competitor benchmark on key EcoDesign indicators such as energy, weight, and packaging.



Align product-specific EcoDesign requirements

Engage with the product manager and sustainability engineer right after Project Initiation to identify product-specific sustainability user or business requirements. Translate these into clear, measurable system-level requirements according to the V-model.



Translate mandatory EcoDesign requirements

Assess the applicability of all mandatory EcoDesign requirements and translate them into BU-specific, measurable system requirements before the gate. Align with Group Sustainability to confirm correctness, completeness, and applicability of the translated requirements.



Review EcoDesign guidelines in design reviews

Actively review the EcoDesign guidelines during each design review, from concept through detailed design. Make trade-offs between EcoDesign, clinical performance, and cost explicit, discuss them with all relevant stakeholders, and document the rationale behind final design decisions.



Verify and document EcoDesign evidence

Start verifying EcoDesign requirements as early as possible and update evidence iteratively throughout the project. Prioritize energy, packaging, and circularity requirements before the gate, and ensure all requirements are fully evidenced and documented in WindChill before the gate for GSO to verify.



Prepare sustainability FAQ

Before product launch, develop a sustainability FAQ as the single source of truth for sales teams and tender responses. Create a mandatory EcoPassport, and consider preparing an Environmental Product Brochure, standardized MEPA tender answers, and Product Carbon Footprint information to support consistent customer communication.

Figure 8.3: Overview of the six steps in the EcoDesign in PDLM handbook.

8.3 Eco-Innovation starter package

The Eco-Innovation starter package operationalizes the second track of the framework. It consists of the EcoDesign Position Tool, which is used as a conversation starter in the Eco-Innovation workshop. Together, these components open up discussions on the more innovative side of EcoDesign and create momentum for a product sustainability roadmap.

The package is deliberately designed as a first trigger, rather than as a complete implementation of the Eco-Innovation track. Its main purpose is to create momentum towards a product sustainability or EcoDesign roadmap, as the design process showed that roadmaps are important for embedding new topics within Philips. More structured elements, such as roadmap templates, educational programs, or full process descriptions would become more useful once BUs are already engaging with Eco-Innovation. Therefore, the first step is to create awareness, engagement, and direction. In line with Monticelli and Zurlo (2026), the value of the package lies not only in the tool itself, but also in the interactions, negotiations, and learning it supports. More structured elements can therefore be developed later, as discussed in Section 10.4.

8.3.1 EcoDesign Position Tool

The EcoDesign Position Tool is an interactive dashboard that gives BUs a structured and visual overview of their EcoDesign position. Its purpose is not to support the technical embedding of EcoDesign in the product development process, but to start strategic discussions. The decision to build a tool followed from the workshop and stakeholder feedback (Section 7.2), suggesting that BUs first need to understand why EcoDesign matters, supported by specific product data.

Several formats were considered for presenting this information. A one-pager was not selected because the design phase indicated that product development teams focus on accurate, product-specific information rather than general insights. A pre-filled PowerPoint template was considered as a low-effort option, but would lead to just another PowerPoint, being less interactive and engaging. A web-based tool was therefore chosen, as it can present product-specific information in a more interactive format. The intended concept includes an AI-extraction layer that can extract the necessary information from documents that the user uploads. This layer was designed so that other BUs could use the tool independently, without GSO having to upload the data manually.

The tool is organized into five tabs. The first explains why EcoDesign matters for Philips, covering general topics such as the role of MEPA in sustainable procurement, upcoming regulations, and Philips' 2030 Impact Ambitions. The other four tabs each cover one EcoDesign focal area, presenting a competitor benchmark, customer and tender insights, a regulatory outlook, and broader environmental impact information. The tool is shown in Figure 8.4.

In its current form, the tool is an advanced prototype using sample data, instead of having a working AI layer. This was a deliberate scoping decision, allowing the tool’s perceived value to be assessed with end users before further technical development. For now, it is therefore recommended that the workshop facilitator prepares the relevant data before each Eco-Innovation workshop. Another limitation of the current tool is that the substances focal area is less developed than the others, as material data is more complex and the available information limited. However, this is less problematic because EcoDesign improvements in this area are mainly driven by regulatory developments, rather than by competitor performance or strong interest of customers in the healthcare industry (Ujaczki et al., 2022).

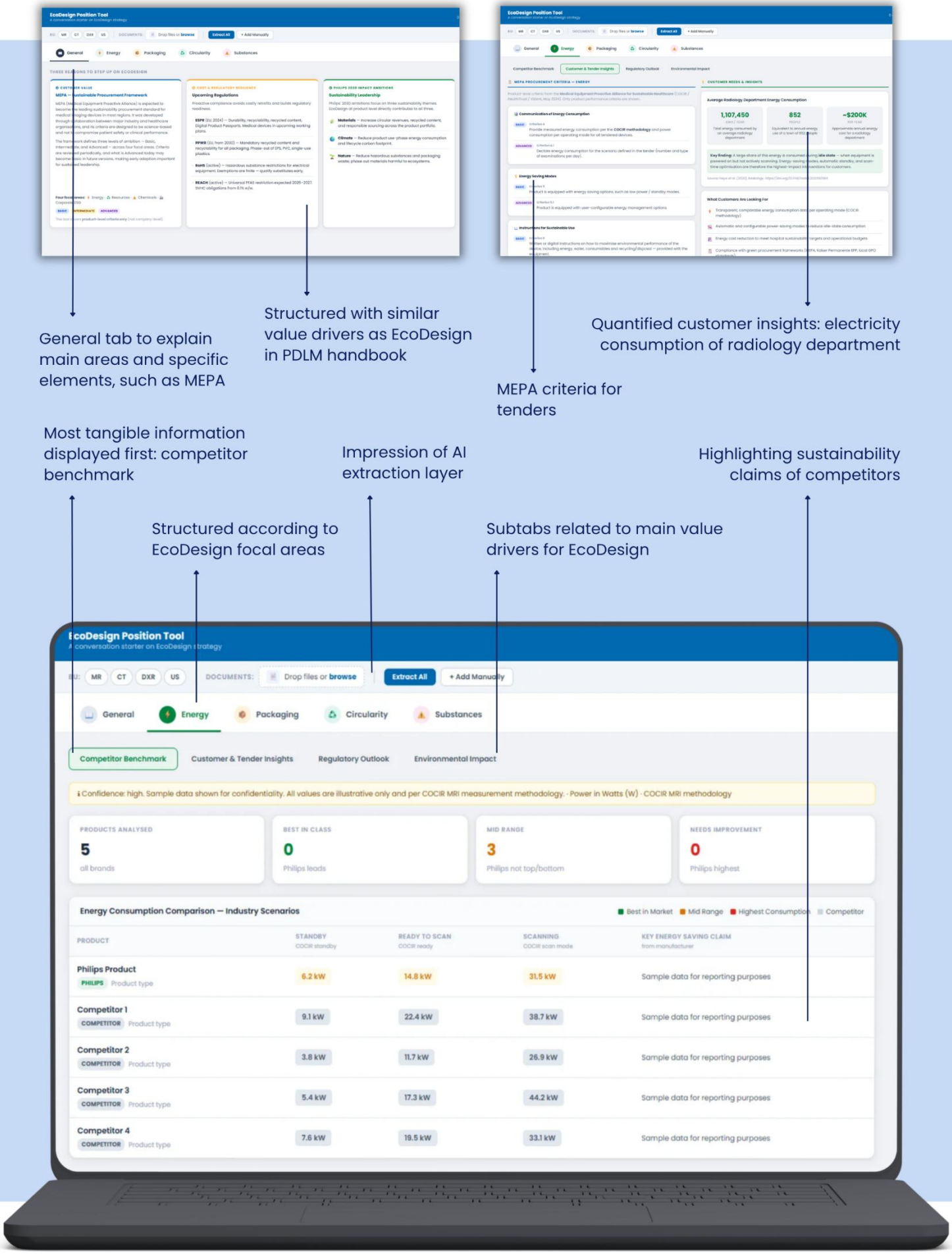


Figure 8.4: EcoDesign Position Tool.

8.3.2 Eco-Innovation workshop

The Eco-Innovation workshop is a structured 90-minute session that brings together product managers, sustainability/R&D/system engineers, designers, and business developers to discuss EcoDesign strategically for their product or portfolio. A workshop was chosen as a low-effort way to stimulate the cross-functional collaboration that was found to be largely absent in practice. As a facilitated rather than mandated intervention, it also fits Philips' decentralized operating model, in which BUs are in the lead and GSO has an enabling role. The workshop can also be implemented without new governance structures or formal approvals.

The workshop consists of five phases, detailed in Appendix K, and is preceded by the EcoDesign Position Tool as a pre-read. As part of the preparation, participants are also asked to identify EcoDesign "opportunities" for their BU. These are understood as concrete areas where the BU could improve its EcoDesign performance or use it more actively as a differentiator. Examples include reducing packaging weight, increasing recyclability by changing specific materials, or increasing energy efficiency through new components or software updates. Preparing these in advance maximizes discussion time within the session. The workshop can be held online in Miro or in person, and Figure 8.5 gives an impression of several workshop exercises.

The exercises are designed to help participants think beyond baseline EcoDesign and discuss what EcoDesign could mean for the positioning of their product. Several formats were explored, but a positioning matrix was chosen because it is simple to facilitate while still producing structured output. In the exercise, participants place the opportunities on two axes. The first axis, ranging from ‘license to operate’ to ‘competitive differentiator’, encourages participants to consider where EcoDesign could create value. The second axis captures the effort needed for each opportunity. This time-related dimension helps to relatively easily translate outcomes into a product sustainability roadmap.

A second exercise, the reality check, is included to keep the discussion grounded in reality. It asks participants to reflect on what would be needed to make the identified opportunities realistic, helping to prevent the session from becoming too idealistic or disconnected from implementation or technical challenges.

It is recommended that the workshop is facilitated by the respective BP from GSO for the BU, as this role combines sustainability expertise with knowledge of the BU’s products and portfolio. The facilitator should guide participants to think about opportunities in all quadrants in the matrix, so that the session does not only focus on low-effort improvements but also considers more strategic Eco-Innovation opportunities. A member of the GSO EcoDesign team should also be present to answer more detailed technical or methodological questions. As only discussing superficial sustainability opportunities is a risk of the current workshop, GSO participants should steer the workshop to actual radical EcoDesign projects and avoid greenwashing at all times.

As the workshop is intended as a starting point for the Eco-Innovation track, it should end with clear follow-up actions and next steps, as already included in the workshop template. The BP should monitor these actions and work with preferably the product manager to maintain momentum towards a product sustainability roadmap, helping to further embed the Eco-Innovation track within the BU.

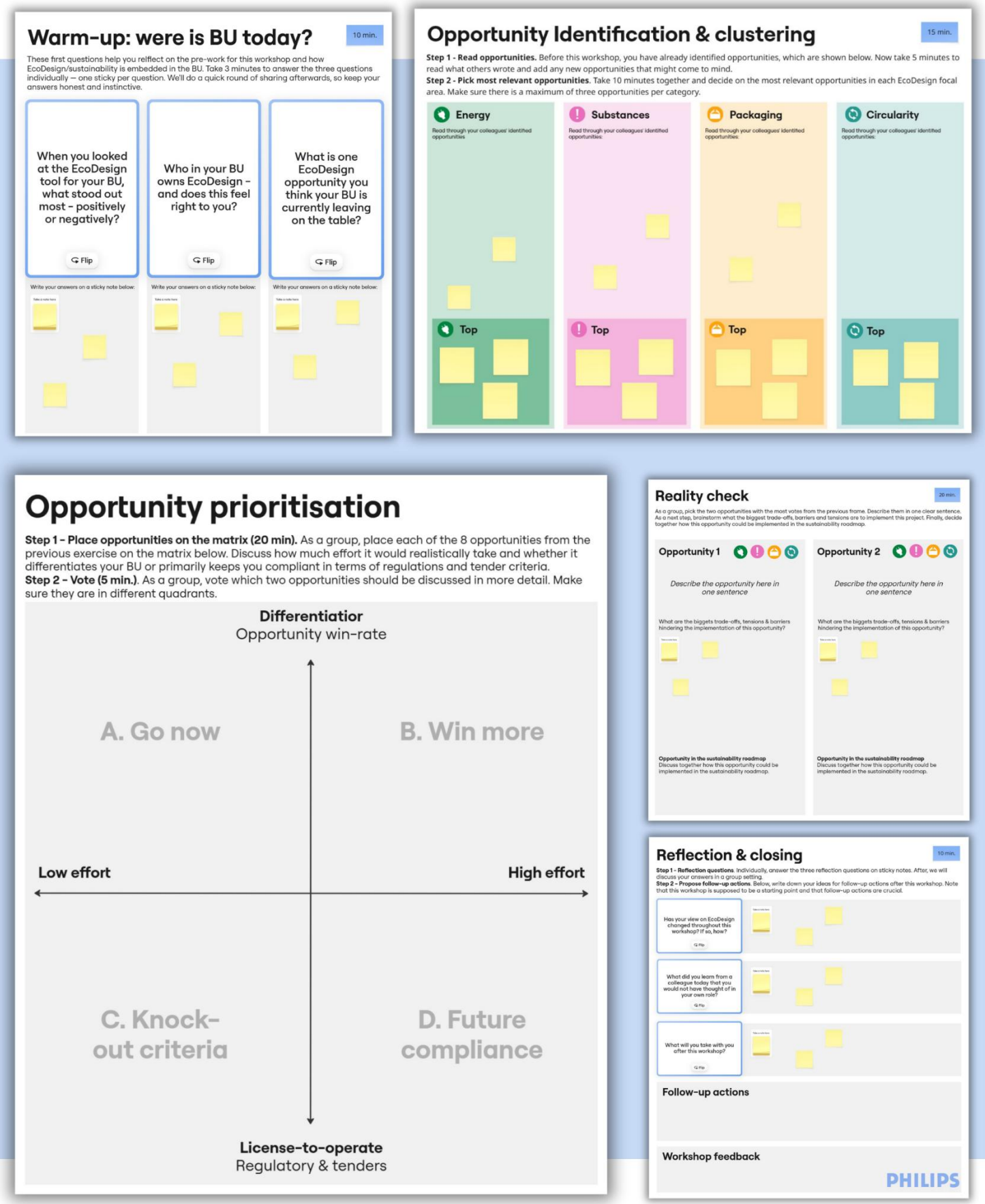


Figure 8.5: Strategic Eco-Innovation workshop templates.

9. Validation

This chapter presents the validation of the design solutions, conducted in two stages. First, the overall framework and deliverables were validated within GSO (Section 9.1), as internal alignment was a precondition before formally involving the BUs. Second, the design interventions of both tracks were validated with BU stakeholders (Section 9.2).

9.1 Group Sustainability validation

The validation within GSO took place in two sessions. The design solutions were first presented formally to the GSO Management Team, including Philips' Global Head of Sustainability, and later to the wider GSO department, including BPs. Since the most important GSO stakeholders had already been closely involved in co-creating the solutions, these sessions mainly served to confirm internal alignment and obtain approval to validate the solutions with the BUs.

In the Management Team presentation, the proposed framework and design solutions were presented, with a focus on the differences compared to the current EcoDesign standard and way of working. The response confirmed support for the distinction between the two EcoDesign tracks and gave approval to test the handbook with the BUs and pilot the Eco-Innovation workshop within the one BU. This BU was considered a suitable pilot, as a successful application there could create a concrete example for other BUs to follow.

The discussion also helped place baseline EcoDesign in a broader strategic context. Investor expectations were mentioned as an additional financial argument, particularly because Philips reports externally on several metrics related to EcoDesigned products. This can create expectations around, for example, the share of revenue from these products and the level of sustainability-related innovation spend. The link with Philips' sustainability innovation bonds reinforces this point (Philips, 2026a). This higher-level perspective is relevant for the BUs, as it strengthens the case for having a clear set of baseline requirements by showing how EcoDesign can also function as an indirect financial value driver. This can be added to the start of the EcoDesign in PDLM handbook, where the value of EcoDesign is explained.

The research findings and design solutions were then presented to the wider GSO department. In this session, the EcoDesign Position Tool generated particular interest and revealed a broader use than initially intended. While it was designed to support strategic conversations within BUs, GSO stakeholders noted that the tool could also support GSO in its role as a central organizational body. By making sustainability performance more tangible and easier to understand, it could help GSO show the value of sustainability and strengthen its role as an enabling function for the BUs. One participant also suggested that sales teams might benefit from these insights. However, this use case requires very reliable underlying data.

9.2 Business Unit validation

After endorsement from GSO, both EcoDesign tracks were separately validated with stakeholders from the BUs. The EcoDesign in PDLM handbook, including the updated requirements, was evaluated with system and sustainability engineers, as described in Section 9.2.1. The Eco-Innovation starter package was piloted with one specific BU (Section 9.2.2).

9.2.1 EcoDesign in PDLM handbook

The EcoDesign in PDLM handbook was validated through a feedback form and two follow-up online Q&A sessions. The form was shared together with the handbook in advance and asked respondents to reflect on the overall approach, the format of the handbook, and the clarity and feasibility of the requirements in practice. Respondents were also asked to compare the handbook with the current EcoDesign standard. The Q&A sessions were then used to discuss the feedback in more detail. In total, ten responses were received from sustainability engineers and system engineers across different BUs.

All respondents considered the handbook, including the revised requirements, a clear improvement over the current standard. The revised structure of the requirements was received particularly positively. It was mentioned that the requirements better fit "*the way requirements are written within Philips BUs*" and that this makes it "*easy to absorb and implement the provided information*". The choice to include a separate rationale, applicability description, and exemption rule for each requirement was also valued. Sustainability engineers especially appreciated that the handbook starts with the rationale for why EcoDesign matters, as this could help them position sustainability more clearly within their BUs.

A central point of discussion was the need for more guidance on requirement exemptions. The handbook allows requirements to be non-applicable when a good rationale is provided, for example because of safety reasons or regulatory constraints. For example, some medical equipment cannot have a power-save mode because of patient safety. While this principle was understood, the Q&A sessions showed that exemptions need clearer evidence rules to remain auditable. Follow-up work should therefore define templates or standard criteria for when an argument is strong enough to make a requirement non-applicable. In that sense, it can be seen as a simple and practical form of the trade-off logic identified as important in the literature review (Watz & Hallstedt, 2022), applied specifically to baseline EcoDesign requirements.

A second set of feedback concerned what is needed to turn the handbook into an official Philips standard. It was noted that EcoDesign experts should not be named in the document, as role changes may otherwise require frequent updates to the standard. Respondents also requested an acronym table and glossary. Besides improving usability, this glossary would help address another issue raised in the feedback: BUs sometimes use different terms for the same concept, such as "system" and "product". A glossary could explain alignment in terminology to make the handbook directly relevant to a wide range of BUs.

Finally, participants raised practical feedback on several individual requirements, explained in Confidential Appendix VI. These topics require further co-creation with BU stakeholders to ensure that the requirements remain clear, auditable and feasible in practice.

9.2.2 Eco-Innovation starter package

The Eco-Innovation starter package was piloted in one session with a specific BU in June 2026. The session involved five participants from different roles: a designer, a system engineer, a sustainability engineer, and two product managers. On average, they had around sixteen years of experience within Philips. For this pilot, the session was facilitated by the researcher, with the GSO BP and an EcoDesign expert present. Due to confidentiality, this section only presents the general findings and participants' perceptions of the EcoDesign Position Tool and workshop format. Some more content-related findings are shown in Confidential Appendix VI.

The EcoDesign Position Tool worked well as a starting point for the conversation. The competitor benchmark in particular triggered valuable discussions, as it made sustainability performance more tangible and easier to compare. The session confirmed that one focal area remains a priority. At the same time, the tool helped surface the importance of other topics, such as packaging: although its contribution to the total environmental impact is limited, the workshop discussion highlighted that it is an important topic for customers. For the tool, several participants questioned where the underlying data came from. This shows that the tool needs to make its data sources more transparent for future use.

More broadly, the workshop opened up a strategic conversation about EcoDesign that does not usually take place in this form. Participants valued discussing EcoDesign with a multi-disciplinary group of stakeholders, rather than keeping the topic mainly within a small group of EcoDesign experts. The workshop helped connect different perspectives and formed a first step towards a product sustainability roadmap. At the same time, the pilot showed that the workshop format was too much for the time available. There was not enough time to work through the exercises in a structured way, and the "reality check" exercise had to be skipped. This suggests that the workshop should be longer or simplified.

The pilot produced several further recommendations:

- The data in the tool should be made as quantitative as possible. Where possible, insights should be linked to the customer's Total Cost of Ownership and operational benefits for the customer.
- A customer-facing participant should be included in the session, such as a sales or service engineer. This would help bring in what customers ask for, struggle with, and value in practice. The GSO Customer First team could also contribute with insights here, given its consultancy work with hospitals and hospital case studies on sustainability.
- Multiple workshops should be run within a single BU where relevant. Since each session focuses on one product development team, BUs with multiple systems may need separate workshops to develop product-level EcoDesign roadmaps for each relevant system.

10. Discussion

This chapter discusses the project's findings and outcomes. Section 10.1 reflects on the main insights from the research and design phases in relation to existing literature. The chapter then presents the project's contributions and limitations, and closes with recommendations for future research and for Philips.

10.1 Findings in relation to the literature

A first observation is that the implementation challenges identified at Philips align closely with frequently identified challenges in the literature. Process integration and collaboration are often found to be difficult, but essential for successful EcoDesign implementation (Dekoninck et al., 2016). Similar problems are seen within Philips, where EcoDesign is integrated too late and cross-functional collaboration remains limited. In contrast, knowledge and operational EcoDesign tools appeared to be less central barriers, both in the literature and in this research (Dekoninck et al., 2016). Beyond confirming these factors, this thesis places emphasis on the alignment between strategic, tactical and operational levels of implementation, following the EcoDesign Transition Framework of Brones et al. (2021) and findings of Watz & Hallstedt (2022).

Second, acknowledging the three different forms of EcoDesign helps to explain several of the tensions in EcoDesign implementation literature (Section 3.4). First, baseline EcoDesign aligns well with the need for clear roles, responsibilities and explicit knowledge, such as checklists and requirements (Watz & Hallstedt, 2022), as its main goal is verification and documentation. In contrast, more innovative forms of EcoDesign benefit from cross-functional collaboration and the tacit knowledge emerging from it (Brones et al., 2021; Dekoninck et al., 2016).

The second tension, around tools, can be explained in a similar way. Vicente and Camocho (2024) found that the level of innovation targeted by a tool, ranging from incremental redesign to disruptive new solutions, is one of the most important criteria designers consider when classifying and selecting EcoDesign tools. This suggests that the most suitable tool depends on the type of EcoDesign being addressed. Baseline EcoDesign could benefit from checklists, as the focus is on verification (Buchert et al., 2015). On the other hand, innovation and product improvements are specifically mentioned as drivers for the use of more advanced tools such as LCAs (Hjellvik & Kirkels, 2025). It is argued that more advanced tools are needed to assess whether larger investments are justified by their environmental impact, and to help prioritize the projects with the greatest potential. For example, LCAs can show whether improvement efforts should focus on energy consumption during the use phase or material impacts at end-of-life.

The final tension, about how requirements are formulated, can also be explained by the different forms of EcoDesign and directly links to the two tracks of the designed framework. Concrete and measurable requirements, written in engineering language, fit the EcoDesign in PDLM track, particularly for baseline and incremental EcoDesign (Baldassarre et al., 2020). More innovative EcoDesign approaches may benefit from strategic requirements, such as company-wide carbon reduction targets, because these leave more room for different design solutions (Vicente & Camocho, 2024; Watz & Hallstedt, 2022). From this perspective, Philips' 2030 Impact Ambitions could be included in the EcoDesign Position Tool as an example of a strategic target that provides direction while still allowing room for creativity.

10.2 Contributions

This section discusses the main contributions of this project, split between theoretical and practical contributions.

10.2.1 Theoretical contributions

The main theoretical contribution of this thesis is that it views the different forms of EcoDesign as complementary instead of as levels of maturity, as is common in the existing literature (see Figure 10.1). Pigosso et al. (2013) frame EcoDesign implementation as a sequence of evolution levels, with Evolution level 2 focusing on incremental improvements and Evolution level 5 specifically on "*system innovation, through the development of new products and services that require changes in its business models and infrastructure*" (Pigosso et al., 2013, p. 165). Watz and Hallstedt (2022) similarly order EcoDesign implementation into ascending profiles, from compliance to systematic, ambitious, and strategic. Most models in the literature are therefore stepwise, treating compliance or baseline EcoDesign as an early stage to be moved beyond. The approach designed for Philips in this project instead pushes for a complementary view, in which baseline and more innovative forms of EcoDesign are done in parallel. Philips should continue to meet basic customer criteria and improve reporting of products, while simultaneously innovating products to improve their environmental performance. It can be argued that this complementary view is driven by recent developments such as increasing regulation and sustainable procurement practices, causing it to be increasingly important and complex for organizations to deliver complete and accurate information to regulators and customers.



Figure 10.1: Visualization of the central contribution of the thesis.

On a theoretical level, the findings also contribute to the literature on EcoDesign implementation by extending the conceptual model of Dekoninck et al. (2016), as described in Section 3.2. Organizing the themes in strategic, tactical, and operational levels, the model proved to be a useful analytical lens for structuring the challenges encountered in a large organizational context. The findings at Philips also resemble the challenges identified by Dekoninck et al. (2016), suggesting that these barriers can persist over time, even in an organization with a long history of EcoDesign. This thesis extends the model by arguing that different forms of EcoDesign require different manifestations and relative importance of the six implementation themes.

Third, this research offers an in-depth view of EcoDesign implementation in a mature organization. Existing research often studies multiple organizations and structures the findings into broader models (Dekoninck et al., 2016; Delaney & Liu, 2024; Kara et al., 2014; Pigosso et al., 2013; Rodrigues et al., 2017; Vilochani et al., 2024b; Watz & Hallstedt, 2022). Other related studies focus on EcoDesign implementation in specific industries (Poulikidou et al., 2014; Schöggl et al., 2023). Dekoninck et al. (2016) note that little is known about companies with longer EcoDesign experience, partly because they are often reluctant to share details for competitive reasons. In addition, Horn et al. (2023) emphasize that limited case-studies exist of companies having implemented EcoDesign systematically. Within the limits of confidentiality, this study

partially addresses that gap by studying EcoDesign implementation in depth within one organization that has already moved beyond initial adoption.

Finally, this research contributes by showing how conceptual and empirical insights on EcoDesign implementation can be translated into an organization-wide implementation approach. All practical design outputs of this project are part of a broader approach that connects EcoDesign to processes, organizational structures and roles. This responds to calls by Faludi et al. (2020) and Vilochani et al. (2024b) to move beyond isolated tool creation and towards better integration of EcoDesign in organizational practice. Therefore, this thesis provides a concrete example for researchers and organizations seeking to improve EcoDesign implementation.

10.2.2 Practical contributions

First, the empirical research offers an evidence-based understanding of how EcoDesign is currently implemented across roles and BUs at Philips. At the start of the project, there was no structured overview of the main challenges, and internal discussions were often shaped by individual assumptions and perspectives. By conducting interviews across different roles and BUs, this research gives Philips a clearer view of where EcoDesign works well and where it remains difficult.

Second, when properly implemented, the new EcoDesign framework and design solutions can provide multiple practical benefits. Aligning the EcoDesign requirements in the handbook with the MEPA criteria can create value by improving Philips' ability to answer sustainability-related tender questions. The framework can also improve operational efficiency by reducing ambiguity and connecting EcoDesign evidence processes to existing reporting practices, linking to the disciplined execution pillar in Philips' strategy. Finally, the solutions support environmental improvement and can contribute to Philips' 2030 Impact Ambitions, especially through the Eco-Innovation track. By using the tool and workshop as input for product sustainability roadmaps, EcoDesign can become a planned part of product strategy, rather than an add-on that risks being deprioritized during projects.

Beyond the specific theoretical and practical contributions, the project itself shows the value of close education-industry collaboration, as advocated by Faludi et al. (2020). The connections established during this project create a basis for follow-up work, including future thesis projects or internships, potentially building on the directions described in Section 10.4.

10.3 Limitations

This research is conducted as a single case study within Philips, focusing specifically on the Health Systems BUs. As discussed in the previous section, this case-based approach is one of the contributions of the study, providing more in-depth insights into EcoDesign implementation. However, as the solutions are strongly tailored to Philips' specific context, including PDLM and I2M processes and the decentralized operating model, they cannot directly be generalized to other organizations or contexts.

A second set of limitations follows from the qualitative methodology. The research relies primarily on semi-structured interviews, which are based on subjective insights instead of objective measurements. The sampling also introduces limitations, as participants were selected because of their relevance to EcoDesign. This means that informed perspectives may be overrepresented, while resistance, lack of awareness, or competing priorities may be less visible, especially because crucial senior leadership was only represented to a limited extent (Vilochani et al., 2025). Finally, the analysis involves researcher interpretation, reinforced by the researcher's position within GSO. Due to confidentiality, findings had to be presented at an aggregated level

without direct quotations, reducing the transparency of the underlying evidence. Reflexivity and iterative feedback sessions reduced some of this bias, but some bias always remains.

The two-track framework presented in Chapter 8 also has limitations in terms of its practical implementation. During the design phase, it is chosen to focus on the most pressing challenges identified by interview participants, such as improving collaboration and adding the rationale behind EcoDesign requirements. However, a theme as leadership is underrepresented given its importance in the literature (Schäfer & Löwer, 2021). The effectiveness of the designed solutions still depends on BUs actively choosing to engage with them, and thus BU leadership support.

Additionally, the developed approach provides limited guidance on dealing with trade-offs, even though these were identified as central challenges in both the literature and empirical research (Monticelli & Zurlo, 2026; Vilochani et al., 2025). The handbook encourages teams to make trade-offs explicit and supports decision-making by explaining the rationale behind requirements. However, teams still need to interpret and negotiate these trade-offs within their own context. This may lead to inconsistencies in how sustainability is prioritized across projects and BUs.

Another point concerns the decision to develop a new tool. The literature argues that the EcoDesign field should move beyond tool creation towards integrating methods into workflows, organizational structures, and decision-making (Faludi et al., 2020; Vilochani et al., 2024b). From a critical perspective, the EcoDesign Position Tool and workshop could be seen as adding to an already broad toolkit. However, the main purpose is not to support EcoDesign decisions in technical product development, but to help prioritize EcoDesign at a strategic level and create momentum for product sustainability roadmaps. In this sense, the Eco-Innovation starter package aligns with design research from Monticelli & Zurlo (2026) who argue that EcoDesign becomes organizationally meaningful not only through the tools themselves, but through the interactions, negotiations, and learning dynamics they activate. Nevertheless, BUs might not see it this way and consider it simply as an additional tool or process.

A further limitation is that the study focuses mainly on the structural and process side of EcoDesign implementation, while the human and behavioral dimensions are less developed. The literature suggests that this “soft” side of EcoDesign implementation is important and often underdeveloped (Brones et al., 2016; Brones et al., 2021; Dekoninck et al., 2016). Although the interviews with different stakeholders provided more personal insights, the use of the conceptual model as the main analytical framework directed this thesis primarily towards themes such as structures, processes, knowledge, and requirements.

Moreover, stakeholder groups were simplified into distinct roles, such as R&D engineers and product managers. In practice, however, roles and responsibilities differ across BUs, and may be distributed across multiple functions or individuals. Product development processes also vary in their exact implementation. While the simplifications support the clarity of the proposed solutions, they may not fully capture the complexity of Philips’ organizational reality. These limitations should therefore be considered when rolling out the new approach. For example, follow-up sessions or Q&A moments could be used to discuss how the proposed solutions apply to specific BU contexts. The deliverables should also remain adaptable, allowing GSO Business Partners to modify elements, such as the Strategic Eco-Innovation workshop, where needed.

Validation of the developed approach and design solutions was primarily conducted through workshops and feedback sessions with potential users. As such, validation was based on the perceived clarity and feasibility, instead of on the actual usage and impact within projects. For example, the handbook was not tested within a full PDLM project with real project conditions, such as time constraints, competing priorities, and stakeholder dynamics.

10.4 Recommendations

This section presents a set of recommendations beyond the validation presented in Chapter 9.

10.4.1 Recommendations for future research

Future research could build on the conceptual contributions of this study by further validating and refining the conceptual model (Figure 6.4). At the moment, the identified EcoDesign forms emerged from a single case study and a limited number of external interviews. Also, the link between the six implementation themes and the three EcoDesign forms is primarily interpretive. Further research is needed to make more explicit how the relative importance and manifestation of the six themes in the conceptual model differ across the three forms. This could support the development of more prescriptive materials, such as assessment tools, implementation frameworks, or EcoDesign implementation stress-tests, helping organizations identify which form of EcoDesign they are pursuing and what implementation approach is most suitable.

A second important direction is the development of approaches that support trade-off decision-making in EcoDesign. This thesis highlights that trade-offs are central to implementation challenges in practice. Future research could examine how such trade-offs are currently made in engineering and product development contexts and develop frameworks or tools that support more consistent and transparent decision-making. This should include trade-offs for specific product decisions, as well as strategic-level trade-offs, where organizations need to prioritize between different EcoDesign opportunities, projects, and objectives. This would further support the type of decision-making needed for the Eco-Innovation track. When building further on this topic, it is important to consider the organizational embedding of solutions, as done in this thesis.

Further research is also recommended into the behavioral and cultural dimensions of EcoDesign implementation, examining how motivation, incentives, ownership, and organizational culture shape EcoDesign implementation in practice. This could be studied within a single organization or across multiple, with attention to differences in perceptions and attitudes between various roles or stakeholder groups.

10.4.2 Practical recommendations for Philips

First, it is recommended to strengthen the strategic positioning of EcoDesign within Philips by making it more value-driven. Currently, EcoDesign can be perceived as an internal compliance topic. For example, Philips could consider renaming the EcoDesign focal areas towards more value-based terminology. In addition, the feedback loop from tender and customer requirements to product development and innovation teams should be strengthened. While Philips already has a sustainability tender support desk, its current role is mainly to help sales teams find the right information. In the short term, this desk could systematically collect recurring sustainability tender insights and share them also with R&D teams (e.g. through the EcoDesign Position Tool). In the longer term, sales teams should bring these insights more directly into earlier product development phases. Figure 10.2 visualizes how these feedback loops could be structured.

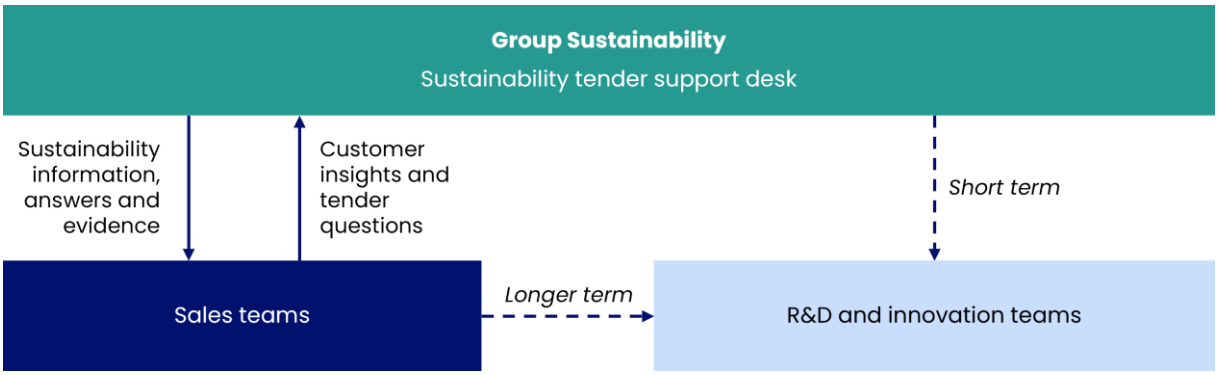


Figure 10.2: Suggested feedback loops for sustainability customer insights.

Second, it is recommended to further develop the Eco-Innovation track. Currently, the EcoDesign Position Tool and Eco-Innovation workshop mainly function as triggers to create a product sustainability roadmap. To strengthen this track, GSO could provide standardized product sustainability or EcoDesign roadmap templates and offer more guidance on how EcoDesign can be embedded in AD and VPC processes. The ongoing pilot, as described in Chapter 9, can be used as a research-through-design process to test, learn, and iteratively improve how GSO supports BUs in this track.

Finally, Philips should critically discuss the future role and governance of the EcoDesign Position Tool. As described in Chapter 9, the tool was considered relevant for starting strategic conversations at BU-level. It was also seen as valuable for GSO, as it could help position the importance of EcoDesign when working with BUs. However, in its current form, the tool would require significant development and maintenance before it can be used more broadly, for example by ensuring that the AI extraction works reliably and by building the tool within the right digital infrastructure. Before deciding on the tool's future, Philips is recommended to continue testing it and explore whether it can serve additional purposes, for example by supporting sales teams in communicating the sustainability value of Philips products. Based on these insights, Philips has two main options:

- Develop the tool into a more formal organization-wide solution. This would require integration with relevant internal systems, such as sales insights from Salesforce and real-time environmental reporting data from platforms such as Windchill. It would also require clear ownership and governance, making sure the tool works consistently and accurately.
- Keep the tool as a lightweight support tool. In this case, it would stay close to its original purpose: preparation for the Eco-Innovation workshop. The facilitating BP could manually update the tool before each workshop. If this is considered too complex, the content could also be translated into a PowerPoint template, although this would reduce the interactive character and desirability.

11. Conclusion

This chapter concludes the project by answering the research and design sub-questions posed in the introduction, followed by the answer to the main research question.

SQ1. What success factors and barriers influence the implementation of EcoDesign within product development processes in organizations?
The first sub-question is answered through the structured literature review in Chapter 3, which extends the framework of Dekoninck et al. (2016). Six themes are identified that together capture the organizational and managerial factors influencing EcoDesign implementation, organized across strategic, tactical, and operational levels. At the strategic level, leadership and strategic alignment are important. At the tactical level, organizational structure and collaboration and the formal integration of EcoDesign into the product development process determine whether EcoDesign can be effectively coordinated in practice. At the operational level, knowledge, tools and methods, and requirement-specific factors explain the practical reality of EcoDesign. An overview of the complete set of factors is presented in Figure 3.4.

SQ2. How do the success factors and barriers identified in the literature manifest themselves in the context of Philips?
The empirical research, consisting of twenty-six semi-structured interviews across four internal stakeholder groups and four external organizations, shows that three challenges consistently arise. First, EcoDesign is integrated too late, both within PDLM projects and within the broader innovation process. Second, some EcoDesign requirements are written ambigiously, lack an explicit rationale, and do not fit the systems engineering V-model. Third, formalized cross-functional collaboration on EcoDesign is limited. In addition to confirming the relevance of the six themes, the empirical research also generated another important insight: EcoDesign takes different forms in practice, ranging from baseline to incremental improvement to radical innovation, each requiring different implementation approaches.

SQ3. How can the identified organizational barriers and success factors be translated into an improved EcoDesign implementation framework for Philips?
The third sub-question is answered through the two-track EcoDesign framework presented in Chapter 8. The first track, EcoDesign in PDLM, organizes baseline and incremental EcoDesign within PDLM through structured requirements and guidelines, targeting engineers responsible for translating EcoDesign into concrete product decisions. The second track, Eco-Innovation, steers larger incremental improvements and radical EcoDesign through product sustainability roadmaps, targeting product managers and increased cross-functional collaboration. Together, the two tracks form a complementary approach where strategic objectives of EcoDesign are better aligned with their tactical coordination and operational reality.

SQ4. What types of design interventions can support the operational integration of this EcoDesign implementation framework?
The fourth sub-question is answered through three concrete design deliverables presented in Chapter 8. The EcoDesign in PDLM handbook guides engineers through a structured six-step process for embedding EcoDesign in PDLM projects, including revised requirements with explicit rationale, applicability rules, and evidence guidance. To activate Eco-Innovation, a starter package was developed consisting of the EcoDesign Position Tool and the Strategic Eco-Innovation workshop. Together, these deliverables should help product development teams to

collaborate and see the value of EcoDesign more. The validation in Chapter 9 shows that the interventions help to support the new framework and are considered an improvement compared to previous approaches, but need further refinement to be implemented on a larger scale.

Main research question: How can the implementation of EcoDesign within product development processes be improved in the context of a large organization like Philips?
The main research question is answered by combining the research findings and design outcomes of this project. Improving EcoDesign implementation in a large organization requires recognizing that different forms of EcoDesign demand different organizational implementation approaches, and that a single implementation approach is insufficient. For Philips, this means creating two complementary tracks, one focused on the EcoDesign baseline for new product introductions, another on more innovative approaches. The revised framework and design deliverables developed in this project operationalize these tracks in the Philips context. In doing so, this thesis shows how EcoDesign implementation in a mature organization can move beyond a single process or tool, towards complementary approaches that support both baseline requirements and innovation.

12. Personal reflection

This reflection discusses the main personal lessons and insights I gained during the project. It also indirectly reflects on the personal learning ambitions that were set at the start of the project (Appendix B). The reflection is structured around three themes: process and deliverables, independence and collaboration, and sustainability in a corporation.

12.1 Process and deliverables

Reflecting on the process from start to finish, the hardest moment for me was the transition from the research phase into the design phase. The main struggle was that I went into the details of the specific EcoDesign requirements quite rapidly, while I realized later that the framework I needed to develop had to be broader than that. What helped was going back to the interview findings and creating a clear overview of the most important insights per stakeholder group and per element in the conceptual model. Looking back, this connects to how I work more generally. I am results-oriented and I like to keep pace, which usually works well. However, at this moment in the project it meant that I started producing deliverables too soon, before the underlying thinking had settled.

At the same time, this project taught me that creating something is often what makes a conversation productive. Putting a first prototype on the table, like a first sketch I made for the EcoDesign Positioning Tool, helped to validate ideas and surface assumptions, including the wrong ones, far more effectively than an open question. The main lesson for me is therefore not to slow down and produce less, but to be more deliberate about what I produce and when. Purposefully creating low-fidelity conversation starters, rather than envisioning the final product from the start of the design phase, is one of the most useful takeaways from this project.

A related theme is the constant choice between zooming in and zooming out. EcoDesign is a complex topic and engagements with experts often went in depth quickly. At the same time, the scope of this project was primarily organizational and on a more systems thinking level. Therefore, I had to continuously decide when to zoom in on the details and when to zoom out and look at the broader picture. The same applied to working with BUs. Solutions had to be generalizable across BUs, but BUs differ significantly in maturity and ways of working, so addressing all of them at once would have made the problem unmanageable. Learning when to focus on a specific BU and when to consider the organization as a whole was a true skill I developed during this project.

12.2 Independence and collaboration

One of my goals at the start of this project was to learn how to run a large project on my own, after a master's program full of group work. I learned throughout the project that I am quite comfortable doing this. It really helped that I consider myself a generalist, and that I could keep the pace I wanted throughout the whole project.

At the same time, I learned that working independently is not the same as working alone in a graduation project. I realized that it is more about ownership over the project: taking initiative, deciding what needs to happen next, and actively reaching out to the people who can help, both in the research and design phases. A large share of the progress I made came from conversations such as the interviews, informal exchanges with Philips colleagues and discussions with other

students about their own projects. New opportunities or directions often came up in these conversations, and they helped me become more confident in choices I had already made.

Collaborating also allowed me to learn a lot, especially because of the diverse range of people I worked with. This ranged from colleagues with 30+ years of experience to people just starting, from marketing and product management to engineering and audit, and across different cultural and academic backgrounds. The interviews with external organizations added another valuable layer, giving me a view of how sustainability is approached in different contexts. Across all of these conversations, I developed a better sense of how people think and what drives them, which is something I will be able to anticipate better in future situations.

One thing I noticed across these collaborations is that people often assume that others share their context. Especially at the start, this made collaborating with colleagues intense and challenging. For example, it was often assumed that I was familiar with internal abbreviations or with what different substances in products actually were, such as Halogenated Flame Retardants. I believe this same assumption is part of the reason why BUs encounter challenges with EcoDesign at Philips. As someone new to the organization, I had to ask basic questions, and those often turned out to be the useful ones. Working with the diverse range of people also ties back to the designed solutions and I realized by collaborating that collaboration between roles is part of the solution to better implement EcoDesign.

12.3 Sustainability in a large organization

One of the bigger insights I take with me is that sustainability is often also an organizational problem, not only a technical one. This was true for EcoDesign, but I noticed it more broadly during my time in GSO, where I got exposure to topics such as sustainability reporting and circular business models. I often saw that making sustainability work in practice depends heavily on how the organization is set up and decisions are made. Therefore, I also realized that working on sustainability topics requires not only technical knowledge, but also the right soft skills.

A related observation is that sustainability professionals often want to do a lot and are very ambitious in making a positive impact. For example, throughout this project I noticed that everyone wanted to add new EcoDesign requirements and that colleagues were often working on multiple projects at the same time. However, I realized that, to actually make a positive environmental impact, sometimes you just need to make decisions and focus. Trying to do everything at once usually means that nothing lands properly in the organization.

This shift in how I see sustainability in large organizations has also changed how I think about my own career. Starting this project, I was focused on finding a job specifically in sustainability or ESG after graduating. After this project, I see it differently. I believe that I can move into sustainability roles at a later stage in my career as well, and that building broader experience in business or strategy first can be a strong foundation to have impact in sustainability later on.

12.4 Closing

Looking back, this project has provided me with a very steep learning curve, both professionally and personally. I learned a lot about EcoDesign, large organizations and myself. I am grateful that I got the opportunity to do this project within Philips, an organization with a strong positioning on sustainability and a true ambition to keep improving on it. What made it especially valuable was that the project was set in such a real-world environment, with practical implications that will actually shape how Philips approaches EcoDesign going forward. I am leaving this project with more clarity about how I want to work, what I want to contribute, and where sustainability fits into that, and I am looking forward to taking those lessons into whatever comes next.

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Appendices

A. AI-statement

Artificial intelligence tools (ChatGPT, Claude, and Microsoft Copilot) were used throughout this graduation project to support and accelerate the work. All information generated with the help of AI was verified and prompted by me, and I take full responsibility for the content, contributions, and findings of this report. Below, the most relevant use-cases of AI are described in more detail:

- **Writing**: AI was used to structure chapters, improve writing in style, grammar, and spelling, and to summarize or shorten texts I had already written. Every section of the report was reviewed and revised by me, and the final text reflects my own judgment and choices.
- **Literature review**: As mentioned in Chapter 3, ResearchRabbit was used for citation-based snowballing to identify relevant academic papers, which were checked by me before actual inclusion. AI was also used to summarize papers before reading them in full, to speed up the screening and analysis process. All references were verified manually to confirm that they correspond to real publications and accurately reflect the cited content.
- **Transcription**: Audio recordings of interviews were transcribed using Microsoft Copilot, as approved by Philips for this purpose.
- **Illustrations**: ChatGPT was used to generate images the images/icons in the EcoDesign in PDLM handbook based on own prompts and sketch input.
- **EcoDesign Position tool:** The tool was developed in co-creation with Claude (Anthropic) based on my own input and prompts. I specified the structure, layout, and functional design through low-fidelity prototypes and written prompts, and Claude generated the underlying code to quickly arrive at a working prototype.
- **Feedback & brainstorming:** Throughout the project, several AI-tools were used to get feedback on ideas, pressure-test design choices, and brainstorm.

B. Project brief

Project Proposal form

IDE Master Graduation Project

In this proposal the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document needs to be prepared for the Kick-off meeting and should be submitted in MyCase.

Name student Tobias Rumphorst **Student number** 5079454

Project title Future-proofing EcoDesign requirements at Philips

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

MSc programme ☐ Design for Interaction ☐ Integrated Product Design ☑ Strategic Product Design

☐ Other *(in case of a double degree outside IDE):*

Introduction

Describe the context of your project in the box below; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

The project is situated within Philips, a global health-technology company focused on improving people's health and well-being through meaningful innovtion. Philips develops and delivers medical systems, devices, professional healthcare solutions worldwide.

Within this setting, the project revolves around Philips' EcoDesign requirements. EcoDesign refers to the structured integration of environmental considerations, such as energy and material use, circularity, etc., into product development decisions across the product life cycle. Philips currently works with a set of EcoDesign requirements that product development teams must apply and evidence for PDLM (Product Development, Launch, Maintain) projects. This specific graduation project will primarily focus on the health systems (professional/B2B) segment at Philips.

The main stakeholders are Philips Group Sustainability, which defines and maintains the EcoDesign requirements, and the product development teams of the various Business Units, that work with these requirements. Additional stakeholder interests include customers (e.g. hospitals and healthcare providers), who increasingly demand sustainable products, and Philips at large (e.g. compliance officers), which relies on EcoDesign to support regulatory readiness and compliance, competitiveness for its products in tenders, and long-term resilience.

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TU Delft | Industrial Design Engineering

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice. (max 200 words)

The main problem lies in how EcoDesign requirements are currently dealt with by the BUs. Product development teams encounter several issues when working with the current set of EcoDesign requirements. Potential issues are that current requirements are unclear, misunderstood, overcomplicated, or difficult to evidence for auditing processes. Additionally, BUs do not always understand the reasoning or objectives behind current EcoDesign requirements (e.g. business resilience, contributions to environmental commitments, or customer needs).

The exact problem and root causes will be further researched in the first half of this graduation project.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project (1 sentence. As you graduate as an industrial design engineer, your assignment will start with a verb (Investigate/Design/Validate/Create), and you may use the format:
(Investigate/Design/Validate/Create) a (what will be the deliverable → prototype/roadmap/process/ intervention /approach/guideline/strategy/…) to (what should it do →(create/understand/evaluate/validate/ improve/execute/ analyse/…) (the objective → experience/value/process/product/…) for (whom → target group/client/…) in (what context).

Design a future-proof EcoDesign framework and way of working (processes) to strengthen the relevance, clarity, and applicability of EcoDesign requirements during New Product Introductions, for Philips product development teams in the Business Units and Philips Group Sustainability (a collaborative approach), specifically in the context of Philips' health systems (B2B segment).

Explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words).

The project uses a research-through-design approach that combines qualitative research with focused design and validation. Semi-structured interviews with Philips Group Sustainability and selected Business Unit product development teams are conducted to test hypotheses/theories about why EcoDesign requirements are difficult to apply (e.g., clarity, relevance, exception handling, and evidencing burden). Additionally, interviews will be held with external organizations that work with EcoDesign to learn from their best practices, frameworks and processes, accompanied by (academic) desk research on the topic.

After this initial research phase, the processes will be mapped and redesigned based on the findings. New frameworks/solutions will be developed to better connect the EcoDesign requirements to their underlying objectives and to improve the way compliance with these requirements is evidenced. Finally, these proposals are validated through structured workshops with selected BUs to assess feasibility, usability, and audit-readiness.

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some (max 5) personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology (200 words max).

My learning ambitions for this project are:
1. Learn how to independtly run a large project. After doing various courses in groups, I want to experience how it is to indepently work on a large project and discover my own strengths and weaknesses throughout this process.
2. Develop in-depth knowledge on environmental sustainability and EcoDesign. Learning the technical aspects, but also how this is implemented and done in practice in organizations such as Philips.
3. Improve my ability to balance academic research with design. I would like to learn how to create a real-world and practical solution that is clearly grounded in proper research. This also means doing good academic interviews and using the right methods at the right time.
4. Grow professionally and learn how to behave better in a large company such as Philips. Learning how to collaborate with different stakeholders and also better understand my own potential next steps in a future career.

I believe this project is the right project as my graduation project because it combines environmental sustainability with organizational complexity, two topics that I am deeply interested in and worked on in previous activities within the MSc programme and during extra-curricular activities, such as my recent internship. I am very motivated to work on the mentioned learning goals above.

C. Search String literature review

```
TS = (
 (
  ecodesign* OR "eco design"
  OR "design for environment*" OR DfE
  OR "environmental design requirement*"
  OR "ecodesign guideline*"
  OR "environmental product requirement*"
 )
 AND
 (
  driver* OR incentive* OR motivat* OR enabler*
  OR barrier* OR obstacle* OR challenge* OR constraint*
  OR facilitator* OR determinant*
 )
 AND
 (
  "product development" OR "product design"
  OR "new product development" OR NPD
  OR "engineering organization*"
  OR manufactur* OR "industrial product*"
  OR "consumer product*"
 )
)
NOT TS = (
 infrastructure OR construction OR architecture
 OR building* OR "built environment"
 OR urban OR civil
)
```

D. Interview protocols

D1. Philips BUs - Interview protocol (45-60 min.)

Introduction **3 min.**

Thank you very much for taking the time to speak with me today.

As a brief introduction: I'm conducting this interview as part of my Master's thesis at TU Delft. My research focuses on how EcoDesign requirements are implemented within PDLM projects at Philips. The project is done in collaboration with Philips Group Sustainability.

In this interview, I'm particularly interested in your experiences from the Business Unit perspective: how EcoDesign requirements are embedded in day-to-day development work, what works well, and where challenges arise in practice. To be clear, this interview is not an evaluation of performance, projects, or individuals. The results will only be presented at an aggregated, company-wide level.

Your participation is completely voluntary. You are free not to answer any question if you prefer not to, and you can stop the interview at any moment without giving a reason.

- Before we start, would it be okay if I record this interview? The recording will be used solely for transcription and analysis for my master's thesis and the project within Philips. The audio file will not be shared with anyone else and will be stored securely. Only anonymized insights will be included in the thesis.
- Do you have any questions before we start with the interview?

Context & strategy **5 min.**

The first part of this interview will focus on your role, and the context and strategy of your BU.

- Can you briefly describe your role and responsibilities in PDLM projects? How does it connect to EcoDesign?
    - Are you familiar with the EcoDesign requirements (SUS-035) and EcoDesign evidencing (SUS-032) documents?
- How would you describe Philips' EcoDesign strategy?
    - How is this translated within your BU?
    - How is senior management support for this?

Organizational & process integration **15 min.**

In the next section I would like to know more about a recent project in which EcoDesign played a role.

- Can you walk me through a recent PDLM project in which EcoDesign played a role, preferably with a clear timeline?
    - What went well? What could be improved?
    - When are EcoDesign relevant decisions being made?
    - How were roles and responsibilities around EcoDesign organized? Could you briefly describe some of the most important relationships?
    - Who are collaborating when it comes to EcoDesign within the BU?
    - How does your BU experience working with Group Sustainability around EcoDesign?
    - What steps are taken to integrate EcoDesign requirements in PDLM processes?
    - How do you experience the current stage-gates for EcoDesign: PDC and SR?
    - How is the evidencing process for EcoDesign experienced in your BU?

Knowledge, tools & methods **5 min.**

This section focuses on knowledge, tools and methods for EcoDesign.

- How do you experience your team's/BU's knowledge on sustainability or EcoDesign topics?
- Is your BU using any tools to support EcoDesign implementation (which includes making design decisions, setting specific requirements, validating requirements)? If so, which tools and what are the experiences with these tools?
    - At which stages in the process are these tools being used?
    - How usable do you consider the current tools?
    - What are current barriers to tool usage?

Requirement specific **10 min.**

Now we will focus more on the specific EcoDesign requirements as outlined in the current SUS035 document.

- How does your BU experience the current EcoDesign requirements?
    - What are the biggest challenges?
    - What type of solutions do you envision for this?
    - How do requirements get translated to product-level decisions?
    - Can you give an example of a requirement that was difficult to implement?
    - How can we incentivize your BU to work on design effort requirements?
- How does your BU evaluate the relevance of the current EcoDesign requirements?

Closing **7 min.**

We have come to some of the closing questions.

- If you could change one thing with regards to EcoDesign at Philips, what would it be?
- Do you have any ideas about the new EcoDesign requirements that you have not shared yet?

D2. GSO - Interview protocol (45-60 min.)

Introduction **3 min.**

Thank you very much for taking the time to speak with me today.
As a brief introduction: I'm conducting this interview as part of my master's thesis at TU Delft. My research focuses on how EcoDesign requirements are implemented within product development processes at Philips. The project is part of the larger project to future-proof the EcoDesign requirements at Philips, in line with the priorities of Group Sustainability.

In this conversation, I'm particularly interested in the Group Sustainability perspective: how the EcoDesign requirements are designed and governed, what they are intended to achieve, and how they are meant to work across the different Business Units. I'm also interested in how GSO experiences the interaction with BUs in practice, for example around alignment, support, and evidencing. To be clear, this interview is not an evaluation of you, GSO, or the requirements themselves. I'm trying to understand what enables or hinders effective EcoDesign implementation and come up with ways to overcome current challenges.

Your participation is completely voluntary. You are free not to answer any question if you prefer not to, and you can stop the interview at any moment without giving a reason.

- Before we start, would it be okay if I record this interview? The recording will be used solely for transcription and analysis for my master's thesis and the project within Philips. The audio file will not be shared with anyone else and will be stored securely. Only anonymized insights will be included in the thesis.
- Do you have any questions before we start with the interview?

Context & strategy **7 min.**

First, we will start with some questions to provide context and go into the strategy around EcoDesign.

- Can you describe your role and involvement in EcoDesign?

Before we dive into the more detailed questions, I'd like to start at a higher level.

- When you think about EcoDesign at Philips today, what stands out most to you: positively and negatively?
- How does EcoDesign connect to Philips' broader strategy?
    - Do you experience enough leadership support for EcoDesign within Philips?

Organizational & process integration **15 min.**

In the next section I would like to know more about how EcoDesign is experienced in practice in PDLM projects by the different BUs.

- How does the collaboration between GSO and BUs unfold in practice?
- How would you describe the current integration of EcoDesign in PDLM processes, preferably through an example?
    - Where is this lacking?
    - What are concrete experiences with the two formal gates (PDC & SR)?
    - What makes integration of EcoDesign difficult?
- How is ownership structured around EcoDesign, within the BU and GSO?
    - Could you sketch out some of the relations of the most important people involved in EcoDesign projects?

Knowledge, tools & methods **5 min.**

This following section touches upon knowledge, tools, and methods for EcoDesign.

- From your perspective, what capabilities are essential within BUs for effective EcoDesign?
    - Capabilities are for example specific types of knowledge about life cycle, materials and their environmental impact, but can also be more on the soft skill side.
- Where do you see capability gaps most often?
- How does GSO try to support or influence capability building?
- What tools or mechanisms has GSO introduced to support implementation?

Requirement specific **10 min.**

This final official section dives into the specific requirements that are currently in place at Philips (SUS035 document).

- What is your feedback on Philips' current EcoDesign requirements?
    - What are frequent questions or concerns from BUs?
- What principles guided the current EcoDesign requirements?
    - How is this presented to the BUs?
- If you could redesign the EcoDesign requirements today, what would you keep and what would you change and why?
- How would you incentivize BUs to work more on the current design effort requirements?

Closing **5 min.**

- If EcoDesign were functioning optimally across Philips in five years, what would look different compared to today?

D3. External - Interview protocol (45-60 min.)

Introduction **3 min.**

Thank you very much for taking the time to speak with me today.
As a brief introduction: I'm conducting this interview as part of my master's thesis at TU Delft. My research focuses on how EcoDesign is implemented within product development processes in large organizations. The project is done in collaboration with Philips, and findings might be used to inform how EcoDesign is implemented in their organization.

I'm interested in understanding how EcoDesign or sustainability requirements, or sustainability expectations more broadly, are embedded in day-to-day design and development practice. This interview is not an evaluation of your company or assessing performance in any way. I'm trying to understand patterns, processes, and practical lessons across different organizations. Your insights will help me identify what enables or hinders effective implementation.

Your participation is completely voluntary. You are free not to answer any question if you prefer not to, and you can stop the interview at any moment without giving a reason.

- Before we start, would it be okay if I record this interview? The recording will be used solely for transcription and analysis for my master's thesis and the project within Philips. The audio file will not be shared with anyone else and will be stored securely. Only anonymized insights will be included in the thesis.
- Do you have any questions before we start with the interview?

Context & strategy **8 min.**

Let's start this interview with some context.
- Could you briefly describe your role and how it connects to product development?
- How would you describe your organization's overall ambition regarding sustainability/EcoDesign in product development?
    - Does your organization have a formal EcoDesign program?

Organizational & process integration **15 min.**

By going through an example, I would like to learn more about how your organization is embedding sustainability in the organizational structure and product development processes.
- Can you walk me through a recent product development project where sustainability considerations played a meaningful role?
    - Are sustainability requirements formally integrated in the process? How?
    - When did sustainability become relevant in the process?
    - Which team members initiate sustainability/EcoDesign?
    - Which team members are working together to drive sustainability?
    - What were important milestones in this process?

Knowledge, tools & methods **5 min.**

The next section focuses on tools, knowledge and methods to implement sustainability in product development or EcoDesign.

- What capabilities are needed for product teams to implement EcoDesign effectively?
- How are these capabilities developed?
- What tools or methods are used to support EcoDesign/sustainable design?
- How would you evaluate the (non-)usage of these tools?

Requirement specific **7 min.**

- Does your organization work with formal sustainability requirements or targets for products?
    - What makes such requirements effective, or ineffective?
    - How do you measure success of EcoDesign?
    - Can you recall a requirement that worked particularly well or created friction? Why?
    - How do you ensure buy-in from product development teams?

If not:

- How are sustainability ambitions communicated to product development teams?
- How is compliance or progress on sustainability demonstrated?

Closing **7 min.**

In this last section I would like to ask more about what truly helped your organization in sustainable product development and what not.

- Looking back, what has been the most important enabler for embedding sustainability into product development?
- What has been the biggest barrier?
- If a large organization wanted to strengthen EcoDesign integration, what advice would you give?
- What is often underestimated when organizations try to implement sustainability requirements?

Thanks for your time. If you want to learn more about the results, let me know so I can update you about my graduation presentation in June.

E. Informed Consent Forms (template)

Consent forms – Interview EcoDesign

You are being invited to participate in a research study titled "Future-proof EcoDesign requirements at Philips". This study is being conducted by Tobias Rumphorst, a master's student from TU Delft, and is carried out in collaboration with Philips as the host organisation for this master's thesis.

The purpose of this research study is to better understand how EcoDesign is implemented in practice and to identify opportunities to improve its use in the product design and development process. Participation will take approximately 45 minutes. We will be asking you to take part in a semi-structured interview about your professional experiences with EcoDesign or similar approaches, such as how requirements are interpreted, applied, and where challenges or improvement opportunities exist. This interview can be held online or in person and will be recorded (with permission). In a later stage, you might be invited for an additional interview or workshop to validate some of the designed solutions. The data will be used for a master's thesis, may inform internal recommendations at Philips, and may be used for academic dissemination in anonymised and aggregated form.

To the best of our ability, your contributions will remain confidential. We will minimise risks by collecting only limited personal data (e.g. name and contact details for scheduling and consent), storing all data on secure, password-protected Philips systems, restricting access to the researcher and direct supervisors (at university and Philips) only, and anonymising interview transcripts by removing names, roles, and organizational identifiers.

Your participation in this study is entirely voluntary. You may withdraw at any time and are free to omit any questions. You may request removal of your data up until the point where the data has been anonymised and incorporated into the analysis.

If you have any questions about this study or your participation, please contact the Responsible Researcher:

- Tobias Rumphorst, master's student, TU Delft
- Email: t.j.b.rumphorst@student.tudelft.nl or tobias.rumphorst@philips.com

A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICIPANT TASKS AND VOLUNTARY PARTICIPATION	Yes	No
1. I have read and understood the study information dated 27/02/2026, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: taking part in audio-recorded semi-structured interview(s) about EcoDesign adoption in the product development process. The audio files will be transcribed to text, analysed and destroyed afterwards. A second interview or workshop might be scheduled in a later stage to validate some designs in line with the goal of the study.	☐	☐
4. I understand that the study will end in June 2026 latest.	☐	☐

B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
5. I understand that taking part in the study involves the following risks: the possibility of indirect identification due to the professional context and small number of expert participants. I understand that these risks will be mitigated by anonymising the data, removing or generalising names, roles, and organisational references, securely storing all data with restricted access, and reporting findings only at an aggregated level.	☐	☐
6. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach: anonymising personal identifiable information, storing data on secure password protected locations (TU Delft and Philips approved).	☐	☐
7. I understand that personal information collected about me that can identify me, such as name or emailaddress, will not be shared beyond the study team and will be used for administrative purposes (scheduling interviews, informed consent forms) only.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
8. I understand that after the research study the de-identified information I provide will be used for the report of a masters thesis/graduation project. Results will be published on an aggregated level only. The results from the study might inform internal decisions at Philips with regards to EcoDesign.	☐	☐

Signatures

_____ _____ _____

Name of participant Signature Date

I, as researcher, have accurately described the research to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____ _____ _____

Researcher name Signature Date

Study contact details for further information:

Tobias Rumphorst
+31631514347
t.j.b.rumphorst@student.tudelft.nl or tobias.rumphorst@philips.com

Contact Responsible Researcher:

Shahrokh Nikou, S.N.Nikou@tudelft.nl

F. Contextual interview findings

This appendix presents a number of additional findings that emerged from the empirical interviews. These findings are more contextual: they describe the wider environment in which EcoDesign at Philips operates, but are difficult to influence directly when implementing EcoDesign and therefore fall outside the scope of this project. They are documented here for completeness.

Long innovation timelines

One additional theme that emerged from the interviews is the impact of long innovation timelines on EcoDesign implementation. Within the Health Systems segment, product development cycles are significantly longer than in the Personal Health segment. Due to the complexity and regulatory requirements of professional medical devices, innovation processes can take more than 10 years. Interviewees indicate that this makes it harder to keep sustainability considerations relevant and up to date throughout the full development process.

This finding is noted as an important contextual factor that shapes how EcoDesign is experienced within Philips' Health Systems businesses, but since reducing innovation timelines falls outside the scope of this project, it is not incorporated into the conceptual model or the design solutions.

Geographical differences in sustainability priorities

Multiple interview participants pointed to clear geographical differences in how sustainability is valued by customers markets. Regions such as the Nordics were consistently mentioned as markets with strong sustainability expectations, where EcoDesign-related claims can serve as a useful competitive differentiator. In contrast, several participants indicated that sustainability is not something to actively market in China, where for example recycled materials are often perceived as inferior in quality. The US gave mixed signals: some participants also saw recent developments in the US as making sustainability less important, while others indicated that hospitals are still taking action with regards to sustainability.

These geographical differences influence how sustainability is positioned commercially, but they are too detailed to consider within the implementation approach developed in this project. Interviewees also indicated that Philips' products are typically sold to a wide range of geographical markets at the same time, which makes it difficult to incorporate region-specific sustainability priorities into product-level decisions. The finding is documented here as relevant context for product managers and commercial teams when considering how EcoDesign is communicated externally, rather than as a factor that the framework or design deliverables can directly address.

Regulated medical device industry

The medical device industry is heavily regulated, which interview participants identified as a structural constraint on EcoDesign implementation. For example, several participants indicated that recycled materials are often not allowed for clinical reasons, and that material choices, manufacturing processes, and supplier changes are subject to extensive validation requirements that can make sustainability-related changes slow and costly to implement.

These constraints are external to Philips and apply across the medical device industry more broadly. They are also highly technical in nature, with the specific implications differing per product or material. For these reasons, the regulatory context is not incorporated into the conceptual model and only documented here as an important industry-level factor that limits the design space for EcoDesign.

G. Design principles & constraints

The design phase was guided by iteratively refined principles and constraints, drawn from the empirical findings, Philips' organizational context, and the design activities in Section 7.2. Principles describe what solutions should achieve. Constraints define the boundaries within which solutions must operate. Together, these define the solution space explored in this chapter and the next.

G1. Design principles

The most important design principles that the design solutions aim to achieve are:

- **Enable cross-functional collaboration**. As the empirical findings indicated that there is a lack of cross-functional collaboration, the designed solutions must create conditions in which sustainability and R&D engineers also collaborate with product managers, and preferably also other roles.
- **Move towards earlier process integration**. Interviewees across all stakeholder groups identified late integration as one of the most significant barriers to impactful EcoDesign. By the time EcoDesign is actively addressed in PDLM, many fundamental design decisions have already been made. The solutions should therefore support earlier engagement with EcoDesign, ideally in upstream I2M phases such as AD and VPC, where design freedom is still high.
- **Make the relevance of EcoDesign explicit**. Requirements and guidelines are currently experienced as lacking a clear rationale. Without understanding why a requirement exists, product development teams find it difficult to prioritize EcoDesign when it competes with cost, performance, or clinical considerations. The solutions should therefore clearly communicate the relevance of EcoDesign, connecting requirements and guidance to concrete drivers such as customer and tender needs, competitive positioning, regulatory developments, and Philips' internal sustainability ambitions.

G2. Design constraints

In parallel, the most important design constraints emerging from the context and design activities are:

- **Maintain the existing EcoDesign focal areas**. The four focal areas (energy, packaging, substances, and circularity) are well-established within Philips. The solutions should work within this structure rather than proposing changes to it.
- **Build on existing elements where possible**. Philips is already doing a lot with regards to sustainability. The solutions should integrate with and extend these rather than adding or replacing initiatives.
- **Do not increase workload for Group Sustainability**. GSO and the EcoDesign team specifically operate with limited resource capacity. The solutions should reduce administrative burden where possible, rather than creating additional review or coordination tasks.
- **Be implementable within typical project capacity**. Stakeholders such as product managers, R&D engineers, and sustainability engineers already operate under significant time pressure. The solutions should therefore be low-effort to adopt and use.
- **Fit within the decentralized operating model of Philips**. Business Units operate with considerable autonomy and are accountable for their own portfolios. The solutions should work with this model, supporting BUs rather than overriding their decision-making authority.
- **Be applicable across varying levels of EcoDesign maturity**. Business Units (even within Health Systems) differ considerably in sustainability maturity, resources, and ways of working. The solutions should be usable for the different BUs.

H. Frameworks for requirements analysis

During the development of the EcoDesign framework presented in Chapter 7, two alternative directions were explored in more depth before the final framework was chosen. Both ideas were proposed by colleagues within Group Sustainability, or interviewed external organizations would work in a similar way. The shared goal of these two proposals was to make EcoDesign more attractive and easier to understand for the BUs. Both ideas would be implemented in the PDLM process. Even though both ideas look like good ways to improve EcoDesign implementation, both were not taken forward for several reasons. This appendix describes the ideas in more detail and explains the reasoning behind these decisions.

H1. Level-based framework

The first idea was to define EcoDesign levels for each focal area (energy, packaging, substances, and circularity), where choosing an ambition level for a product would activate a specific set of EcoDesign requirements. Levels would range from insufficient, which could not be chosen, to basic, intermediate, and advanced, which could consequently be linked to the MEPA criteria. The main strength of this idea was to communicate more easily with the Business Units on EcoDesign, create more motivation to work on EcoDesign (to level-up) and to more easily compare different products in Philips' portfolio.

Despite these strengths, the level-based framework was not explored further for several reasons. The most fundamental reason is that the approach would not fit well within Philips' operating model, in which BUs lead on product decisions

A second concern is that fixed levels cannot reflect BU-specific priorities, especially within complex focal areas such as circularity. For example, a new helium-free MR system would represent a major sustainability achievement, but could still end up in a low level due to its weight characteristics, even though the system itself is a significant improvement over predecessors. Such mismatches would create friction and reduce the credibility of the framework.

Finally, introducing levels would mean introducing a new way of working that does not always fit how BUs currently operate, adding complexity without clearly resolving an underlying problem. Problems such as late integration, limited collaboration, and a missing rationale of EcoDesign requirements would not be solved directly.

H2. Score-based framework

The second idea was to assign each product a single EcoDesign score, calculated based on weighted performance across requirements or focal areas. The main strength of this approach was that it would allow products to be benchmarked against each other and over time, providing a clear and quantifiable score for EcoDesign/sustainability performance.

The scoring-based framework was also not taken forward, for reasons that mainly mirror the level-based discussion. The most important reason is that EcoDesign is often not the leading consideration in product development decisions. A product team could aim for a certain score at the start of a project, but throughout development trade-offs are made for cost, performance, clinical, or time-to-market reasons, and EcoDesign performance can shift accordingly. This means that even a well-defined target score risks not being met for reasons outside of EcoDesign itself, which undermines the credibility and governance of the system.

In addition, a scoring system introduces significant complexity. Proper scoring requires weightings per requirement or focal area, based on BU focuses. Without these weightings, BUs

are likely to focus on easy wins rather than on high-impact improvements. If BUs are allowed to set their own weightings, a product could appear strong on its overall score while remaining weak on focal areas that matter most for actual environmental impact or customer expectations. Finally, a score-based system also makes governance harder: replacing mandatory pass/fail requirements with a gradient allows weak performance in one area to be compensated by strong performance in another, which weakens the enforceability of EcoDesign at Philips.

H3. Conclusion

Both alternative directions had real strengths, particularly around benchmarking and communication. However, they did not directly address the main issues identified in the empirical research, such as the late integration of EcoDesign in product development processes and the ambiguity of existing requirements. At the same time, they would add new complexity, require additional governance, and move against the operating model in which BUs are in the lead. Such frameworks might work for organizations with a less diverse product portfolio, but they are difficult to apply across the wide range of complex products that Philips offers. In addition, adopting these frameworks would require more effort from GSO to deploy it to the BUs, while delivering relatively limited impact.

The eventual framework, with two complementary tracks is therefore preferred as it deliberately separates baseline EcoDesign approaches from more innovative EcoDesign forms. It also helps to better align strategic, tactical and operational levels.

J. Handbook steps

As mentioned in Section 8.2, the EcoDesign in PDLM handbook highlights six steps that guide product development teams in implementing EcoDesign. The steps are mainly directed at system engineers and sustainability engineers, while specific steps also involve product managers, Group Sustainability and sales-related stakeholders. This appendix provides additional information on the six steps and the rationale behind them, based on interview findings and learnings from the design phase.

	Description	Rationale
1	**Define prerequisites**: Teams define the predecessor product and standard product configuration early in Project Initiation. These form the foundation of how EcoDesign is measured and how improvements are assessed. It is also recommended to do a competitor benchmark in this step, even though not mandatory.	Defining them earlier makes the requirements easier to interpret and helps teams understand what level of performance, such as maximum energy consumption, is expected.
2	**Align product-specific requirements**: Product-specific business or user requirements related to sustainability are identified and translated into measurable system-level requirements. These requirements should be raised by product managers, for example to make sustainability claims.	This step ensures that the most important sustainability ambitions enter the project early. In line with the V-model, product managers define these business or user requirements, after which system engineers translate them into measurable system or product requirements.
3	**Translate mandatory EcoDesign requirements**: The applicability of the mandatory EcoDesign requirements in the handbook is assessed per requirement. Applicable requirements are translated into measurable system requirements. Group Sustainability confirms if requirements are embedded at a specific stage-gate.	These requirements form the baseline for a product to be considered EcoDesigned within Philips, therefore are checked by GSO. Because they are written for multiple BUs, they often need additional translation to fit specific BU contexts.
4	**Review EcoDesign guidelines in design reviews**: EcoDesign guidelines are reviewed during design reviews. Unlike requirements, these guidelines are not formally verified, but guide design decisions, help make trade-offs explicit and suggest improvement opportunities.	Not all EcoDesign considerations can be captured as mandatory requirements. Reviewing guidelines during design reviews keeps EcoDesign visible and helps prevent unintended reverse progress through other design decisions , such as a product getting heavier without clear additional benefits.
5	**Verify and document EcoDesign evidence**: Teams verify and document evidence for meeting the applicable EcoDesign requirements. Evidence for the mandatory requirements from Step 3 must be available before a specific stage-gate for GSO to verify.	This step makes EcoDesign auditable and doing it on time prevents verification from becoming a late administrative task.
6	**Prepare sustainability FAQ**: Before product launch, the sustainability engineer is recommended to prepare a sustainability FAQ with product-level sustainability information for sales teams, tenders and customer interactions. An example is providing answers to the MEPA criteria.	The design phase indicated that sales teams often struggle to find the right information. Preparing this information before launch makes the process more efficient and helps to share information consistently and reliably across the organization.

The six steps are aligned with the V-model and with the roles most commonly involved in product development teams. Each step is tailored to the people expected to execute it, with a clear timing, and expected outcome. This makes the handbook action-oriented and helps teams address important EcoDesign decisions earlier in the process, when decisions can still be influenced.