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# **System boundary framing and institutional logics in circular economy decision making**

A qualitative study of Nordic-OEM utility ecosystems.

School of Technology and Innovations  
Master's Thesis in Industrial Systems Analytics  
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**ABSTRACT :**

The circular economy (CE) is frequently presented as practical path to minimizing resource consumption, extending product and component lifetimes and supporting sustainability transitions. In critical electrical infrastructure, however, circular options were evaluated within a highly regulated and risk sensitive operating context, where reliability, safety, compliance, cost and long-term performance shaped decision making. This thesis explores how CE decisions were constructed within Nordic original equipment manufacturer utility ecosystems through the combined lenses of system boundary framing and institutional logics.

The aims of the study were to explain how organizations framed what belonged inside or outside the decision making scope when considering circular options, which institutional logics became dominant in these decisions and how these factors shaped circular strategy orientation. The theoretical framework integrated CE literature with system boundary framing, institutional logics and institutional complexity. Rather than treating CE as an inherently sustainable alternative, the study examined it as a contested organizational agenda shaped by risk interpretation, responsibility allocation, evidence requirements and performance expectations.

The study adopted an exploratory qualitative dominant research design. Empirical data were gathered through an anonymous practitioner survey conducted at EnergyWeek 2026 in Vaasa, Finland, among professionals involved in energy and electrical infrastructure. Closed ended responses were used descriptively to identify general response patterns while open ended responses were analyzed through theory driven thematic analysis.

The findings showed that CE decision making was shaped by multiple and shifting system boundaries rather than by a single fixed decision framework. Although some responses reflected lifecycle level and system level thinking, decision boundaries often narrowed under conditions of uncertainty, urgency, limited information or operational risk. The findings also showed that institutional logic structured how circular options were assessed. Sustainability logic was visible in strategic priority setting, but reliability, safety, compliance and cost logic gained stronger operational authority during implementation. Circular strategy orientation was therefore shaped not only by technical feasibility but by the interaction between boundary framing and dominant decision logics.

The thesis concluded that CE implementation in Nordic OEM utility ecosystems depended on how organizations defined the relevant decision boundary and which institutional logics were granted authority in practice. Improving CE decision making requires broader lifecycle assessment, stronger data and traceability systems, clearer certification and evidence practices and better alignment between sustainability, operational and financial decision criteria.

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**KEYWORDS:** System boundary framing, Circular economy, Institutional logics, Nordic OEM utility ecosystems, Circular strategy orientation, Electrical infrastructure

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**Abbreviations**

CE	=	Circular Economy
OEM	=	Original Equipment Manufacturer
ESG	=	Environmental, Social and Governance
KPI	=	Key Performance Indicators
LCA	=	Life Cycle Assessment
LCC	=	Life Cycle Costing
CPQ	=	Certainty of Product Quality
IoT	=	Internet of Things
SBF	=	System Boundary Framing
IL	=	Institutional Logics
IC	=	Institutional Complexity
CSO	=	Circular Strategy Orientation

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## **1. Introduction**

The circular economy (CE) is often framed as a critical approach to decoupling economic growth from environmental pressures and resource depletion (Geissdoerfer et al., 2017). This research argues that CE decision making in Nordic original equipment manufacturer (OEM) and utility ecosystems is not just driven by technical factors, but also system boundary and institutional processes. This is significant as CE is often seen as inherently sustainable and readily implementable whereas critical infrastructure industries display more limited and controversial decision making settings. In these cases, CE projects are evaluated against criteria for grid stability, safety, regulatory and cost requirements. As a result, CE cannot be considered a technical (or environmental) innovation. Instead, it must be seen as an organisational process of negotiation between interests and risks.

In this regard, the study adds to the CE literature by discussing the framing of circular options in highly regulated Nordic energy infrastructure ecosystems. It is not just about the accessibility of circular strategies, but how system boundaries are framed and how dominant institutional logics shape perceptions of what is possible, desirable and acceptable. Therefore, this chapter outlines the research problem, research purpose and research questions that guide the empirical work. It also introduces the concepts that the thesis engages with circular economy, system boundary framing, institutional logics, institutional complexity and circular strategy orientation. Thus, this chapter sets the stage for the thesis on the structural tensions of pro environmental ambitions and performance requirements of critical electrical infrastructure.

### **1.1 Background and Motivation**

CE is frequently framed as a means to reduce resource consumption and environmental pressures by slowing down, dematerialising and reclosing material and energy flows (Geissdoerfer et al., 2017). In industry, this often comes in repair, refurbishment, remanufacturing, recycling and other types of secondary production to "keep value in

use" and prevent waste (Aarikka-Stenroos et al., 2021; Bocken et al., 2016a; Zink & Geyer, 2017). However, CE is not just a technological alternative to linear processes. It requires changes in supply chain organisation, technological systems and inter organisational coordination, so circularity is a matter of industrial ecosystem organisation and governance, as well as materials processing (Aarikka-Stenroos et al., 2021; Geissdoerfer et al., 2017).

But the CE literature no longer takes for granted that circularity is sustainable or successful. Critical studies have shown that CE rests on contested assumptions, such as unclear boundaries, weak theoretical underpinnings and considerable structural barriers to implementation (Corvellec et al., 2022). A typical critique is that many CE projects assume one-for-one substitution of secondary production for primary production, which is not necessarily the case (Zink & Geyer, 2017). However, rebound, market growth and techno economics can undermine or even reverse environmental gains (Castro et al., 2022; Zink & Geyer, 2017). Therefore, CE's sustainability benefits cannot be assumed; it depends on how organizations define the system, weigh up trade-offs and allocate responsibility across actors and the product lifecycle (Corvellec et al., 2022; Velter et al., 2021).

This is notably the case in Nordic OEM utility ecosystems. In this thesis, we use this term to describe the interconnected system of equipment manufacturers, power utilities, service providers and other entities responsible for the specification, procurement, operation, maintenance, repair, refurbishment and replacement of electrical assets. This is an important context to examine not only because it is regulated, but because circularity decisions are spread across multiple organisations with different roles, responsibilities and incentives. The Nordic region is known for its green policies and waste management but this does not always translate to corporate circularity (Anttiroiko, 2023; Ridwan et al., 2025). In the electricity sector, for instance, CE initiatives such as repair, life extension, remanufacturing or local re-use are balanced against reliability, safety, compliance and cost considerations. Circularity is therefore assessed in a context where pro environmental considerations are not the only factors at play.

Institutional complexity thus becomes a key aspect. In Nordic OEM utility ecosystems, decisions are impacted by the interaction between different types of logics, in particular market and performance logics on the one side and pro environmental logics on the other (Vedula et al., 2022). These logics manifest in system boundary work where firms decide what phases of the product life cycle, risks, costs and impacts to include in formal decision making and what to exclude (Vedula et al., 2022). If boundary framing prioritises short term reliability, compliance and risk, infrastructural circular strategies may be deemed unviable, even if they are more sustainable in the long term. Though CE research is now paying greater attention to boundary work and multi stakeholder coordination, empirical research has paid little attention to the role of boundaries and logics in critical infrastructure (Ho et al., 2022; Velter et al., 2021). This thesis addresses this by examining how circular strategies are evaluated, rationalized, restricted and even rejected in the Nordic OEM utility ecosystems.

## **1.2 Purpose and Objectives of the Study**

This research seeks to understand the decision making processes surrounding CE strategies in Nordic OEM utility ecosystems in critical electrical infrastructure. Specifically, the thesis examines how system boundary framing and institutional logics combine to influence the assessment, choice and avoidance of circular strategies. This is important because CE strategies, such as repair, reuse, remanufacturing and recycling, are often described as being environmentally preferable, but their use in large power systems is limited by the need to balance concerns for reliability, safety, regulatory compliance and cost effectiveness (Corvellec et al., 2022). The research therefore aims to understand how organisations negotiate the inclusion and exclusion of the most relevant matters in decision making and how such system boundary decisions are shaped by current dominant logics in infrastructure asset management.

The specific objectives of the thesis are:

- First, it examines how organisations frame and negotiate system boundaries in the assessment of circular options, including the lifecycle stages, impacts and performance metrics that are formally included or excluded from the assessment.
- Second, it maps the dominant institutional logics that shape CE decision making in electrical infrastructure, particularly focusing on the interaction between market, reliability and cost oriented logics with pro environmental interests (Vedula et al., 2022).
- Third, it describes how the interaction between system boundary framing and institutional complexity shapes the overall orientation of organizational circular strategies within OEM utility ecosystems.

In this way, the thesis fills a gap in CE research, which has focused more on macro level (environmental) promise and circular business models than on micro level (decision making) rationalities that shape whether circular initiatives are prioritised, limited or abandoned in risk averse infrastructure settings.

### **1.3 Research Problem and Research Questions**

The issue with the current literature is that CE research has focused more on environmental promise than organisational decision making. While critical research has demonstrated that CE is conceptually volatile, technologically and economically biased, and challenging to operationalise, there has been less focus on how organisations assess circular options in the context of multiple operational priorities (Corvellec et al., 2022; Zink & Geyer, 2017). In particular, existing research has not explored in detail how boundary framing and institutional logics intersect in critical infrastructure contexts, where circular options are not evaluated abstractly, but in terms of risk, performance and accountability criteria (Dagilienė et al., 2024; Jatmiko et al., 2025). So, the problem in the literature is not that there is no discussion of CE, but that there is no empirical account of how CE strategies are deemed feasible or not in highly constrained settings.

The practical problem is equally specific. In Nordic OEM utility ecosystems, professionals who manage infrastructure assets must make judgement calls about circular strategies such as repair, remanufacturing and extending lifetimes while adhering to rigorous standards of reliability, safety, compliance and cost effectiveness. In this context, the choice to pursue or forego a circular strategy is determined by the formal boundary of evaluation and the institutional logics that prevail in that evaluation. Lifecycle impacts may be acknowledged, but not considered in practice if short term performance, regulatory compliance and operational risk management are favored. This research addresses the literature problem and the industry problem by exploring the drawing of system boundaries, the dominance of institutional logics and their interaction in shaping the orientation of circular strategies in Nordic OEM utility ecosystems (Corvellec et al., 2022; Jatmiko et al., 2025; Zink & Geyer, 2017).

To address this research problem and achieve the purpose of the study, the thesis is based on three research questions:

- How do Nordic power companies and equipment manufacturers decide what is included and what is excluded when defining circular economy in their decision processes?
- Which institutional logics dominate circular economy decision making in electrical infrastructure contexts?
- How does the interaction between system boundary framing and institutional logics shape circular strategy orientation in OEM utility ecosystems?

#### **1.4 Key Concepts and Thesis Focus**

This thesis employs a narrow set of concepts to understand how decisions about the circular economy are made in Nordic OEM utility ecosystems. The concepts are not used as isolated research literature review areas. They are applied as work tools to describe how practitioners assess circular options in critical electrical infrastructure.

**Circular Economy.** For the purposes of this thesis, CE relates to attempts to decelerate, shrink and close material and energy cycles to minimise resource consumption, waste, emissions and energy leaks (Geissdoerfer et al., 2017). The research does not assume CE to be sustainable. Rather, it treats CE as a contested organisational project whose sustainability impacts depend on how CE options are evaluated and put into practice (Corvellec et al., 2022). This is important here because the substitution of primary production by secondary production is not a straightforward process (Zink & Geyer, 2017). CE thus represents the empirical context of the decision making process, rather than a normative outcome.

**System Boundary Framing (SBF).** SBF is the process by which organisations define what is in and out of scope of their evaluation, responsibility and action (Velter et al., 2021). In this thesis, it is the key analytical process by which decision makers decide what lifecycle stages, impacts, risks and performance criteria are relevant in the evaluation of circular options. The term is applied to understand why some circular options seem plausible and valid, while others are ruled out at the early stages of organisational decision making. It thus connects the abstract sustainability goals to the concrete evaluation practices of organisations.

**Institutional Logics (IL).** IL are the socially constructed values, beliefs, norms and practices that organisations use to define what is right, proper and legitimate (Thornton et al., 2012). In this research, the term is employed to recognise the prominent rationalities underpinning CE in critical infrastructure. These include business logics (focused on profitability and efficiency), performance logics (focused on reliability and safety) and environmental logics (focused on environmental sustainability) (Lee & Lounsbury, 2015). The concept is used to understand how practitioners justify their strategic decisions and how multiple criteria are prioritised.

**Institutional Complexity (IC).** IC refers to cases where organisations are exposed to multiple institutional logics that compete or contradict each other (Greenwood et al., 2011). Institutional complexity is not the primary paired concept to system boundary framing in this thesis; rather, it is the environment in which system boundary framing

takes place. In Nordic OEM utility ecosystems, simultaneous institutional logics of circularity, cost, safety, compliance and system reliability are at play. The concept is thus used to describe the context in which logics must be interpreted and balanced.

**OEM Utility Ecosystems.** OEM utility ecosystems are used here to describe the interconnected ecosystem of manufacturers, utilities, service providers and other actors engaged in the procurement, operation, maintenance, repair, refurbishment and replacement of electrical assets. Ecosystems are defined as interdependent relationships where outcomes at the system level cannot be achieved by a single organisation (Thomas & Autio, 2020). This thesis uses the term to define the empirical scope and to highlight the fact that circular decisions are made along organisational relationships and not in isolation.

**Circular Strategy Orientation (CSO).** CSO is the orientation of an organisation towards circular implementation, particularly in relation to slowing, narrowing or closing the resource loop (Bocken et al., 2016; Geissdoerfer et al., 2017). It is the primary outcome of interest in this thesis. This term is used to describe the adoption, constrained or avoided adoption of circular initiatives. It is thus the bridge between decision making and strategy.

## **1.5 Thesis Focus and Delimitations**

The research examines the making of circular economy decisions in OEM utility ecosystems in the Nordic region focusing on critical electrical infrastructure. In particular, it explores how framing of system boundaries and institutional logics play out in organisations' assessment of circular strategies like repair, remanufacturing, refurbishment and lifetime extension. The aim of the study is to unpack why some circular options are considered thinkable and legitimate while others are deemed unfeasible. It thus provides empirical evidence of decision making practices that are often taken for granted in CE studies.

There are a number of delimitations of the study. First, the thesis focuses on organisational decision making as a socially constructed phenomenon. It does not perform technical life cycle assessment, material flow analysis or thermodynamic assessment of circularity. Second, the research focuses on the Nordic power sector and on actors related to electrical infrastructure asset management. This means that the study does not cover consumer behaviour, the assessment of macro CE policies or other industries. Third, the empirical data are based on a cross sectional, qualitative dominant survey, gathering self reports from infrastructure specialists, complemented with descriptive statistics when appropriate. The study reflects how interviewees report decision criteria and boundary setting at a given moment in time, but not how it has evolved over time or how unspoken practices are enacted beyond what is reported.

## **1.6 Significance of the Study**

The research is important because it investigates an understudied issue in the field of CE research: the evaluation of circular decisions in critical infrastructure contexts where environmental goals compete with concerns for reliability, safety, compliance and cost. It is to be considered an exploratory and insightful contribution. The research draws on cross sectional survey data from 44 event based case studies and does not claim to represent the entire energy sector. Rather, it provides a narrow empirical study of the interpretation, constraints and prioritisation of circular options in Nordic OEM utility ecosystems. In this regard, the thesis provides analysis of a field of CE research that is frequently debated in abstract terms but less so in terms of organisational decision making.

The research makes two contributions to academia. First, the thesis contributes to CE literature by refocusing attention from the general promise of circularity to the specific criteria used to evaluate circular options as feasible or not in infrastructure. This is important because CE literature has been criticised for technical economic biases, including the assumption that "secondary production" simply replaces "primary

production", despite the influence of structural and market factors (Zink & Geyer, 2017). CE has also been criticised for conceptual blurriness and unclear sustainability outcomes, so it requires more empirical research on organisational evaluation processes (Corvellec et al., 2022). Second, the thesis contributes to institutional logics research by extending it to an area where it has been less widely applied, infrastructure asset management. While institutional logics have been used to explain how organisations respond to multiple pressures such as profitability and environmental sustainability, they have been less applied to describe how these logics are translated into specific asset related decision making criteria in electrical infrastructure (Thornton et al., 2012). This research rectifies this by demonstrating how institutional logics influence boundary choices and how boundary choices drive circular strategy orientation (Vedula et al., 2022).

The study is also relevant contextually and practically. Contextually, it adds to the knowledge of CE in the Nordic region, which is often seen as having good sustainability policies but with still high material consumption and reliance on primary resource production (Johansson & Henriksson, 2020). This is evident in electrical infrastructure, where circular decision making is dependent on the complex relationships between OEMs and utilities (Aarikka-Stenroos et al., 2021). In terms of practice, the findings are most relevant to utilities, OEMs, asset managers, procurement and sustainability professionals involved in infrastructure assets. For them, the study provides insights into how system boundaries are defined and how circular strategies such as repair, remanufacturing and lifetime extension might be limited by prevailing performance logics. The results might also be of interest to policymakers and sustainability intermediaries as a source of evidence on how firm level actors interpret circular ambitions in practice. But the study should be seen as contributing to more context specific debate and reflection, rather than as a source for generalised policy (Coenen et al., 2025; Lowe et al., 2024; Shabbir & Salman, 2025; Shnayder et al., 2021; Smink et al., 2015).

## **1.7 Structure of the Thesis**

The thesis is organised in five chapters. In Chapter 1, the research is introduced through the background, problem, objectives, research questions, concepts and delimitations. Chapter 2 establishes the theoretical and analytical framework through literature on circular economy, system boundary setting and institutional logics in critical infrastructure. Chapter 3 explains the research design, empirical setting, data collection and analysis. Chapter 4 provides empirical findings in the context of the study's research questions and framework. In chapter 5, the thesis is concluded with a discussion of the key findings, theoretical and practical implications, limitations and suggestions for future research.

## **2. Literature Review and Theoretical Framework**

This chapter sets out the framework for analysing how CE options are assessed in Nordic OEM utility ecosystems. The chapter examines what CE research reveals about infrastructure decision making, defines system boundary framing in the operational sense that is used in this thesis and clarifies the institutional logics that are likely to be present in practitioner decision accounts. These threads are then woven together in an approach to understanding the uptake, denial or avoidance of circular strategies in critical electrical infrastructure.

### **2.1 Introduction to the Chapter**

The literature review is two fold. First, it focuses the CE debate from general claims about circularity to the problem of how organisations assess circular options in regulated, asset intensive settings. Second, it provides an analytical framework that can be used to understand what respondents include and exclude from the decision making process, which institutional logics are used to justify these decisions and how this translates into a circular strategy orientation. So the chapter shifts from general CE debate to operational decision making.

### **2.2 Circular Economy in Infrastructure Decision Contexts**

In industrial and infrastructure contexts, CE typically refers to strategies to preserve value in long lived assets, such as repair, refurbishment, remanufacturing, reuse and recycling, rather than retail sales to consumers. Academic literature refers to these approaches as efforts to retain value and avoid primary resource extraction (Zink & Geyer, 2017). Industry leaning commentary has discussed the same goal in terms of infrastructure asset renewal and lifespan extension but should be read with caution and as a supplementary source. In this thesis, CE in infrastructure is defined as a set of

organisational decisions about the use of such secondary strategies in the governance of technical assets.

However, this promise is contested. CE is frequently explained as a pathway towards green growth and decoupling, but it does not necessarily lead to improvements in sustainability (Geissdoerfer et al., 2017). Critical analyses reveal that CE has fuzzy conceptual limits and often relies on techno economic assumptions that downplay thermodynamic, social and political limits (Corvellec et al., 2022). A key critique concerns substitution: secondary production does not necessarily substitute primary production on a one-to-one basis (Zink & Geyer, 2017). Instead, production of secondary goods may stimulate demand and material use, particularly when secondary goods are cheaper and open new markets or trigger new demand (Castro et al., 2022). This is relevant for infrastructure because circular measures cannot be assessed only in terms of their technical feasibility. They need to be considered in terms of their likely system impacts and implementation conditions (Lowe et al., 2024).

The difficulty of implementation is evident in capital intensive and safety critical industries. Studies of circular supply chain redesign indicate that uncertainty around return, quality, timing, liability and coordination can severely constrain circular implementation despite the existence of technical options (Bressanelli et al., 2019). Research on second life lithium ion batteries indicates that choices are contingent on uncertainty about residual performance, reliability and the extent to which reuse avoids new asset creation (Wrålsen & O'Born, 2023). Studies of solar photovoltaics similarly show that circular recovery strategies are constrained by long asset lifetime, uncertain end-of-life timing and infrastructural design that complicates reuse and recycling options (Strupeit et al., 2024). These examples are good analogies for power infrastructure because they involve long lived, high investment assets, stringent performance standards and the consequences of failure.

Similar insights emerge in Scandinavian studies of maritime and heavy equipment remanufacturing. In these cases, circularity is constrained by uptime, certification, customer risk and the operational impacts of part failure (Milios et al., 2019). These

studies also demonstrate that remanufacturing is more challenging where replacement decisions reflect reliability first priorities and where second hand components are accepted based on trust, traceability and institutional legitimacy (Milius & Matsumoto, 2019). These findings are consistent with research on industrial CE more generally: circularity in regulated industries is constrained by technical, economic, organisational and regulatory factors rather than environmental preference (Gaha et al., 2021).

Such concerns are important in Nordic infrastructure settings. The region is often celebrated for progressive environmental policy, waste management practices and circular policy aspirations (Anttiroiko, 2023). Local studies also show high level CE ambitions and policy settings (Ridwan et al., 2025). At the same time, studies document ongoing reliance on primary resource extraction and variable incorporation of cumulative circularity into practical industry (Zu Castell-Rüdenhausen et al., 2021). The existing research explains some of this gap at the supply chain and policy level, but it explains less about how practitioners within infrastructure organisations assess specific circular options when they are under operational pressure (Bressanelli et al., 2019).

This is the gap that this thesis seeks to address. Existing CE research does part of the job in explaining why circular transitions are so hard, but it does not explain how infrastructure professionals determine what matters in the assessment of circular options in Nordic OEM utility ecosystems. Here, technical feasibility is only one dimension. It also has to do with what scope decision makers adopt and what institutional logics underpin their decision making. The following two sections take up these two gaps by looking at system boundary framing and institutional logics.

### **2.3 System Boundary Framing**

SBF refers to how organizations define what is included and excluded within the scope of evaluation, responsibility and action (Velter et al., 2021). This is important in CE debates because circularity relates to what is relevant for decision making the cost now, the lifecycle impact, the operational risk, the compliance risk, the value of the asset over

time or the resource allocation across the organization. Boundary framing is not a technical issue, then. It is an interpretive practice whereby organizations determine what the decision is "about" and what impacts are legitimate to consider.

For the purposes of this thesis, system boundary framing is used in a very technical sense. It is the way respondents set limits on five elements of circular evaluation: lifecycle scope, impact scope, risk scope, cost horizon and responsibility scope. Lifecycle scope concerns which life cycle phases are assessed, such as procurement, operation, maintenance, end of life recovery or system effects. Impact scope concerns which environmental, operational or financial effects are considered. Risk scope concerns which risks are prioritised, such as reliability, safety, liability, downtime, reputation. Cost horizon concerns whether the focus is on short term costs or the cost over the lifecycle. Liability scope concerns whether liability is focused on the focal firm or spans suppliers, OEMs, utilities and others. These are the attributes on which the concept will be coded.

Other work in CE sometimes refers to boundaries at an ecosystem level through notions of interdependence, spatiality, relationality or multi actor coordination (Aarikka-Stenroos et al., 2021). It also emphasises that circular transitions are about negotiation between organisations rather than just within a single firm (Ho et al., 2022). Other research illustrates how ecosystem boundaries can be defined by spatiality, local recovery systems and relationships (Anttiroiko, 2023). Other research highlights the impact of inter organisational structure on the organisation of circular collaboration (Ingstrup et al., 2021). These views are valuable context, but this thesis does not examine ecosystem boundaries in their full theoretical depth. Rather, it addresses the more specific question of infrastructure professionals' framing of specific circular decisions.

This narrower view is particularly important in regulated infrastructure settings. If the boundary is framed primarily in terms of short term reliability, cost, safety risk or regulatory risk, for instance, then wider circular alternatives might not be considered. By contrast, when the decision boundary includes lifecycle impacts, recovery options or inter organisational responsibilities, a broader range of circular options can enter the discussion. Previous research on cross boundary coordination indicates that such

framing is important because organisational boundaries and misalignments can stand in the way of implementing sustainability initiatives (Shnayder et al., 2021). In this thesis, system boundary framing is therefore the practical mechanism by which circular options are broadened, constrained or ruled out during the evaluation process.

## **2.4 Institutional Logics and Institutional Complexity**

IL theory explains why organisations do not consider circular options solely from a technical perspective. IL are socially constructed values, beliefs, rules and practices that constitute definitions of rational, legitimate and appropriate behaviour in a given field (Thornton et al., 2012). These logics are not single level. They are field and organisation level but in this study they are examined through practitioner narratives. The case study examines how institutional logics are expressed and invoked by infrastructure professionals in their descriptions of decision criteria. That is, this study approaches logics as institutional patterns that are expressed by practitioners.

Research identifies a number of logics particularly important to CE. A market logic emphasises cost effectiveness, profitability and marketability. A pro environmental logic focuses on resource efficiency, lifecycle minimisation and environmental sustainability (Vedula et al., 2022). In infrastructure, a performance or reliability logic is also important because the continuity, technical integrity and availability of the service or system is prioritised. A compliance logic is also relevant but distinct. It focuses on regulatory adherence, legal defensibility and risk mitigation. These logics are analytically distinct, but they can be complementary in practice. Here, they are considered as the primary logics that may influence circular evaluation in Nordic OEM utility ecosystems.

IC is the situation where organisations are exposed to multiple, sometimes competing, logics (Greenwood et al., 2011). This is relevant to this thesis, but it is used as a context rather than a causal mechanism. Infrastructure actors operate across multiple logics. They work in contexts where they must navigate market, compliance, reliability and sustainability demands. ESG and sustainability strategy research illustrates how this can

lead to a privileging of economically visible actions while relegating sustainability concerns as secondary unless they can be reconciled with existing performance metrics (Jatmiko et al., 2025). Related research on moral markets demonstrates that environmental intentions are mediated by the institutional environment (Vedula et al., 2022).

Research on CE adds more detail. Research on circular strategy reveals that firms can respond through compliance and commercial approaches, in which circular actions are constrained to compliance or cost savings or through value chain and value creation approaches, where circularity is embedded in inter organisational collaboration and strategic reframing (Dagilienė et al., 2024). Here, the distinction is helpful as a sensitising device, not as a typology of logics. It provides clues to how the core logics outlined above play out in more conservative and more expansive CE responses.

Critical infrastructure is a heightened context. Infrastructure organisations are highly publicly, technically and legally scrutinised. They rely on dependability, security and compliance for legitimacy. Research on sustainability transitions in contested industries demonstrates that incumbent firms often perceive systemic change as a threat when it disrupts the status quo operating environment (Benito & Meyer, 2024). In the Nordic OEM utility ecosystems, this means that rationales for repair, remanufacturing or lifetime extension that are pro environmental may be at odds with reliability and compliance rationales that focus on proven performance and low risk of operation. The role of institutional logics in this thesis is therefore to understand which of these rationalities are dominant in decision accounts and how they play out in system boundary framing in the assessment of circular options.

## **2.5 Synthesis of the Literature and Analytical Framework**

The above literature suggests that CE in critical infrastructure cannot be explained by technical considerations alone. CE research shows that circularity is contested and that its sustainability impact depends on the circumstances of its implementation (Corvellec

et al., 2022). Infrastructure studies demonstrate that circular alternatives are shaped by uncertainty, regulation, coordination costs and failure costs (Bressanelli et al., 2019). Institutional logics research explains why these pressures are not seen as neutral constraints but as socially organised legitimacy and rationality criteria (Thornton et al., 2012). System boundary framing then explains how these criteria are operationalised in specific decision scopes and evaluative blind spots (Velter et al., 2021). These literatures suggest an organisational explanation for circular strategy choice.

The analytical framework used for this thesis therefore has one condition, two main analytical mechanisms and one outcome. The contextual condition is institutional complexity: Nordic OEM utility ecosystems are simultaneously pressured to be circular, cost-effective, reliable, safe and compliant (Greenwood et al., 2011). The first analytical mechanism is institutional logics, which capture the dominant rationalities shaping decision makers' perceptions of what is legitimate and possible. The second analytical mechanism is system boundary framing, which represent the translation of those rationalities into inclusion and exclusion in circular evaluation. The result is circular strategy orientation, defined here as whether circular options are embraced, partially constrained or excluded.

This approach also resolves the role of decision drivers and barriers. In this thesis, they are not a separate theoretical construct. Rather, they are empirical signs of how the two mechanisms are expressed in the data. For instance, mentions of downtime risk, certification, short payback periods or lifecycle benefits are interpreted as indicators of the expression of institutional logics and boundary choices. This maintains analytical consistency and prevents the framework from becoming a different theory that describes survey content.

The framework informs Chapter 4 directly. For RQ1, the analysis identifies what the respondents include and exclude from their assessment of circular options, with the boundary dimensions of lifecycle scope, impact scope, risk scope, cost horizon and responsibility scope. For RQ2, the analysis identifies institutional logics that are invoked in the accounts, particularly market, reliability, compliance and pro environmental logics.

For RQ3, the analysis explores how the interaction between these logics and boundaries determine circular strategy orientation. The framework is thus not merely descriptive. It offers an operational logic for coding, analysing and interpreting the data.

In conclusion, this chapter suggests that CE decisions in Nordic OEM utility ecosystems are best conceptualised as social evaluation processes conducted in institutional complexity. The following chapter explains how this study operationalises this framework in a qualitative dominant, cross sectional survey design and how the data are analysed.

### **3. Research Methodology**

To understand the design of CE decisions in the Nordic OEM utility ecosystems, a methodology was needed. This chapter described the research design, data collection and analysis methods used to study this question. The research started with the premises outlined in the earlier chapters: CE decision making in critical electrical infrastructure was not merely a matter of technical evaluation but of system boundary conceptualisation and institutional logics. As such, the research design needed to capture how infrastructure professionals perceived decision criteria, operational limitations and organisational priorities. Accordingly, the study opted for a cross sectional, qualitative dominant survey design, which featured a structured questionnaire with a mixture of closed and open ended questions. This enabled us to describe patterns across the sample and to gather interpretive data relevant to the study's analytical framework (Creswell, 2023; Patton, 2015).

The chapter was structured around the key steps of the research process. Chapter 3.1 outlined the research context and justified the use of a survey with a qualitative dominant design in relation to the research questions. Chapter 3.2 outlined the use of the survey as the main data collection tool and the use of both closed and open ended items. Chapter 3.3 described the purposive sampling approach to engage infrastructure practitioners during EnergyWeek 2026 and reflected on the event based nature of this sample (Etikan, 2016; Palinkas et al., 2015a). Chapter 3.4 described the data analysis, which featured descriptive statistical summaries and theory informed qualitative thematic analysis of boundary framing and institutional logics in the accounts of respondents (Braun & Clarke, 2006; Nowell et al., 2017). Chapter 3.5 then discussed the reliability, validity and ethics of the research process to ensure research transparency and methodological rigour (Orb et al., 2001).

### 3.1 Research Context and Study Design

This study was conducted in the empirical setting of Nordic OEM utility ecosystems engaged in electricity infrastructure asset management. This was a relevant context because CE options in such ecosystems needed to be weighed against considerations of system reliability, safety, compliance and cost. The research examined practitioners operating across these inter dependent organisational settings, where the decision making processes for repair, refurbishment, remanufacturing and lifetime extension were influenced not only by technical issues but also by institutional priorities and boundary setting.

The data were gathered in Vaasa, Finland, at EnergyWeek 2026. The event was not just a convenient site, but one that included actors relevant to the study's analytical frame. The EnergyWeek event was advertised in the official programme as a multi day event involving seminars, exhibitions and matchmaking activities, with themes such as circular economy, energy systems, regulation, storage, business and innovation (EnergyWeek, n.d.-a). Additionally, the event was attended by partner organisations and companies from the energy, technology, regional development and university sectors, making it a convenient opportunity to reach a range of respondents from across the infrastructure ecosystem, rather than from a specific organisation or role (EnergyWeek, n.d.-a, n.d.-b). However, the event may also have influenced responses by drawing participants who were already involved in sectoral discussion, innovation activity or sustainability related conversations and this was regarded as a contextual limitation of the study. The survey invitation leaflet used during EnergyWeek 2026 is presented in Appendix A.

The research conducted an exploratory, qualitative dominant, cross sectional survey. This distinction is important. It was not a full mixed methods survey in which the quantitative and qualitative elements were given equal weight in the analysis. Rather, the survey was used primarily to produce qualitative data on how practitioners described decision criteria and constraints, and circular evaluation practices, while closed ended items were used to provide descriptive statistical evidence to support identifying common themes among respondents. This approach was justified because the research

questions were concerned with how institutional logics and system boundary framing were present in practitioners' accounts not about hypothesis testing or statistical inference (Creswell, 2023; Patton, 2015). The final survey instrument used in the study is reproduced in Appendix B.

Consequently, the survey used closed and open ended items. Closed ended questions were used to describe trends, such as which decision criteria respondents reported as most important and which organisational priorities were mentioned most often. Open ended items were used to understand how that was described by the respondents and how they described inclusion, exclusion, trade-offs and constraints in circular decision making. Therefore, the open ended survey responses were fundamental to this research because they provided the interpretive data needed to understand how decision making boundaries were defined and how institutional logics were operationalised (Patton, 2015). The descriptive statistics did not provide an independent explanatory dimension but complemented the qualitative analysis by displaying the degree to which certain themes or criteria were present in the sample (Creswell, 2023).

The study was therefore analytically rather than statistically representative. The sample was purposive and event based and centred on professionals whose work brings them into contact with infrastructure asset decision making in Nordic energy sectors (Patton, 2015). This made the study fit for purpose in terms of providing insights into the organisational processes underpinning the research questions, but not for making population inferences. The results should thus be interpreted as explorative and theoretically illuminating descriptions of decision making at a particular sectoral location and time.

### **3.2 Data Collection Methods**

We used a structured, self completed survey using the online survey platform Webropol. The survey included 14 items, including both closed and open ended questions. The questionnaire was designed to be completed in 3-4 minutes, as stated in the event

leaflet. It was promoted during EnergyWeek 2026 in Vaasa via QR linked printed leaflets, posters and it was also sent by email after talks and to some professionals individually. This means that the survey could be filled in during visits to the event halls, afterwards following a discussion with the researcher or online via the QR link. The questionnaire was voluntary and anonymous, with 44 responses received. The final questionnaire is reproduced in Appendix B and the recruitment and response context is summarised in Appendix C.

The source version of the questionnaire was in English. Finnish and Swedish versions were then developed with the help of Finnish and Swedish speaking reviewers, to ensure that the meaning of each item was as close as possible to the English version. Equivalence was tested by comparing the wording of the items with the source version, and by verbally checking with Finnish and Swedish speaking people during the data collection phase that the wording was easy to understand. The questionnaire was not pre tested before the event, which is a limitation of the study. However, the language checking process minimised the risk that large variations in wording would influence the interpretation of the three language versions. The English source version of the questionnaire is presented in Appendix B.

The questionnaire was developed to support a qualitative dominant survey. The questionnaire contained closed items that asked about the respondent's industry, role, the most common circular strategies considered, the system boundaries used, the most common perspectives taken in decision making and how frequently conflicts arose among goals. These questions allowed for descriptive statistical analyses of common patterns among the sample. The open ended questions then sought to understand what typically triggered circular evaluation, what was included and what was excluded from assessment, what occurred when circular objectives were in conflict with reliability, safety, cost or compliance, what were the major barriers and a recent decision case. As Patton (2015) notes, these open responses were crucial because they provided respondents' descriptions of their decision rationalities, context constraints and organisational practices rather than only those expressed in the categories provided.

The response context requires careful interpretation. Some 250 flyers were distributed at EnergyWeek and 22 invitations were sent by email for an approximate total of 272 invitations. Based on this, the response rate for the 44 completed surveys was 16%. This figure must be interpreted with caution, however, as invitations were sent via several channels, some respondents may have seen the survey more than once and it is not possible to know how many people saw but did not scan the invitation. Thus, the survey was not designed to calculate an official response rate, in the survey statistical sense. Rather, it was intended to provide evidence for exploratory purposes from a targeted group of infrastructure professionals. But the potential for response bias remained, especially in favour of those already engaged with circularity, innovation or broader sectoral debate. A summary of the recruitment routes, invitation volume and response context is provided in Appendix C.

### **3.3 Sampling and Participants**

This survey employed a purposive event based sampling that also had elements of convenience and self selection. It was purposive because the survey was targeted at professionals who are likely to have an insight into infrastructure or asset management decisions in the Nordic energy sector and the invitation was sent mainly to those encountered in that sector. It was also convenient because the participants were recruited at an accessible industry event and by the researcher personally distributing leaflets and sending emails. And it was self selecting because there was no guarantee that people would scan the QR code and respond to the questionnaire. So, the sampling strategy should be clearly identified as purposive convenience with self selecting, rather than as purely controlled purposive (Etikan, 2016; Fowler, 2014; Palinkas et al., 2015a; Patton, 2015).

Participants were included based on practical rather than organisational criteria. Participants were deemed relevant if they were from an organisation that was related to energy or electrical infrastructure and their role was related to or involved,

infrastructure, asset, engineering, sustainability, innovation, policy or regulatory decisions. This was verified by the first two questions in the survey, which asked respondents to describe their organisational sector and their role in making infrastructure or asset decisions. The invitation was also distributed in person to professionals who seemed relevant to the thesis based on discussion at the conference and the same screening questions were used for targeted email distribution. This did not rule out the possibility of fringe respondents, but it did offer a broad screening to ensure that the majority of participants were from the targeted professional group. The screening items used to identify respondents' sector and role are included in Appendix B.

We received 44 fully completed responses. The sector breakdown was: power generation or utility, 9 (20.4%); transmission or distribution or grid operator, 8 (18.2%); equipment manufacturer, 7 (15.9%); technology provider or digital solutions, 5 (11.4%); consultancy or advisory, 4 (9.1%); government or regulator or policymaking body, 3 (6.8%); research or academia, 7 (15.9%); and other, 1 (2.3%). Similarly, the role distribution was diverse: strategic decision maker, 5 (11.4%); engineering or technical specialist, 7 (15.9%); asset management or maintenance, 9 (20.5%); sustainability or ESG, 6 (13.6%); innovation or business development, 6 (13.6%); policy or regulatory, 3 (6.8%); research or academic, 7 (15.9%); and other, 1 (2.3%). This ensured that the study was able to capture decision accounts from a range of areas within the infrastructure sector, rather than just one part of the organisation. The full participant profile is presented in Appendix D.

This variation was helpful because the thesis considered the decisions about the circular economy as the outcome of diverse priorities among organisational and professional roles. Participants from engineering, asset management, sustainability, innovation and policy positions were likely to have different evaluation criteria and different institutional pressures. The sample thus supported the thesis' focus on system boundary definition and institutional logic expressions across a connected, yet internally diverse ecosystem. However, the sample cannot be considered representative of the Nordic energy sector.

It only represented those people who attended or were invited to the event, found the topic interesting and decided to participate.

These limitations are important. The event, direct approach and voluntary responses mean that the sample could have included those who were already interested in the topic of circularity, innovation or broader sectoral issues. The event format also meant that the sample was not completely controllable, as with a closed sampling frame. As a result, the results are best seen as being exploratory and analytically descriptive rather than statistically representative. They offer insights into reasoning, inclusion, exclusion and prioritisation among a targeted group of infrastructure professionals, rather than extrapolating population level frequencies for the infrastructure sector (Patton, 2015).

### **3.4 Data Analysis Methods**

The analysis in this study involved a two pronged approach, which involved descriptive analysis of the closed ended survey questions and theory driven thematic analysis of the open ended questions. The descriptive analysis involved frequencies and percentages calculated from the Webropol survey data. These were used to describe the representation of the sample across sectors and roles, and the patterns of response in terms of circular strategies, factors in decision making, system boundaries, dominant views and frequency of conflict. The descriptive analysis was not inferential. It was used to organise the sample and demonstrate which issues were the most common among respondents (Fowler, 2014). The qualitative analysis then provided the bulk of the explanatory burden, as per the qualitative dominant study design (Creswell, 2023). The descriptive results used in Chapter 4 are presented in Appendix E and item level response counts are reported in Appendix F.

The open text responses were analysed using thematic analysis as described by Braun & Clarke (2006). The first step was to read the entire open text data set multiple times to gain a sense of the content, style and diversity of respondents' accounts. At this stage the researcher made preliminary notes about how the respondents talked about circular

decision criteria, constraints, trade-offs and organisational priorities. This was a critical step because the purpose was to identify common words or themes, but also to explore how respondents framed the decision context (Braun & Clarke, 2006).

The coding process was theory driven, but not rigidly bound by it. The initial codes were derived from the main analytical concepts identified in Chapter 2 system boundary framing, institutional logics and circular strategy orientation. This meant that we were coding for what respondents reported as included and excluded in the assessment, which logics seemed to be at play and how circular opportunities were justified, constrained or dismissed. However, we did not attempt to fit responses that did not fit those categories. New codes were added when respondents referred to issues like lack of data, certification, urgency, trust, planning or implementation. This enabled the analysis to be theoretically driven, but not purely confirmatory. The coding framework used in the thematic analysis is presented in Appendix G.

The coding was done by the researcher and was refined throughout the analysis. Following the initial coding, the codes were merged, broad codes were divided and the structure was refined to enhance clarity and consistency across the data. The refined codes were then organised into higher level themes that corresponded to the research questions boundary framings in circular evaluation, dominant institutional logics and the interplay between these two. During this stage, decision drivers and barriers were used as empirical manifestations rather than as a theoretical construct. They were used to demonstrate how boundary framing and institutional logics played out, rather than as a separate dimension of analysis to the Chapter 2 framework.

The last step was to interpret these themes in the light of the analysis framework. In this stage, the qualitative data were interpreted through the lens of the descriptive patterns in the survey to achieve a move from description to explanation. For instance, the structured responses indicated the most common boundary levels or decision logics that were selected, but the open ended responses explained how the decision making was justified and when these selections became critical. This allowed us to analyse not just what respondents chose, but also how they explained the practical making of circular

economy decisions in Nordic OEM utility ecosystems (Nowell et al., 2017). The outcome was an analysis that was rooted in the survey data, but that was also able to produce theory driven interpretations relevant to the three research questions (Patton, 2015). Additional anonymised response excerpts organised by theme are presented in Appendix H.

### **3.5 Reliability, Validity and Ethical Considerations**

In this exploratory, qualitative dominant survey study, quality of the study was determined more by credibility, dependability, confirmability and transparency than by statistical generalisability (Patton, 2015). Credibility was enhanced in a number of ways. First, the items in the survey were framed to correspond with the analysis concepts, particularly system boundary framing and institutional logics, so that the structured and open ended questions tapped into the same phenomenon from different perspectives (Creswell, 2023). Second, the Finnish and Swedish surveys were reviewed against the English version of the survey by Finnish and Swedish speaking colleagues to ensure that translations were equivalent. Third, in the analysis, brief or vague open ended comments were analysed multiple times and interpreted in view of the respondent's structured answers and broader data. This helped to minimise the risk of overinterpreting short survey comments or reading more into them than was warranted. The coding framework and supporting thematic excerpts are presented in Appendices G and H.

Dependability was enhanced by an iterative and transparent analytical process. The researcher coded the data manually and took brief analytical notes during the familiarisation, coding and theme development stages to record how interpretations evolved across the data (Braun & Clarke, 2006; Nowell et al., 2017). Codes were modified where initial categories were too vague, redundant or inconsistent with the expressions used by the respondents. Confirmability was enhanced by limiting interpretation to the material in the responses and by conservatively considering open ended responses,

particularly short ones. The descriptive statistics also contributed to confirmability by indicating if the qualitative observations were consistent or inconsistent with the closed ended items. However, there were also limitations. The findings were self reported, cross sectional and drawn from an event based convenience sample. The data thus reflected participant perceptions of decision making at a snap shot in time and not a direct assessment of organisational practices and were vulnerable to participation bias and social desirability (Fowler, 2014).

The research also adhered to ethical guidelines for anonymous volunteering. Participants were provided with an overview of the survey's aims, voluntary nature and anonymity at the beginning of the survey. Webropol was set up so that personal data were not automatically collected, unless the respondents provided such information in their answers. They were instructed not to share confidential company information in the free response questions. The University of Vaasa describes itself as committed to responsible science, good scientific practice and the ethical standards of the humanities, social sciences and behavioural sciences and that it complies with the Finnish Code of Conduct for Research Integrity published by TENK (University of Vaasa, n.d.). The university also states that it is important to manage research data so that confidentiality, privacy and data security are assured and that, once a study or research project has ended, national data services such as Fair data can be used for publishing and archiving research data (University of Vaasa, n.d.). Following this guidance, the survey data, data analysis files and draft of the thesis were managed in the researcher's password protected University of Vaasa OneDrive account to which only the researcher had access. The working files will be kept and handled according to University of Vaasa research data guidance and supervisory guidelines and then securely disposed of (University of Vaasa, n.d.). A summary of the participant information and data handling procedures is provided in Appendix I.

## 4. Findings and Analysis

This chapter presents the empirical findings of the study and explores them through the theoretical framework developed in Chapter 2. The study combines descriptive use of the closed ended survey questions with theory based thematic analysis of the open ended questions. The focus was not only to report response patterns, but also to examine how CE decisions were framed within Nordic OEM utility ecosystems through the interaction of system boundary framing and institutional logics. The empirical material was drawn from 44 anonymous survey responses collected from practitioners connected to energy and electrical infrastructure. Respondents represented utilities, grid operators, OEMs, technology providers, consultants, regulators and academic or research oriented roles. Their professional backgrounds included asset management, engineering, sustainability, innovation, policy and strategy. Since the sample was self selected and exploratory, the findings are not presented as statistically generalisable. Rather, the responses provide an informative indication of how CE decision making was understood within this sample of infrastructure related professionals. Descriptive survey tables are provided in Appendices D-F, while additional thematic extracts are presented in Appendix H.

The chapter is organised in direct relation to the three research questions. Section 4.1 addresses RQ1 by examining how respondents framed the system boundary considered relevant when assessing circular options. Section 4.2 addresses RQ2 by analysing the institutional logics that appeared to shape CE decision making, particularly reliability, safety, compliance, cost and sustainability. Section 4.3 addresses RQ3 by examining how system boundary framing and institutional logics interacted in shaping circular strategy orientation. Section 4.4 then evaluates and refines the analytical framework introduced in Chapter 2 while Section 4.5 draws practical implications for improving CE decision making in Nordic OEM utility ecosystems.

Overall, the data suggest that CE decisions within this sample were not made from a single sustainability perspective. Instead, the responses indicate that circular options

were assessed through shifting and sometimes contested decision boundaries. Lifecycle oriented sustainability goals were often balanced against shorter term operational priorities, while cost, reliability, compliance and sustainability appeared as recurring decision criteria. The chapter therefore distinguishes between the empirical patterns reported by respondents and the interpretation of those patterns through the study's theoretical framework.

#### **4.1 Boundary Definitions in Circular Economy Decision Making**

This section addresses RQ1 by examining how respondents defined the system boundary considered relevant when assessing CE options. Within this sample, the responses suggest that CE decision making in Nordic OEM utility ecosystems was not guided by one dominant boundary. Instead, respondents referred to several possible scopes of evaluation, ranging from parts and equipment to organisational, system level and lifecycle level boundaries. This indicates that circular decisions were shaped not only by the technical characteristics of an asset but also by what actors considered relevant, measurable and legitimate in the decision context.

The closed ended responses show a distributed pattern of boundary framing. The most frequently selected boundary was the system level, such as a substation, line, plant or section of the grid, identified by 25.0% of respondents. This was followed by the full lifecycle or supply chain level at 22.7%. Smaller or narrower boundaries were also visible 18.2% selected the equipment or product level, 18.2% selected the organisational level and 15.9% selected the part or element level. These results indicate that circular evaluation was neither fully narrow nor fully lifecycle oriented. Rather, the data suggest a multi level pattern in which different respondents located circular decisions at different points in the infrastructure system. The full descriptive statistics are presented in Appendix E, Table E3.

The open ended responses help explain why these boundaries varied. One important pattern was lifecycle scope. Some respondents described CE evaluation in broad terms

including “full lifecycle emissions, upstream materials, downstream impact” and “entire system impacts,” including materials, emissions and reuse cycles. These responses suggest that lifecycle thinking was present within the sample, especially where respondents framed CE as a long term resource and sustainability issue. However, lifecycle scope was not always the applied decision boundary. Several responses also noted that broader lifecycle considerations could be excluded when they were difficult to measure, lacked reliable data or conflicted with immediate operational requirements.

A second pattern concerned impact scope. Some respondents included environmental impacts, material use, emissions, reuse potential and end of life consequences in their assessment of circular options. Others framed impact more narrowly through asset performance, reliability and service continuity. For example, one respondent stated that the organisation primarily considered the operational performance of the asset and that emissions or upstream impacts were not usually part of the discussion. This distinction is important because it shows that CE was not always assessed as a broad sustainability intervention. In some responses, circularity was interpreted through the narrower question of whether the asset would continue to perform safely and reliably.

A third pattern was risk scope. Several responses suggest that risk sensitive infrastructure contexts narrowed the CE boundary around reliability, safety and failure avoidance. In these cases, circular options were considered only if they did not increase operational uncertainty. Respondents referred to system stability, safety and performance as included factors, while wider environmental or supply chain considerations were sometimes excluded. This pattern was especially visible in responses that reflected an operational or asset management perspective. Although the anonymous survey design does not allow a strict comparison between professional groups, the language of these responses suggests that actors closer to asset operation tended to frame CE through risk control and service continuity.

A fourth pattern concerned the cost horizon. Some respondents included lifecycle cost and long term value in circular evaluation while others indicated that short term cost, repair feasibility and execution constraints dominated actual decisions. This difference

shows that cost was not a single category. It could be framed narrowly as immediate cost, outage cost or project cost, or more broadly as lifecycle cost and long term system value. One response captured this tension by stating that analysis may include materials, emissions and lifecycle cost but that companies often narrow the perspective when making decisions. The data therefore suggest that cost horizon affected whether circular options appeared viable or risky.

A fifth pattern related to responsibility scope. Some responses framed CE as a shared ecosystem issue involving suppliers, OEMs, utilities, customers, regulators and asset owners. Others located responsibility mainly inside the organisation or within the immediate asset decision. This matters because circular strategies such as reuse, refurbishment, remanufacturing and recycling often require coordination beyond a single organisation. Aarikka-Stenroos et al. (2021) argue that CE ecosystems must be understood through interdependence and coordination rather than isolated firm level decision making. Similarly, Velter et al. (2021) show that sustainable and circular innovation requires boundary work where actors negotiate what belongs inside and outside the solution boundary.

The responses also indicate that boundaries could contract under urgency. Several respondents noted that when failure, outage or time pressure occurred, broader lifecycle and sustainability considerations became less visible. One respondent stated, "We try to solve the problem quickly. We do not think about the big picture or lifecycle." This suggests that boundary framing was not fixed. When time, data and coordination were available, wider lifecycle or system level boundaries could be considered. In urgent operational settings, however, the effective boundary often narrowed to repair feasibility, safety, service continuity and short term risk reduction.

Information limitations were another reason why boundaries narrowed. Several exclusions were not based on rejection of lifecycle thinking but on the difficulty of accessing reliable data or combining supply chain, environmental and operational evidence in decision making. This finding is consistent with Charnley et al. (2019), who show that circular decisions in industrial contexts rely on information that is often

incomplete or difficult to access. Anttiroiko (2023) similarly argues that circularity in complex systems depends not only on ambition but also on technologies and governance arrangements that improve system transparency. Setyadi et al. (2025) further suggest that sustainable operations require the translation of broad decision architectures into practical organisational routines.

Taken together, the findings indicate that boundary definitions in CE decision making were multiple, shifting and context dependent. Within this sample, lifecycle and system level framings were clearly present but they coexisted with narrower product, component, organisational, cost and risk based boundaries. The data suggest that broader boundary framing required stronger information, coordination and responsibility sharing across the ecosystem. When these conditions were weak, CE decisions tended to contract toward operational reliability, immediate cost, compliance and risk control. This finding provides the basis for Section 4.2 which examines the institutional logics that shaped how these boundaries were prioritised in practice.

## **4.2 Dominant Institutional Logics in OEM–Utility Ecosystems**

This section addresses RQ2 by examining which institutional logics shaped CE decision making in Nordic OEM utility ecosystems. The responses suggest that CE decisions were not governed by a single evaluative principle. Instead, several logics were present at the same time including sustainability, financial, technical reliability, compliance, innovation and stakeholder oriented perspectives. The key finding, however, is not simply that these logics coexisted. Rather, the data indicate a situational hierarchy sustainability was prominent at the level of ambition and strategic framing while reliability, safety, cost and compliance gained stronger authority during implementation.

The closed ended responses show the salience of several decision perspectives. Sustainability or environmental considerations were selected by 63.6% of respondents, followed by economic or cost considerations at 52.3% and technical reliability at 50.0%. Innovation or competitiveness was selected by 40.9%, while stakeholder or reputation

perspectives were selected by 29.5%. Risk management and regulatory compliance appeared less frequently in the closed ended responses, at 20.5% and 18.2%, respectively. However, the conflict related responses show that these perspectives did not operate harmoniously 54.5% of respondents reported that conflicts occurred frequently while a further 22.7% reported that they occurred sometimes. These results suggest that salience was not the same as dominance. The full descriptive results are presented in Appendix E, Tables E4 and E5.

This distinction is analytically important. A decision factor becomes an institutional logic when it functions as a rule for what counts as legitimate, acceptable or responsible action. For example, cost is not automatically a market or financial logic. It becomes one when short term budgets, return on investment expectations or cost efficiency requirements determine whether a circular option is considered acceptable. Similarly, reliability becomes a technical operational logic when safety, uptime and failure avoidance define the limits of what can be implemented. This section therefore treats the survey responses not as a simple list of factors but as evidence of how different logics gained authority under different decision conditions.

The strongest operational logic in the open ended responses was technical reliability and safety. Respondents repeatedly referred to system stability, service continuity, failure avoidance and safety as decisive criteria. Statements such as “Reliability always overrides sustainability”, “Safety always wins” and “In practice, reliability trumps all” show how circular options were filtered through operational risk. In this context, a refurbished transformer, reused cable or remanufactured component was not assessed only as a circular or sustainable option. It was assessed as part of a critical infrastructure system where malfunction could create service disruption, safety consequences, liability exposure or reputational damage.

The financial or market logic was also strong. In the closed ended responses, cost efficiency was the most frequently selected decision factor at 61.4%. Open ended responses reinforced this pattern through references to “cost dominates”, “budget constraints”, “limited financial flexibility”, “lower up front cost” and “unclear return on

investment". These responses suggest that financial logic shaped implementation through project budgets, procurement routines and expectations of measurable returns. As a result, circular options with long term lifecycle benefits could become difficult to justify when they required higher initial investment, additional coordination, uncertain payback or stronger evidence before adoption.

Sustainability logic was clearly present but its authority was more conditional. Respondents referred to carbon targets, ESG reporting, sustainability plans, customer reporting and environmental directives as reasons for considering circular options. In some cases, circular strategies such as refurbishment or predictive maintenance were supported because they reduced emissions, prolonged asset life or avoided unnecessary replacement. These examples show that sustainability logic was not merely symbolic. It influenced which options entered the decision space. However, the same responses also suggest that sustainability was often negotiated, compromised when it conflicted with reliability, safety, cost or compliance requirements.

Compliance logic played a more decisive role than its closed ended frequency initially suggests. Although regulatory compliance was selected by only 18.2% of respondents in the structured item, the open ended responses show that standards, certification, liability, policy targets and environmental regulation could determine whether circular options were accepted or rejected. In this sense, compliance logic functioned as a gatekeeper. When certification, legal responsibility or long term performance accountability was uncertain, the sustainability appeal of a circular option was often insufficient. This aligns with Shnayder et al. (2021), who show that infrastructure organisations must manage several internal and external logics at once with regulatory regimes shaping both internal integration and external positioning.

Innovation and competitiveness logic appeared as an enabling rather than dominant logic. Respondents mentioned digital diagnostics, predictive analytics, pilot projects, innovation programmes, transformation plans and market differentiation as ways to support circular options. These responses indicate that CE was not viewed only as a constraint or compliance burden. It was also seen as a potential source of learning,

differentiation and technical development. However, innovation logic appeared strongest when it reduced uncertainty or improved evidence. It rarely displaced technical reliability or financial logic by itself. Instead, innovation became influential when it supported safer, more traceable and more economically defensible circular strategies.

These findings are best understood through institutional complexity. Dagilienė et al. (2024) show that circular transition in companies is shaped by compliance, commercial, value chain and value creation logics. Vedula et al. (2022) similarly demonstrate that pro environmental and market logics can coexist, compete and reshape decision making environments. The findings of this study suggest a comparable configuration within critical electrical infrastructure but with stronger operational constraints. Sustainability logic was visible and sometimes influential yet it entered a decision environment already structured by reliability, safety, cost, compliance and urgency.

Overall, the responses indicate a hierarchy of institutional logics rather than a single dominant logic. Sustainability was most visible in strategic ambition and in the justification for considering circular options. Technical reliability and safety dominated when circular options moved toward implementation. Financial logic shaped whether options were affordable, fundable and justifiable within existing procurement and investment routines. Compliance logic became decisive when standards, certification or liability were uncertain. Innovation logic created opportunities but mainly when it strengthened evidence, traceability or risk reduction. Additional anonymised respondent extracts are provided in Appendix H, Sections H4–H7.

### **4.3 Interaction Between Boundary Framing and Institutional Logics**

This section addresses RQ3 by examining how system boundary framing and institutional logics interacted in shaping circular strategy orientation. The findings suggest that these two dimensions did not operate separately. Boundary framing shaped which decision criteria became relevant while institutional logics shaped which boundaries were treated

as acceptable or legitimate. In practical terms, what respondents included in the decision influenced which logic gained priority. At the same time, the dominant logic influenced what respondents considered necessary to include or exclude. The codebook used to identify these interaction patterns is provided in Appendix G.

The first interaction pattern linked narrow operational boundaries with reliability and safety logics. When respondents framed the circular decision around an immediate asset, component or grid function, the decision was usually assessed through performance, continuity and failure avoidance. In these cases, the relevant boundary was not the full lifecycle or wider supply chain. It was the asset or infrastructure element under direct operational scrutiny. Responses that included system stability, safety and immediate repair feasibility, while excluding environmental or upstream supply chain impacts reflect this pattern. The data therefore suggest that reliability logic did not merely coexist with a narrow boundary. It helped justify why the boundary should remain narrow.

This does not mean that reliability always dominated every circular decision. The responses suggest a more specific pattern. Reliability and safety gained priority when circular options were perceived to create uncertainty about failure, downtime, service continuity, liability or technical performance. Under these conditions, respondents treated the wider sustainability value of a circular option as secondary to the need for dependable infrastructure operation. This is especially relevant in critical electrical infrastructure, where an asset decision can affect not only environmental performance but also safety, continuity of supply and organisational responsibility for failure.

The second interaction pattern linked short term cost boundaries with financial logic. When respondents framed the decision around immediate project cost, available budget or short term feasibility, long term lifecycle benefits became less visible in the decision. Responses such as “Includes budget and operational cost; excludes lifecycle and environmental impact” and “Replacement selected due to lower upfront cost despite higher lifecycle impact” illustrate this pattern. In these cases, financial logic did not only prioritise cost. It also shaped what counted as economically relevant. Long term savings,

avoided emissions and future reuse value could be recognised in principle but still remain outside the practical decision boundary.

The third interaction pattern showed that wider lifecycle and system boundaries allowed sustainability and circular value logics to become more relevant. When respondents included emissions, materials, reuse cycles, lifecycle cost and supply chain effects circular options were more likely to be assessed as long term value creation strategies rather than only as technical substitutions. This wider boundary made it easier to justify repair, refurbishment, predictive maintenance or redesign for longer life. However, the responses also suggest that this wider framing was unstable. It depended on the availability of data, time, coordination and confidence that circular options would not increase operational or compliance risk.

A fourth pattern concerned the gap between strategic analysis and implementation. Several responses distinguished between what organisations include in analysis and what they apply in actual decisions. One respondent stated that in analysis, “we include everything materials, emissions, lifecycle costs. But in reality, companies narrow the scope when making decisions”. This statement captures a central finding of the study. Sustainability oriented boundaries could exist at the level of planning, reporting or strategic discussion while narrower operational boundaries became more influential when a decision had to be implemented. The interaction between boundaries and logics therefore occurred not only between different ideas but also between different organisational levels.

This process can be understood as practical institutional filtering. CE entered the decision environment with broad sustainability aims but these aims were filtered through reliability, cost, compliance and urgency. At each decision point, the effective boundary could either remain broad or contract. The responses suggest that circular options could be technically feasible, strategically desirable or environmentally positive yet still fail to move forward when the applied boundary narrowed around risk, cost, certification or short term operational need. Further extracts on these implementation gaps are provided in Appendix H, Sections H8-H10.

Compliance added another layer to this interaction. When certification, liability, standards or regulatory responsibility were unclear, compliance logic could restrict the boundary even further. In such cases, the question was not only whether a reused, refurbished or remanufactured option was technically possible. The question was whether it could be accepted within existing rules and accountability structures. This helps explain why some circular strategies required more evidence than conventional replacement. A new component may fit existing procurement and certification routines more easily while a circular alternative may require additional proof of quality, traceability and long term performance.

This finding is consistent with research on boundary work and institutional plurality. Velter et al. (2021) show that sustainable business model innovation requires actors to negotiate organisational boundaries around new value propositions. Ho et al. (2022) similarly argue that circular transitions involve both collaboration and contestation across organisational boundaries. The present study extends this discussion to critical infrastructure decision making. Here, boundary work was not only about collaboration between organisations. It was also about deciding what kind of evidence, risk, cost, responsibility and lifecycle impact belonged inside the decision.

The interaction between boundaries and logics also helps explain the circular strategies preferred by respondents. The most frequently selected strategy was repair or maintenance at 52.3%, followed by redesign for longer life at 50.0%. Refurbishment or upgrade and replacement each received 43.2%, component reuse received 40.9%, recycling of materials received 34.1% and remanufacturing received 27.3%. This pattern suggests that strategies closer to existing operational boundaries were easier to justify. Repair, maintenance and redesign for longer life could often be aligned with reliability, asset performance and cost control. By contrast, remanufacturing or component reuse often required wider lifecycle coordination, supplier involvement, traceability, certification and shared responsibility.

Overall, the data suggest that CE decision making in Nordic OEM utility ecosystems was shaped through a mutual interaction between boundary framing and institutional logics.

Narrow component level, asset level or short term cost boundaries gave greater weight to reliability, safety and financial logics. Wider lifecycle and system boundaries created more room for sustainability and circular value logics. In conflict situations, reliability did not automatically dominate every decision but it became decisive when safety, downtime, liability or continuity of service were at stake. This interaction shaped circular strategy orientation by determining which circular options appeared legitimate, feasible and acceptable in practice.

#### **4.4 Comparison with the Analytical Framework**

The analytical framework presented in Chapter 2 proposed that CE decision making in Nordic OEM utility ecosystems can be understood through one contextual condition, two analytical mechanisms and one outcome. The contextual condition was institutional complexity. The two mechanisms were system boundary framing and institutional logics. The outcome was circular strategy orientation. The empirical findings support this structure, but they also refine it in important ways. The coding structure linking the empirical material to the analytical framework is presented in Appendix G.

The first refinement concerns boundary framing. The findings confirm that boundary definitions were central to CE decision making rather than secondary or incidental. Respondents varied in whether they located circular decisions at the part, product, system, organisational or lifecycle level. This supports the framework's assumption that circularity is assessed through specific decision boundaries not through an unlimited view of all possible environmental and organisational impacts. The findings also refine the framework by showing that boundaries were not fixed. They expanded or contracted depending on urgency, uncertainty, information availability, risk perception and operational pressure.

The second refinement concerns institutional logics. The findings confirm that multiple logics were present in the OEM utility ecosystem. Sustainability, financial, technical reliability, compliance, innovation and stakeholder oriented logics were all visible in the

responses. This supports the use of institutional complexity as the contextual condition. However, the findings also show that these logics were not equal in practice. Sustainability logic was visible in strategic ambition and in the justification for considering circular options but reliability, safety, cost and compliance gained stronger influence during implementation. The framework should therefore not be read as a horizontal list of coexisting logics. It should be understood as a hierarchy of logics whose dominance changed by situation.

The third refinement concerns the interaction between boundaries and logics. The findings support the framework's central claim that system boundary framing and institutional logics interact to shape circular strategy orientation. Narrow asset level, component level or short term cost boundaries tended to strengthen reliability and financial logics. Wider lifecycle and system level boundaries created more space for sustainability and circular value logics. However, the data also show a recurring gap between strategic framing and operational decision making. Respondents could recognise lifecycle value at the level of analysis yet actual decisions often narrowed around reliability, cost, safety, certification or immediate feasibility.

The fourth refinement concerns circular strategy orientation. The findings support the framework's decision to treat circular strategy orientation as an outcome rather than as an independent starting point. The survey responses showed several circular strategies, including repair, maintenance, redesign for longer life, reuse, refurbishment, recycling, remanufacturing and replacement. However, the choice between these strategies was not determined by technical circularity alone. It was shaped by how the decision boundary was defined and by which logic gained priority in the situation. For this reason, circular strategy orientation should be understood as situational rather than as a stable organisational preference.

A further refinement concerns data and evidence infrastructure. The original framework recognised the importance of boundary framing and institutional logics but the empirical findings show that data capability played a stronger role than expected. Respondents repeatedly referred to missing lifecycle data, limited supplier information, weak

traceability, fragmented information systems and limited long term evidence on refurbished or reused assets. These limitations made it difficult to sustain broader lifecycle boundaries in actual decision making. Data capability should therefore be treated as a cross cutting condition that affects whether broader sustainability reasoning can be maintained.

Taken together, the empirical findings confirm the main structure of the analytical framework but refine how it should be understood. First, boundaries are not fixed they shift according to risk, urgency, information and operational context. Second, institutional logics are not equal they form a situational hierarchy in which reliability, safety, cost and compliance often gain stronger authority during implementation. Third, circular strategy orientation is not a stable preference it emerges from the interaction between boundary framing and the dominant logic in a given decision situation. These refinements strengthen the explanatory value of the framework by showing why circular options may be strategically recognised but still limited in practice.

#### **4.5 Practical Implications for Circular Strategy Orientation**

The findings of this study suggest several practical implications for improving circular strategy orientation in Nordic OEM utility ecosystems. These implications are derived from the response patterns discussed in Sections 4.1-4.4. The data indicate that the main challenge was not simply low awareness of CE, sustainability or lifecycle thinking. Rather, the challenge was that broader circular considerations often became weaker when decisions were made under operational pressure, limited evidence, budget constraints, certification uncertainty or risk sensitive conditions.

The first implication is the need to include lifecycle assessment more systematically in operational decision making. The responses suggest that lifecycle and system level assessment were often recognised during analysis but actual decisions could narrow around immediate reliability, cost or feasibility. This indicates that lifecycle cost, emissions, material recovery potential, reuse value and system integration effects should

be included in routine decision support processes. This does not mean that reliability, safety and cost should be reduced in importance. It means that they should be assessed together with circular and lifecycle criteria rather than separately from them.

The second implication concerns data and traceability. Several respondents pointed to missing lifecycle data, limited supplier information, weak traceability and fragmented information systems as barriers to circular decisions. These findings suggest that digital tools can support circular strategy orientation but only when they are connected to organisational decision processes. Data systems, digital product records, predictive maintenance tools and asset tracking can help widen the decision boundary. However, technology alone does not solve the issue. The value of these tools depends on whether procurement, asset management, maintenance and sustainability teams use the data as part of shared decision making.

The third implication is the need for stronger certification and evidence practices. Respondents often connected the rejection of reuse, refurbishment or remanufacturing to uncertainty about performance, liability, certification and long term reliability. This suggests that circular options need credible technical evidence before they can become acceptable in critical infrastructure settings. Relevant actions include reliability data for refurbished assets, standardised testing procedures, clearer certification for reused components and documented evidence of long term performance. These measures could reduce the perceived risk of circular alternatives and make them easier to compare with conventional replacement. Additional respondent suggestions are presented in Appendix H, Section H11.

The fourth implication concerns planning before emergency replacement. Several responses indicated that circular opportunities were limited by reactive decisions, outage pressure, lack of downtime and emergency replacement needs. This finding suggests that circular strategy orientation depends strongly on timing. When replacement decisions are made under urgent conditions, the decision boundary often contracts toward service continuity and short term risk reduction. Organisations could therefore benefit from asset life prediction, planned maintenance windows, pre

approved circular alternatives and early evaluation of repair, reuse or refurbishment options before assets reach failure conditions.

The fifth implication is the integration of CE into normal infrastructure governance. In practical terms, integration means that circular criteria should be included in procurement requirements, asset management routines, maintenance planning, supplier evaluation, investment decisions and KPI systems. For example, procurement can include lifecycle cost and traceability requirements. Asset management can include repairability and reuse potential. Maintenance planning can include circular ready options before failure occurs. KPI systems can connect uptime, cost, emissions and material efficiency instead of treating sustainability as a separate reporting category. This aligns with Setyadi et al. (2025), who emphasise the role of cross functional decision making in making sustainability operationally effective.

The findings also suggest that CE should not be treated as a replacement for reliability or cost logic. In critical infrastructure, reliability, safety, compliance and financial responsibility remain central. The practical challenge is to create decision processes where these criteria can be assessed together with lifecycle and circular value. This requires wider decision boundaries, better evidence, clearer certification and stronger coordination across organisational functions. Within this sample, circular strategies appeared more likely to become acceptable when they were not framed as external sustainability goals but as part of ordinary infrastructure governance and long term asset performance.

## 5. Discussion and Conclusion

The shift toward a CE in critical electrical infrastructure is not only a technical challenge. It is also an institutional process shaped by risk, accountability, regulation and implementation conditions (Dagilienė et al., 2024; Vedula et al., 2022). This final chapter synthesises the findings of the study and answers the research questions. The findings suggest that practitioners did not treat circular initiatives as automatically feasible or sustainable. Instead, circular options were filtered through concerns related to reliability, safety, cost, compliance, responsibility and evidence. This interpretation is consistent with critical CE literature which cautions against treating circularity as an inherently sustainable route to resource decoupling (Corvellec et al., 2022; Zink & Geyer, 2017).

The chapter first summarises the empirical findings in relation to the three research questions. It then discusses the theoretical contribution of the study by explaining how system boundary framing and institutional logics interact in CE decision making within regulated and risk sensitive infrastructure contexts (Velter et al., 2021). After this, the chapter outlines practical implications for utilities, OEMs and regulators particularly in relation to lifecycle assessment, data traceability, certification, procurement and circular strategy implementation (Bressanelli et al., 2019; Kaddoura et al., 2019). It concludes with a discussion of the study's limitations, future research opportunities and personal reflections from the research process.

### 5.1 Summary of Key Findings

This study examined CE decision making through survey responses from infrastructure professionals at EnergyWeek 2026. Within this exploratory sample, the findings suggest that CE decisions were not guided by a single sustainability logic. Instead, they were shaped within an institutionally complex decision environment, where circular options were assessed through reliability, safety, cost, compliance, risk and evidence requirements. The central finding is that CE decision making in Nordic OEM utility

ecosystems was filtered through existing infrastructure priorities rather than treated as an automatically feasible sustainability pathway.

In relation to RQ1, the findings show that system boundaries in CE decision making were multiple and context dependent. Respondents located circular decisions at different levels including the component, equipment, system, organisational and lifecycle levels. This supports the view that CE ecosystems require interdependent value creation across actors (Aarikka-Stenroos et al., 2021), but the empirical findings also show that wider lifecycle and ecosystem boundaries were not always decisive in practice. Boundary framing therefore appeared not only as a technical modelling issue but also as a practical judgement shaped by urgency, available information, risk, accountability and operational responsibility.

The findings also suggest that boundaries could contract under pressure. In urgent or uncertain situations respondents tended to frame decisions around repair feasibility, asset functionality, service continuity and short term risk. Broader lifecycle concerns, such as emissions, upstream supply chain impacts, material recovery and cross organisational responsibility became harder to include when decisions had to be made quickly. This pattern helps explain why CE may be recognised at the level of strategy or analysis but become narrower during implementation.

In relation to RQ2, the findings show a hierarchy of institutional logics. Sustainability logic was visible in strategic ambition, environmental targets and circularity discourse. However, reliability, safety, cost and compliance became more influential when circular options moved toward implementation. Reliability logic was especially strong when decisions involved system stability, failure avoidance, downtime or safety. Financial logic shaped decisions through budget limits, upfront cost and return on investment expectations. Compliance logic acted as a threshold condition when certification, standards or liability for reused and refurbished assets were uncertain (Shnayder et al., 2021).

This finding supports the interpretation that CE strategies enter an existing field of institutional logics rather than replacing them. In this sample, sustainability did not disappear but it was often negotiated against more established infrastructure logics. This is consistent with research showing that sustainability oriented transitions are shaped by competing commercial, compliance, value chain and pro environmental logics (Dagilienė et al., 2024; Vedula et al., 2022). The findings therefore suggest that the key issue is not whether sustainability is valued but whether it gains enough authority in real decision situations.

In relation to RQ3, the findings show that boundary framing and institutional logics shaped each other. Narrow component level, asset level or short term cost boundaries strengthened reliability and financial logics. Wider lifecycle and system level boundaries created more space for sustainability logic, circular value and ecosystem responsibility. However, these wider boundaries were difficult to maintain when data were missing, certification was unclear or operational risk was high. CE decision making therefore involved boundary work where actors defined which impacts, responsibilities, costs and risks were relevant to the decision (Velter et al., 2021).

Overall, Chapter 4 identified a mechanism of practical institutional filtering. Circular goals could be visible at the strategic level but they were filtered during implementation through reliability, cost, compliance, urgency and information constraints. This helps explain why respondents appeared more comfortable with lower uncertainty strategies such as repair, maintenance and redesign for longer life. Strategies such as remanufacturing and component reuse were more difficult to justify because they required wider boundaries, stronger interorganisational coordination, clearer certification and stronger evidence of technical and regulatory acceptability.

## 5.2 Answers to the Research Questions

This section answers the three research questions in the same order as presented in Chapter 1. The answers are based on the empirical findings discussed in Chapter 4 and are interpreted within the exploratory scope of the survey data.

**RQ1:** How do Nordic power companies and equipment manufacturers decide what is included and what is excluded when defining circular economy in their decision processes?

The findings show that respondents did not use one fixed boundary when defining CE in decision processes. Instead, boundaries varied across component, equipment, system, organisational and lifecycle levels. In broader decision frames, respondents included lifecycle cost, emissions, material use, reuse potential, supply chain effects and long term system value. In narrower decision frames, respondents focused mainly on asset performance, repair feasibility, safety, service continuity, immediate cost and short term operational risk.

The main answer to RQ1 is that inclusion and exclusion were shaped by practical judgements about relevance, risk, evidence and responsibility. Broader lifecycle and ecosystem boundaries were more likely to appear in strategic analysis or planning. Narrower operational boundaries became more influential when decisions involved urgency, limited data, downtime risk or unclear accountability. This means that some environmental and cross organisational impacts were excluded not necessarily because respondents rejected sustainability but because those impacts were difficult to evidence, coordinate or defend in time sensitive infrastructure decisions.

**RQ2:** Which institutional logics dominate circular economy decision making in electrical infrastructure contexts?

The findings show that CE decision making was shaped by a hierarchy of institutional logics. Sustainability logic was visible in strategic ambition, environmental targets, ESG

reporting and circularity discourse. However, reliability, safety, financial and compliance logics became more dominant during implementation.

Reliability logic dominated when circular options raised concerns about grid stability, safety, service continuity, failure risk or downtime. Financial logic dominated when decisions were shaped by upfront cost, budget limits, return on investment expectations or procurement routines. Compliance logic became decisive when certification, standards, liability or long term performance responsibility were uncertain. Innovation logic appeared as an enabler, especially through digital diagnostics, predictive maintenance, pilots and improved data but it rarely overruled reliability, cost or compliance concerns.

The main answer to RQ2 is that sustainability was present but not consistently dominant. In practical decision situations, reliability, safety, cost and compliance often carried greater authority because they defined what counted as acceptable action in critical electrical infrastructure.

**RQ3:** How does the interaction between system boundary framing and institutional logics shape circular strategy orientation in OEM utility ecosystems?

The findings show that system boundary framing and institutional logics shaped each other. Narrow boundaries gave more authority to reliability and financial logics because they focused attention on asset function, short term cost, repair feasibility and immediate operational risk. Wider lifecycle and system boundaries gave more space to sustainability logic because they allowed emissions, material recovery, reuse potential, lifecycle cost and ecosystem responsibility to become visible.

This interaction shaped circular strategy orientation by influencing which circular options appeared feasible and legitimate. Strategies such as repair, maintenance and redesign for longer life were easier to justify because they could fit existing reliability, cost and asset management routines. Strategies such as reuse, refurbishment and remanufacturing were harder to justify when they required wider lifecycle evidence,

stronger supplier coordination, clearer certification and shared responsibility across organisations.

The main answer to RQ3 is that circular strategy orientation was not determined by technical circularity alone. It was shaped by the interaction between the boundary used to assess the option and the logic that gained authority in the decision. When the boundary remained narrow, low uncertainty strategies were favoured. When the boundary widened and stronger evidence was available more ambitious circular strategies became more plausible. This explains why CE could be strategically supported while still becoming limited during implementation.

### **5.3 Theoretical Contributions**

This thesis contributes to CE, system boundary framing and institutional logics literature by examining how practitioners assessed circular options in critical electrical infrastructure. The contribution is context specific and exploratory. The study does not claim to prove whether CE initiatives are environmentally sustainable in outcome. Rather, it shows how CE options were interpreted, narrowed, justified or rejected in practice within a risk sensitive Nordic OEM utility ecosystem.

The first contribution is to CE decision making literature. Much CE research emphasises the potential of circular strategies to reduce resource use, extend asset lifetimes and support sustainability transitions. This thesis adds a more practice oriented view by showing that circular options in critical electrical infrastructure were not treated by respondents as automatically feasible or sustainable. Instead, they were assessed through reliability, safety, compliance, cost, responsibility and evidence requirements. This supports critical CE literature by showing how circularity becomes contested when it enters operational decision making rather than remaining a general sustainability ambition.

The second contribution concerns system boundary framing. Prior research shows that sustainable and circular business model innovation requires boundary work across organisations and stakeholder groups (Ho et al., 2022; Velter et al., 2021). CE ecosystem literature also stresses interorganisational dependence and systemic resource exchange (Aarikka-Stenroos et al., 2021). This thesis adds to these discussions by showing how boundary framing can become unstable in critical infrastructure decisions. The finding of “boundary contraction under urgency” describes how broader lifecycle and ecosystem boundaries may narrow during failure situations, time pressure, supply chain uncertainty or limited data availability. This shows that practitioners do not simply choose between narrow and broad CE boundaries. The boundary can be pulled inward by practical constraints.

The third contribution concerns institutional logics in sustainability contexts. Existing research shows that sustainability transitions often involve competing logics, such as market logics, compliance logics and pro environmental logics (Jatmiko et al., 2025; Vedula et al., 2022). This thesis adds a more specific insight from critical electrical infrastructure: institutional logics were not equal in practice. Sustainability logic was visible in strategic ambition but reliability, safety, cost and compliance gained stronger influence during implementation. This contribution can be described as a hierarchy of situational dominance. In this hierarchy, the dominant logic depended on the decision condition. Reliability became dominant when safety, downtime or service continuity was at stake. Cost became dominant when budget or return expectations framed the decision. Compliance became decisive when certification, standards or liability were uncertain (Shnayder et al., 2021).

The fourth contribution is the link between system boundary framing and institutional logics. The study shows that institutional logics became operational through evaluative boundaries in asset related decisions. For example, a narrow asset level or short term cost boundary made reliability and financial logics more powerful. A wider lifecycle or system level boundary allowed sustainability and circular value logics to become more relevant. This means that logics did not only influence values or attitudes. They shaped

what was included in the decision. At the same time, the chosen boundary shaped which logic appeared most legitimate.

The final theoretical contribution is the concept of “practical institutional filtering”. Prior research shows that institutional logics shape organisational rationality (Dagilienė et al., 2024; Thornton et al., 2012), while sustainable operations research highlights the need to balance sustainability with resilience in complex systems (Setyadi et al., 2025). This thesis connects these ideas by showing how broad CE goals were filtered during implementation through reliability, cost, compliance, urgency and evidence constraints. This helps explain why circular options may be strategically supported but limited in practice.

Overall, the theoretical contribution of this thesis is not that CE is ineffective or unsustainable. Rather, the contribution is that CE strategy orientation in critical electrical infrastructure depends on how actors define the decision boundary and which institutional logic gains authority in that situation. This offers a focused explanation of why circular strategies such as repair and maintenance may appear more acceptable than strategies requiring wider coordination, stronger certification and more shared responsibility across the OEM utility ecosystem.

## **5.4 Practical Contributions**

The practical contribution of this thesis is that CE implementation in Nordic OEM utility ecosystems cannot be improved only through sustainability goals or general circularity commitments. The findings show that circular options become more feasible when perceived operational risk is reduced through better evidence, clearer responsibility, lifecycle data, certification and earlier planning. This means that different stakeholder groups need different forms of action.

For utilities, the findings point to the need to integrate CE into asset management, maintenance planning and investment decision making. Since decision boundaries often

narrowed during urgent operational situations, utilities should assess circular options before assets reach failure conditions. Planned maintenance windows, asset life prediction and pre approved repair, reuse or refurbishment options can reduce the pressure for emergency replacement. Lifecycle assessment and lifecycle costing can also support this process by making long term environmental and economic effects more visible alongside immediate replacement cost (Kaddoura et al., 2019).

For asset managers, the practical contribution concerns decision timing and risk framing. The findings suggest that asset managers are often positioned where sustainability goals meet reliability expectations. Their decisions are therefore shaped by the need to maintain safety, uptime and technical performance. Circular strategies are more likely to become acceptable when asset managers have reliable evidence on remaining life, condition, failure probability and service history. This requires circularity to be included in normal asset management routines rather than added as a separate sustainability consideration after technical decisions have already been made.

For procurement professionals, the findings suggest that procurement criteria can either widen or narrow the circular decision boundary. If tenders favour only new components, lowest upfront cost or conventional replacement routines, circular options may be excluded before they are technically assessed. Procurement processes should therefore include lifecycle cost, repairability, traceability, material recovery potential, supplier take back capacity and evidence of certified reuse or refurbishment. This supports previous research showing that procurement can either enable or restrict circular supply chain redesign (Bressanelli et al., 2019; Milios et al., 2019).

For OEMs, the findings highlight the importance of evidence, traceability and certification. Circular options such as reused, refurbished or remanufactured components were difficult to justify when respondents were uncertain about performance, safety, condition or long term reliability. OEMs can reduce this uncertainty by providing digital asset histories, product traceability, condition monitoring data, testing documentation and clearer performance guarantees. Digital asset passports, embedded sensors and certainty of product quality approaches can support this

evidence base but technology alone is not sufficient. These tools only become useful when their data are accepted in procurement, maintenance and asset management decisions (Charnley et al., 2019).

For OEM utility collaboration, the findings show that circularity depends on shared responsibility across the value chain. Reuse, refurbishment and remanufacturing are difficult to scale when responsibility for performance, liability and lifecycle information remains unclear. OEMs and utilities should therefore develop procurement and service models that distribute responsibility more clearly. Product service systems, extended maintenance agreements and co-produced reuse models can support this by linking product performance, maintenance, data sharing and circular recovery across the asset lifecycle (Strupeit et al., 2024).

For regulators and certification bodies, the findings show that compliance uncertainty can block circular options even when they appear environmentally beneficial. In critical electrical infrastructure, reused or refurbished assets must be technically credible, legally defensible and certifiable. Regulators and classification bodies can support CE implementation by developing clearer standards for reused, refurbished and remanufactured infrastructure components. This includes technical requirements, testing procedures, certification pathways and liability guidance. Without such standards, infrastructure actors are likely to continue favouring conventional replacement because it carries lower regulatory and accountability uncertainty (Milius et al., 2019).

For sustainability managers, the findings suggest that CE needs to be connected to operational and financial performance systems. If circularity remains only part of ESG reporting, it is likely to lose influence when it conflicts with reliability, budget or compliance requirements. Sustainability indicators should therefore be connected with engineering, procurement, maintenance, finance and asset management KPIs. Relevant indicators may include lifecycle cost, avoided replacement, emissions reduction, repair rate, reuse potential, traceability coverage and certified circular alternatives. This

supports the argument that sustainability becomes operationally effective only when it is embedded in cross functional decision making (Setyadi et al., 2025).

Overall, the practical contribution of this thesis is that circularity in critical infrastructure should be treated as a governance and evidence challenge rather than only a sustainability ambition. Utilities need earlier planning and lifecycle based asset decisions. OEMs need to provide traceability and credible performance evidence. Procurement professionals need criteria that allow certified circular alternatives to compete with new replacement. Regulators need to reduce uncertainty through standards and certification. Across all groups, circular strategy orientation becomes more feasible when evidence, responsibility, lifecycle data and compliance structures reduce perceived operational risk.

## **5.5 Limitations of the Study**

This study has several methodological and analytical limitations that should be considered when interpreting the findings. First, the study used event based recruitment during EnergyWeek 2026. This provided access to infrastructure professionals connected to energy, OEMs, utilities, technology, consulting, regulation and related fields. However, the approach also created limits. The sample was not random and participation was voluntary. This may have attracted respondents with stronger interest in sustainability, circular economy, innovation or energy transition issues (Etikan, 2016; Fowler, 2014; Palinkas et al., 2015b).

The sample size is another limitation. The study included 44 survey responses, which is appropriate for an exploratory, qualitative dominant study but it is not sufficient for statistical generalisation to the Nordic energy sector. The sample included different roles and sectors which was useful for exploratory breadth. At the same time, this diversity limits the ability to make precise conclusions about specific professional groups, such as asset managers, OEM representatives, procurement professionals, regulators or

sustainability managers. The findings should therefore be read as analytically useful insights into CE decision making patterns not as population level claims (Patton, 2015).

Second, the study relied on self reported survey data. This means that the analysis is based on what respondents stated about CE decision making rather than direct observation of organisational decisions. Self reported data may reflect personal interpretation, official organisational language or aspirational sustainability statements rather than actual informal decision routines (Fowler, 2014). The anonymous survey format supported broad participation and cross sectoral responses but it did not allow follow up questions, clarification or deeper probing in the way that interviews or case studies would have allowed.

Third, the open ended responses varied in length and depth. Some responses gave rich explanations of boundary framing, reliability concerns, cost pressure, certification uncertainty and lifecycle thinking. Other responses were short and required careful interpretation. This limits the depth of the thematic analysis. The coding was guided by the theoretical framework and the qualitative interpretation was compared with the closed ended response patterns to improve consistency. However, the analysis still involved researcher judgement which is a normal limitation of qualitative thematic analysis.

Fourth, the study was cross sectional. The data were collected at one point in time during EnergyWeek 2026. As a result, the findings capture respondent perspectives at that moment rather than changes over time. This matters because CE decision making in electrical infrastructure may evolve as regulation, certification systems, digital traceability, procurement practices and asset data infrastructures develop. A longitudinal design would be needed to examine how institutional logics and boundary framing change across future projects or policy shifts.

Fifth, the study did not include direct organisational observation or document triangulation. It did not analyse internal procurement documents, asset management records, certification files, maintenance plans or investment decision documents. This

limits the ability to verify how CE decisions are formally recorded or implemented inside organisations. Future research using interviews, case studies, internal documents and direct observation could provide deeper evidence on how circular options move from strategic discussion to operational decision making.

Despite these limitations, the study provides analytically useful insights into how CE options are interpreted and filtered in Nordic OEM utility ecosystems. The findings should not be read as statistically generalisable claims about the whole sector. Rather, they show how infrastructure professionals in this exploratory sample described the role of system boundaries, institutional logics, evidence, risk and responsibility in CE decision making. This supports the thesis aim by explaining why circular options may be strategically recognised but still constrained in practice.

## **5.6 Suggestions for Future Research**

Future research should build on this study by using longitudinal and in-depth qualitative designs. Longitudinal case studies would allow researchers to examine how system boundaries and institutional logics change as organisations respond to regulation, market pressure, asset ageing and CE targets (Vedula et al., 2022). In-depth interviews with practitioners across utilities, OEMs, procurement teams, asset management, sustainability functions and regulators would also provide richer insight into the informal routines and tensions that shape circular decision making (Dagilienè et al., 2024).

A direct next step would be to combine interviews with document analysis. Procurement tenders, asset management rules, maintenance plans, certification requirements and internal investment criteria could show how reliability, cost, compliance and risk are formally embedded in organisational decision processes. This would help verify whether the boundary contraction and practical institutional filtering identified in this thesis also appear in written procedures and formal governance systems (Shnayder et al., 2021).

A second future research direction concerns digital traceability and lifecycle evidence. This thesis suggests that missing lifecycle data, weak supplier information and uncertainty about secondary asset performance limit circular strategy orientation. Future studies could examine whether digital asset passports, condition monitoring, IoT based tracking and shared data platforms help reduce uncertainty and support wider lifecycle boundaries in CE decisions (Rossi & Srai, 2025; Setyadi et al., 2025). However, such research should examine not only the technology but also whether organisations actually use the data in procurement, maintenance and asset management decisions.

Future research could also connect digital traceability with environmental and economic assessment methods. Combining Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) would help evaluate whether circular options such as repair, reuse, refurbishment and remanufacturing can be justified under both sustainability and operational criteria (Kaddoura et al., 2019). This would strengthen understanding of how evidence, certification and lifecycle data can reduce perceived operational risk and make circular options more acceptable in critical infrastructure.

## **5.7 Personal Learning and Development**

This section is included as a separate reflective note and is not part of the research conclusions. Through this thesis process, I developed stronger conceptual, methodological and analytical skills. Conceptually, I learned to approach CE not only as a technical or environmental issue but also as an organisational decision making process shaped by system boundaries, responsibility, risk, evidence and competing priorities. The literature helped me understand that CE can be contested rather than automatically sustainable, especially when circular options are filtered through operational and institutional conditions (Corvellec et al., 2022; Velter et al., 2021; Zink & Geyer, 2017).

Methodologically, I learned how to design and apply an exploratory, qualitative dominant survey. Collecting data at EnergyWeek 2026 gave access to infrastructure related professionals but it also taught me the limits of event based and self selected

data collection. This strengthened my understanding of the difference between analytical insight and statistical generalisation (Patton, 2015). The analysis process also developed my ability to use theory informed thematic analysis, where coding required connecting respondent statements with theoretical concepts such as system boundary framing and institutional logics (Braun & Clarke, 2006; Nowell et al., 2017). Overall, the thesis improved my ability to connect theory with practice, separate findings from interpretation and communicate complex organisational issues in clear academic writing.

## References

- Aarikka-Stenroos, L., Ritala, P., & D. W. Thomas, L. (2021). Circular economy ecosystems: a typology, definitions, and implications. In *Research Handbook of Sustainability Agency*. Edward Elgar Publishing. <https://doi.org/10.4337/9781789906035.00024>
- Anttiroiko, A. V. (2023). Smart Circular Cities: Governing the Relationality, Spatiality, and Digitality in the Promotion of Circular Economy in an Urban Region. *Sustainability (Switzerland)*, 15(17). <https://doi.org/10.3390/su151712680>
- Benito, G. R. G., & Meyer, K. E. (2024). Industrial policy, green challenges, and international business. *Journal of International Business Studies*, 55(9), 1093–1107. <https://doi.org/10.1057/s41267-024-00722-6>
- Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, 33(5), 308–320. <https://doi.org/10.1080/21681015.2016.1172124>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Bressanelli, G., Perona, M., & Sacconi, N. (2019). Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study. *International Journal of Production Research*, 57(23), 7395–7422. <https://doi.org/10.1080/00207543.2018.1542176>
- Castro, C. G., Trevisan, A. H., Pigosso, D. C. A., & Mascarenhas, J. (2022). The rebound effect of circular economy: Definitions, mechanisms and a research agenda. In *Journal of Cleaner Production* (Vol. 345). Elsevier Ltd. <https://doi.org/10.1016/j.jclepro.2022.131136>
- Charnley, F., Tiwari, D., Hutabarat, W., Moreno, M., Okorie, O., & Tiwari, A. (2019). Simulation to Enable a Data-Driven Circular Economy. *Sustainability*, 11(12), 3379. <https://doi.org/10.3390/su11123379>

- Coenen, T. B. B. J., Frederiksen, N., Volker, L., & Visscher, K. (2025). Implementing Circularity in Organizations by Navigating Institutional Plurality. *Business Strategy and the Environment*, 34(8), 10059–10076. <https://doi.org/10.1002/bse.70119>
- Corvellec, H., Stowell, A. F., & Johansson, N. (2022). Critiques of the circular economy. *Journal of Industrial Ecology*, 26(2), 421–432. <https://doi.org/10.1111/jiec.13187>
- Creswell, J. W. (2023). *Research design : qualitative, quantitative, and mixed methods approaches*. SAGE.
- Dagilienė, L., Varaniūtė, V., & Banionienė, J. (2024). Cultivating a sustainable and circular economy: The role of institutional logics in manufacturing companies. *Journal of Cleaner Production*, 434. <https://doi.org/10.1016/j.jclepro.2023.140363>
- EnergyWeek. (n.d.-a). *EnergyWeek 16-19 March 2026*. Retrieved April 20, 2026, from <https://www.energyweek.fi/>
- EnergyWeek. (n.d.-b). *EnergyWeek partners - Energy Week*. Retrieved April 20, 2026, from <https://www.energyweek.fi/partners/>
- Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Fowler, F. J. . (2014). *Survey research methods*. SAGE.
- Gaha, M., Chabane, B., Komljenovic, D., Côté, A., Hébert, C., Blancke, O., Delavari, A., & Abdul-Nour, G. (2021). Global methodology for electrical utilities maintenance assessment based on risk-informed decision making. *Sustainability (Switzerland)*, 13(16). <https://doi.org/10.3390/su13169091>
- Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>

- Greenwood, R., Raynard, M., Kodeih, F., Micelotta, E. R., & Lounsbury, M. (2011). Institutional Complexity and Organizational Responses. *Academy of Management Annals*, 5(1), 317–371. <https://doi.org/10.5465/19416520.2011.590299>
- Ho, C. H., Böhm, S., & Monciardini, D. (2022). The collaborative and contested interplay between business and civil society in circular economy transitions. *Business Strategy and the Environment*, 31(6), 2714–2727. <https://doi.org/10.1002/bse.3001>
- Ingstrup, M. B., Aarikka-Stenroos, L., & Adlin, N. (2021). When institutional logics meet: Alignment and misalignment in collaboration between academia and practitioners. *Industrial Marketing Management*, 92, 267–276. <https://doi.org/10.1016/j.indmarman.2020.01.004>
- Jatmiko, W., Smaoui, H., & Hendranastiti, N. D. (2025). Competing Institutional Logics in Corporate ESG: Evidence From Developing Countries. *Business Strategy and the Environment*, 34(5), 6184–6209. <https://doi.org/10.1002/bse.4283>
- Johansson, N., & Henriksson, M. (2020). Circular economy running in circles? A discourse analysis of shifts in ideas of circularity in Swedish environmental policy. *Sustainable Production and Consumption*, 23, 148–156. <https://doi.org/10.1016/j.spc.2020.05.005>
- Kaddoura, M., Kambanou, M. L., Tillman, A. M., & Sakao, T. (2019). Is prolonging the lifetime of passive durable products a low-hanging fruit of a circular economy? A multiple case study. *Sustainability (Switzerland)*, 11(18). <https://doi.org/10.3390/su11184819>
- Lee, M.-D. P., & Lounsbury, M. (2015). Filtering Institutional Logics: Community Logic Variation and Differential Responses to the Institutional Complexity of Toxic Waste. *Organization Science*, 26(3), 847–866. <https://doi.org/10.1287/orsc.2014.0959>
- Lowe, B. H., Bimpizas-Pinis, M., Zerbino, P., & Genovese, A. (2024). Methods to estimate the circular economy rebound effect: A review. In *Journal of Cleaner Production* (Vol. 443). Elsevier Ltd. <https://doi.org/10.1016/j.jclepro.2024.141063>

- Milios, L., Beqiri, B., Whalen, K. A., & Jelonek, S. H. (2019). Sailing towards a circular economy: Conditions for increased reuse and remanufacturing in the Scandinavian maritime sector. *Journal of Cleaner Production*, 225, 227–235. <https://doi.org/10.1016/j.jclepro.2019.03.330>
- Milios, L., & Matsumoto, M. (2019). Consumer perception of remanufactured automotive parts and policy implications for transitioning to a circular economy in Sweden. *Sustainability (Switzerland)*, 11(22). <https://doi.org/10.3390/su11226264>
- Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, 16(1). <https://doi.org/10.1177/1609406917733847>
- Orb, A., Eisenhauer, L., & Wynaden, D. (2001). Ethics in qualitative research. *Journal of Nursing Scholarship*, 33(1), 93–96. <https://doi.org/10.1111/j.1547-5069.2001.00093.x>
- Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015a). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), 533–544. <https://doi.org/10.1007/s10488-013-0528-y>
- Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015b). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42(5), 533–544. <https://doi.org/10.1007/s10488-013-0528-y>
- Patton, M. Quinn. (2015). *Qualitative research & evaluation methods : integrating theory and practice*. SAGE Publications, Inc.
- Ridwan, M., Akther, A., Dhar, B. K., Roshid, M. M., Mahjabin, T., Bala, S., & Hossain, H. (2025). Advancing Circular Economy for Climate Change Mitigation and Sustainable

- Development in the Nordic Region. *Sustainable Development*, 33(S1), 225–244. <https://doi.org/10.1002/sd.3563>
- Rossi, L. A., & Srai, J. S. (2025). The role of digital technologies in configuring circular ecosystems. *International Journal of Operations and Production Management*, 45(4), 863–894. <https://doi.org/10.1108/IJOPM-12-2023-0973>
- Setyadi, A., Pawirosumarto, S., & Damaris, A. (2025). Rethinking Sustainable Operations: A Multi-Level Integration of Circularity, Localization, and Digital Resilience in Manufacturing Systems. *Sustainability (Switzerland)*, 17(15). <https://doi.org/10.3390/su17156929>
- Shabbir, M. S., & Salman, R. (2025). Sustainable Development Policy Interventions: Stakeholder Engagement and Environmental Policy in Practice. *Business Strategy and the Environment*. <https://doi.org/10.1002/bse.70274>
- Shnayder, L., van Kranenburg, H., & Witjes, S. (2021). Transformational ability of energy network companies: The role of institutional logics and boundary spanners. *Sustainability (Switzerland)*, 13(24). <https://doi.org/10.3390/su132413582>
- Smink, M., Negro, S. O., Niesten, E., & Hekkert, M. P. (2015). How mismatching institutional logics hinder niche-regime interaction and how boundary spanners intervene. *Technological Forecasting and Social Change*, 100, 225–237. <https://doi.org/10.1016/j.techfore.2015.07.004>
- Strupeit, L., Bocken, N., & Van Opstal, W. (2024). Towards a Circular Solar Power Sector: Experience with a Support Framework for Business Model Innovation. *Circular Economy and Sustainability*, 4(3), 2093–2118. <https://doi.org/10.1007/s43615-024-00377-3>
- Thomas, L. D. W., & Autio, E. (2020). Innovation Ecosystems in Management: An Organizing Typology. In *Oxford Research Encyclopedia of Business and Management*. Oxford University Press. <https://doi.org/10.1093/acrefore/9780190224851.013.203>

- Thornton, P. H. ., Ocasio, William., & Lounsbury, Michael. (2012). *The institutional logics perspective : foundations, research, and theoretical elaboration*. Oxford University Press.
- University of Vaasa. (n.d.). *Responsible science and research | University of Vaasa*. Retrieved April 23, 2026, from <https://www.uvasa.fi/en/research/responsible-science-and-research>
- Vedula, S., York, J. G., Conger, M., & Embry, E. (2022). Green to Gone? Regional Institutional Logics and Firm Survival in Moral Markets. *Organization Science*, 33(6), 2274–2299. <https://doi.org/10.1287/orsc.2021.1533>
- Velter, M. G. E., Bitzer, V., Bocken, N. M. P., & Kemp, R. (2021). Boundary Work for Collaborative Sustainable Business Model Innovation: The Journey of a Dutch SME. *Journal of Business Models*, 9(4), 36–66. <https://doi.org/10.5278/jbm.v9i4.6267>
- Wrålsen, B., & O’Born, R. (2023). Use of life cycle assessment to evaluate circular economy business models in the case of Li-ion battery remanufacturing. *International Journal of Life Cycle Assessment*, 28(5), 554–565. <https://doi.org/10.1007/s11367-023-02154-0>
- Zink, T., & Geyer, R. (2017). Circular Economy Rebound. *Journal of Industrial Ecology*, 21(3), 593–602. <https://doi.org/10.1111/jiec.12545>
- Zu Castell-Rüdenhausen, M., Wahlström, M., Fruergaard Astrup, T., Jensen, C., Oberender, A., Johansson, P., & Waerner, E. R. (2021). Policies as drivers for circular economy in the construction sector in the nordics. *Sustainability (Switzerland)*, 13(16). <https://doi.org/10.3390/su13169350>

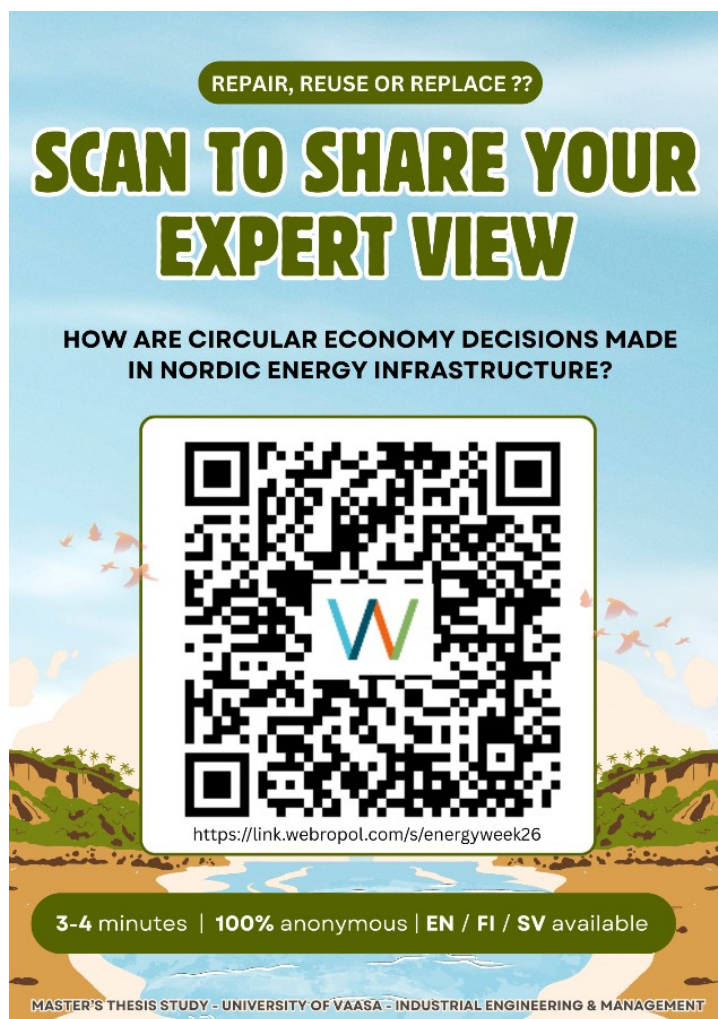
## Appendices

### APPENDIX A. Survey Invitation Leaflet Used at EnergyWeek 2026

This appendix presents the survey invitation leaflet used during EnergyWeek 2026 to recruit respondents for the study.

#### Figure A1

Survey invitation leaflet used during EnergyWeek 2026



The leaflet invited professionals to respond to the survey on circular economy decision-making in energy infrastructure and included a QR code for direct access.

## **APPENDIX B. Final Survey Instrument**

This appendix presents the final survey instrument used for data collection. The questionnaire was administered through Webropol and combined closed ended and open ended questions. Equivalent Finnish and Swedish versions were also used during the data collection period. The instrument contained 14 questions.

**Survey title :** How are Circular Economy decisions made in Energy Infrastructure?

**Survey introduction text :** This survey is part of a Master's thesis study on how circular economy decisions are made in the energy and electrical infrastructure sector.

It explores how professionals evaluate circular options such as repair, refurbishment, reuse, recycling, redesign or replacement, and how factors such as reliability, safety, cost, compliance and sustainability shape these decisions.

When you submit this form, it will not automatically collect your personal details, such as your name or email address, unless you provide them yourself in your response.

The survey is anonymous.

Your participation is voluntary. By taking part in this survey, you are contributing to academic research that can support future understanding of circular decision-making in energy infrastructure.

### **Survey questions**

1. Which sector best describes your organization?
2. What is your role in relation to infrastructure or asset decisions?
3. When your organization evaluates equipment or infrastructure assets, which circular strategies are most commonly considered?
4. What usually triggers consideration of a circular option such as repair, refurbishment, reuse or redesign in your organization?
5. When deciding between repair, reuse, refurbishment, recycling or replacement, which factors are usually most important? Please select up to three.

6. When environmental or circular goals conflict with reliability, safety, cost or compliance, what usually happens in the decision process?
7. When evaluating circular solutions, what system boundary is typically considered?
8. What is usually included and excluded when your organization evaluates a circular option and why?
9. Which perspectives tend to dominate circular economy decisions in your organization? Please select up to three.
10. Have you observed conflicts between these priorities when making circular decisions?
11. If different priorities conflict, which perspective usually wins, and why?
12. What are the biggest barriers to implementing circular economy strategies in power or electrical infrastructure systems?
13. Can you describe one recent example where your organization had to choose between repair, reuse, refurbishment, recycling or replacement? What factors shaped the final choice?
14. If you could change one thing in your organization or industry to improve circular decision making, what would it be?

## APPENDIX C. Recruitment and Response Context

This appendix summarises the recruitment context of the study and clarifies the basis on which the response volume is reported.

**Table C1** : Recruitment and response context

Item	Description
Data collection site	EnergyWeek 2026, Vaasa, Finland
Main recruitment mode	QR code on printed leaflet/poster
Additional recruitment mode	Post-session distribution and individual email invitations
Printed leaflets distributed	Approximately 250
Individual emails sent	22
Approximate invitation base	272
Total completed responses	44
Approximate participation level	16%
Important caution	This should not be treated as a formal survey-statistical response rate because recruitment occurred through multiple routes, some individuals may have encountered the survey more than once, and the number of people who saw the invitation without scanning it could not be verified.

## APPENDIX D. Participant Profile of Respondents

This appendix presents the sectoral and professional profile of the 44 respondents included in the study. The basic report showed responses from utilities, grid operators, OEMs, technology providers, consultants, regulators, and academic participants, as well as roles spanning strategic, technical, asset management, sustainability, innovation, policy, and research functions.

**Table D1 : Sector distribution of respondents**

<b>Sector</b>	<b>n</b>	<b>%</b>
Power generation / utility	9	20.4
Transmission or distribution / grid operator	8	18.2
Equipment manufacturer (Original Equipment Manufacturer)	7	15.9
Technology provider / digital solutions	5	11.4
Consultancy / advisory	4	9.1
Government / regulator / policymaking body	3	6.8
Research / academia	7	15.9
Other	1	2.3
<b>Total</b>	<b>44</b>	<b>100.0</b>

Note: Percentages are based on 44 completed responses.

**Table D2 : Role distribution of respondents**

<b>Role</b>	<b>n</b>	<b>%</b>
Strategic decision-maker	5	11.4
Engineering / technical specialist	7	15.9
Asset management / maintenance	9	20.5
Sustainability / ESG	6	13.6
Innovation / business development	6	13.6
Policy / regulatory	3	6.8
Research / academic	7	15.9
Other	1	2.3
<b>Total</b>	<b>44</b>	<b>100.0</b>

Note: Percentages are based on 44 completed responses.

## APPENDIX E. Descriptive Results for Closed-Ended Survey Items

This appendix presents the descriptive results from the closed ended survey questions used directly in Chapter 4. These tables summarise the distribution of responses across circular strategies, decision factors, system boundaries, dominant perspectives, and experienced conflict between priorities.

**Table E1** : Circular strategies most commonly considered

Circular strategy	n	%
Repair / maintenance	23	52.3
Refurbishment / upgrade	19	43.2
Component reuse	18	40.9
Remanufacturing	12	27.3
Recycling of materials	15	34.1
Product redesign for longer life	22	50.0
Replace with new equipment	19	43.2
Circular options are rarely considered	7	15.9
Other	1	2.3

**Table E2** : Most important decision factors when choosing between repair, reuse, refurbishment, recycling, or replacement

Decision factor	n	%
Cost efficiency	27	61.4
Environmental sustainability	23	52.3
Lifecycle performance	22	50.0
Reliability and system stability	21	47.7
Customer or stakeholder expectations	10	22.7
Regulatory compliance	8	18.2
Time pressure / speed of implementation	8	18.2
Safety requirements	5	11.4
Availability of spare parts	2	4.5
Operational risk	2	4.5
Other	4	9.1

**Table E3** : System boundary typically considered when evaluating circular solutions

<b>System boundary</b>	<b>n</b>	<b>%</b>
System level (e.g., substation, line, plant, or grid section)	11	25.0
Full lifecycle / supply chain level	10	22.7
Equipment / product level	8	18.2
Organizational level	8	18.2
Individual component or part	7	15.9
It depends on the case	0	0.0

**Table E4** : Perspectives that tend to dominate circular economy decisions

<b>Perspective / logic</b>	<b>n</b>	<b>%</b>
Sustainability / environmental logic	28	63.6
Economic / cost logic	23	52.3
Technical reliability logic	22	50.0
Innovation / competitiveness logic	18	40.9
Stakeholder / reputation logic	13	29.5
Risk management logic	9	20.5
Regulatory compliance logic	8	18.2
Other	11	25.0

**Table E5** : Observed conflicts between priorities in circular decisions

<b>Response</b>	<b>n</b>	<b>%</b>
Yes, frequently	24	54.5
Sometimes	10	22.7
Rarely	8	18.2
Never	0	0.0
Not sure	2	4.6

## APPENDIX F. Item-Level Response Counts and Missing Data Note

This appendix reports the number of responses recorded for each survey item. Response counts varied across the open-ended questions, and one follow-up question returned no recorded responses in the basic report. The survey instrument shows that Question 11 was designed as a follow-up to Question 10 through skip logic.

**Table F1** : Response counts by survey item

Question	Response count
Q1. Sector	44
Q2. Role	44
Q3. Circular strategies considered	44
Q4. Trigger for considering circular option	41
Q5. Most important decision factors	44
Q6. What happens when circular goals conflict with reliability, safety, cost, or compliance	38
Q7. System boundary typically considered	44
Q8. What is included and excluded in evaluation	38
Q9. Dominant perspectives / logics	44
Q10. Observed conflicts between priorities	44
Q11. Which perspective usually wins, and why	0
Q12. Biggest barriers to circular economy implementation	42
Q13. Recent example of repair, reuse, refurbishment, recycling, or replacement	41
Q14. One change to improve circular decision-making	40

Note: Question 11 appeared in the survey instrument as a follow-up item linked to the conflict question, but the Webropol basic report showed no recorded responses for that item.

## APPENDIX G. Coding Framework Used in the Thematic Analysis

This appendix presents the coding framework used in the manual, theory-guided thematic analysis of the open-ended survey responses. The coding process was guided by the analytical framework developed in Chapter 2 and operationalised in Chapter 3. Initial codes were developed from the main analytical concepts of system boundary framing, institutional logics and circular strategy orientation. Additional codes were created where respondents referred to issues such as data gaps, certification barriers, urgency, trust, planning limitations, and implementation gaps. These were treated as empirical indicators rather than as separate theoretical dimensions.

**Table G1** : Coding framework for the analysis of open-ended survey responses

Initial code	Short definition	Linked analytical concept	Example response fragment	Final theme
Operational reliability included	Evaluation focuses on continuity, stability, or technical performance	System boundary framing	"Includes operational reliability and cost"	Narrow operational framing
Safety included	Safety is explicitly included in the evaluation boundary	System boundary framing / institutional logics	"Includes system stability and safety"	Narrow operational framing
Cost included	Budget or up-front cost is included as a core decision criterion	System boundary framing / economic logic	"Includes budget and operational cost"	Narrow operational framing
Lifecycle excluded	Lifecycle impacts are excluded from evaluation	System boundary framing	"Excludes lifecycle and environmental impact"	Narrow operational framing
Supply chain excluded	Upstream or supplier-level	System boundary framing	"Excludes full supply chain due to lack of data"	Narrow operational framing

<b>Initial code</b>	<b>Short definition</b>	<b>Linked analytical concept</b>	<b>Example response fragment</b>	<b>Final theme</b>
	impacts are excluded			
System-wide impact included	Evaluation includes broader system or full-system effects	System boundary framing	"Includes system-wide impacts"	Conditional lifecycle framing
Full lifecycle included	Evaluation includes emissions, materials, or downstream effects across the lifecycle	System boundary framing	"Includes full lifecycle emissions, upstream materials, downstream impact"	Conditional lifecycle framing
Execution constraints exclude broader scope	Broader analysis exists, but implementation constraints narrow it	System boundary framing	"Excludes execution constraints"	Conditional lifecycle framing
Urgency narrows scope	Time pressure or emergency reduces the decision boundary	System boundary framing	"We focus on fixing the issue fast"	Boundary contraction under urgency
Immediate functionality dominates	Short-term operability overrides wider concerns	System boundary framing / reliability logic	"Includes immediate functionality; excludes everything else"	Boundary contraction under urgency
Data gaps limit scope	Weak or fragmented data prevents broader boundary framing	System boundary framing	"We still struggle to integrate full lifecycle or supply chain information"	Information constraints
Reliability overrides sustainability	Reliability is treated as the decisive priority in conflict situations	Institutional logics	"Reliability always overrides sustainability"	Reliability logic in practice

Initial code	Short definition	Linked analytical concept	Example response fragment	Final theme
Safety overrides circularity	Safety is treated as non-negotiable when circular options are considered	Institutional logics	"Safety always wins"	Reliability logic in practice
Cost dominates	Cost becomes the final decision criterion	Institutional logics	"Cost dominates"	Cost logic in practice
Short-term financial focus	Up-front cost or ROI outweighs longer-term benefits	Institutional logics	"Lower upfront cost" / "unclear ROI"	Cost logic in practice
Sustainability as strategic aspiration	Sustainability is visible in discourse or targets	Institutional logics	"ESG commitments" / "carbon reduction targets"	Sustainability under constraint
Sustainability negotiated	Sustainability is considered, but not decisive	Institutional logics	"Sustainability is often compromised"	Sustainability under constraint
Compliance blocks option	Certification, regulation, or liability uncertainty blocks circular options	Institutional logics	"Strict compliance requirements" / "certification challenges"	Compliance as threshold logic
Innovation opens possibility	Innovation, pilots, analytics, or redesign create openings for circularity	Institutional logics	"Predictive analytics showed we could extend asset life"	Innovation as enabling logic
Broad analysis, narrow decision	Wider evaluation exists in principle, but the final decision becomes narrower	Interaction	"In analysis, we include everything ... but in reality, companies narrow the scope"	Implementation gap
Strategy-level support, operational rejection	Strategic support for circularity is not translated into operational adoption	Interaction	"There is almost always a gap between what is discussed at strategy level and	Implementation gap

Initial code	Short definition	Linked analytical concept	Example response fragment	Final theme
			what is actually implemented”	
Technically viable but not implemented	Circular option is feasible but still rejected	Interaction / circular strategy orientation	“Refurbishment was technically possible. In the end, we replaced it.”	Constrained circular strategy orientation
Repair preferred under urgency	Repair is chosen because it is the fastest feasible response	Circular strategy orientation	“Repair chosen as fastest option”	Preferred low-uncertainty strategies
Replacement selected under uncertainty	Replacement is chosen when circularity introduces risk	Circular strategy orientation	“Replacement chosen due to failure risk uncertainty”	Preferred low-uncertainty strategies
Reuse rejected due to certification or trust	Reuse is blocked by legitimacy or confidence concerns	Circular strategy orientation	“Reuse rejected due to lack of certification”	Constrained circular strategy orientation
Refurbishment selected with evidence or carbon pressure	Refurbishment is accepted when supported by proof or sustainability targets	Circular strategy orientation	“Refurbishment selected despite higher cost due to carbon targets”	Conditional circular adoption

Note: Codes were revised iteratively during analysis. Overlapping codes were merged, overly broad codes were separated and the final coding structure was grouped into higher order themes aligned with the research questions: boundary definitions in circular evaluation, dominant institutional logics and the interaction between these two dimensions.

## **APPENDIX H. Additional Anonymised Response Excerpts by Theme**

This appendix presents additional anonymised excerpts from the open-ended survey responses. The excerpts are organised by theme to support the interpretation presented in Chapter 4. Wording has been preserved as closely as possible, with only minor cleaning of punctuation where needed.

### **H1. Narrow operational framing**

- “Includes operational reliability and cost; excludes full supply chain due to lack of data.”
- “Includes system stability and safety; excludes environmental considerations.”
- “Includes budget and operational cost; excludes lifecycle and environmental impact.”
- “We mainly look at how the asset performs within the grid. Things like emissions or upstream impacts are not really part of the discussion; it’s more about ‘will this hold or not.’”

### **H2. Conditional lifecycle framing**

- “Includes full lifecycle emissions, upstream materials, downstream impact; excludes short-term operational cost trade-offs.”
- “Includes entire system impacts (materials, emissions, reuse cycles); excludes immediate operational constraints.”
- “Includes data-driven performance and lifecycle insights; excludes short-term cost pressures.”
- “We include lifecycle assessments and material use, but we don’t always consider how the product will behave in different system contexts after deployment.”

### **H3. Boundary contraction under urgency**

- “We focus on fixing the issue fast. Broader impacts or lifecycle thinking are not really part of that moment.”
- “Immediate replacement during outage.”
- “Repair chosen as fastest option.”

- “We had a cable fault recently. We replaced it immediately. There was no time to consider reuse or repair options.”

#### **H4. Reliability logic in practice**

- “Reliability always overrides sustainability.”
- “Safety always wins.”
- “In reality, reliability wins almost every time. We might discuss circular options, but if there’s even a small uncertainty, people lean toward replacement.”
- “Sustainability ignored when risk exists.”

#### **H5. Cost logic in practice**

- “Cost dominates.”
- “Cost-performance trade-off dominates.”
- “Replacement selected due to lower upfront cost despite higher lifecycle impact.”
- “Remanufacturing proposed but rejected due to higher upfront cost.”

#### **H6. Sustainability under constraint**

- “Sustainability is often compromised.”
- “Circular goals are postponed.”
- “Sustainability is considered but not dominant.”
- “Refurbishment selected despite higher cost due to carbon targets.”

#### **H7. Compliance and certification as threshold conditions**

- “Strict compliance requirements.”
- “Certification challenges.”
- “Reuse rejected due to lack of certification.”
- “Boiler system replaced instead of refurbished due to compliance risk.”

#### **H8. Implementation gap between strategy and practice**

- “There is almost always a gap between what is discussed at strategy level and what is actually implemented.”
- “Circular solution viable in model but not implemented.”
- “Optimal circular solution identified but not implemented in practice.”

- “In analysis, we include everything materials, emissions, lifecycle costs. But in reality, companies narrow the scope when making decisions.”

#### **H9. Data and evidence constraints**

- “Data availability is still a big limitation. Decisions are often made with incomplete information.”
- “Limited lifecycle data.”
- “Lack of integrated data systems.”
- “With better data, the conversation becomes less about opinions and more about evidence.”

#### **H10. Barriers to circular strategy implementation**

- “Risk aversion, lack of proven circular solutions.”
- “Business model limitations, unclear ROI.”
- “Zero-risk tolerance culture.”
- “One of the biggest issues is that circular economy is treated as an add-on, not integrated into core decision-making.”

#### **H11. Suggestions for improving circular decision-making**

- “Better data on long-term reliability of refurbished assets.”
- “Regulatory flexibility for circular options.”
- “Align ESG metrics with operational KPIs.”
- “Lifecycle-based budgeting.”
- “Make circular thinking part of standard business processes, not a separate initiative.”

Note: These excerpts were selected because they illustrate recurring patterns relevant to the study’s three research questions. They are not intended to reproduce every response in equal depth, but to provide additional transparency for the thematic interpretation presented in Chapter 4.

## **APPENDIX I. Participant Information and Data Handling Summary**

This appendix summarises the participant information provided at the start of the survey and the study's data handling approach.

Participation in the survey was voluntary and anonymous. Respondents were informed that personal details would not be collected automatically unless they chose to provide them in their own answers. They were also instructed not to include confidential company information in the open-ended responses. The survey data, analysis files, and thesis drafts were stored in the researcher's password-protected University of Vaasa OneDrive account, with access limited to the researcher. The working files will be retained and managed in accordance with University of Vaasa research data guidance and supervisory instructions, after which they will be securely deleted.