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Toward the Sustainable Development of Operations: Improving Energy Efficiency as a Means to Sustainability as Practice

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Improving Energy Efficiency as a Means to Sustainability as Practice
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Abstract

Addressing the challenges of sustainable development demands companies to understand the "how" to actualize sustainability-related objectives and cultivating conditions that encourage practicing sustainability. It also demands companies to structure their operations around less costly economic processes while maintaining the efficient use of resources and standards for workers' well-being at the operational level. Given companies' reliance on and increasing demand for energy-dependent operational processes to produce and transport products and services, sharp upward pressure on energy bills for industries directly exposed to rising prices, and shortages and supply chain disruptions, requires companies to make unprecedented changes. Therefore, as the need to use alternative energy sources has increased, the importance of accelerating improvements in energy efficiency in operations as an energy source itself has been increasingly acknowledged.

In response, this thesis seeks to expand current understandings of improving energy efficiency in operations in order to facilitate sustainability as practice, namely by embedding the concept of sustainable development into the theoretical framework of operations management. First, improving energy efficiency is analyzed as a firm-based practice that results in the actualization of corporate-level objectives for energy efficiency in operations by utilizing resources and influencing individual and/or collective action. Second, operations strategy is the analytical construct used to analyze the strategic–operational alignment of the resources needed to allow engaging in and replicating such an improvement-oriented process constructed and enacted by multiple individuals within and across organizational levels. Third and last, the thesis focuses on development via changes in individual and collective actions and understandings toward promoting sustainability as practice by building up people's skills and competencies.

Drawing from findings in the five appended papers, the thesis first characterizes the improvement of energy efficiency in operations as a practice. Second, the thesis analyzes strategic–operational alignment in organizations by investigating the improvement of energy efficiency in operations as a practice in relation to organizations' strategic intentions for sustainability as well as existing operations strategy. The results showcase examples of the bidirectional perspective on synergy between operations management and energy management. Last, whereas energy efficiency indeed requires focusing on the improvement process, the thesis argues that it also sustains such improvement and creates a constellation of practices that result in changes in people's behavior. Achieving such continuity creates a context for practicing sustainability and gaining leverage to accomplish the sustainable development of operations.

Keywords: Operations management, Operations strategy, Sustainable operations management, Energy efficiency

List of Appended Papers

Paper 1:
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Paper 2:
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Paper 3:
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Paper 4:
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Contribution: Halldórsson and Winter outlined the initial study and conducted the first round of analysis. Winter led data collection with support from Halldórsson and Taghavi. Gremyr and Halldórsson led the study's conceptualization and the development of the discussion of the results and their implications with support from Taghavi, particularly in relation to the literature. All authors contributed to the writing of the paper.

Paper 5:
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Contribution: All authors contributed equally to the paper's planning, analysis, and writing, whereas the first author played a leading role in data collection. C. A. Vural is the corresponding author.

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1. Introduction

This chapter begins by presenting the background of the research conducted for the thesis, followed by its practical and theoretical relevance. After discussing the research's scope, purpose, research questions (RQs), and delimitations, the chapter closes with an outline of the thesis.

1.1 Background and problem statement

According to the Intergovernmental Panel on Climate Change (IPCC, 2018), people, societies, ecosystems, and sectors of the economy are all exposed to the risks of climate change arising from the interactions between hazards, vulnerability, and exposure. In those interactions, the factors of vulnerability and exposure are sensitive to an array of social and economic processes (IPCC, 2018). Driving those risks, tremendous improvements in quality of life afforded by technological development since the Industrial Revolution have not only increased the use of materials and energy to respond to growing populations but also expanded the reliance upon and demand for energy-intensive operational processes to produce products and services. More recently, however, the COVID-19 pandemic has brought into sharp relief "the fragility of our assumptions about the world in which we live, or the amount time we may have to adapt to its change" (Jarzabkowski et al., 2021).

In 2020, under the Paris Agreement, Sweden—the empirical setting of the research in this thesis—submitted its long-term strategy to drive the climate transition in Sweden and thereby achieve net-zero emissions by 2045 and negative net emissions thereafter (Ministry of the Environment, 2020). The strategy has also set energy policy targets for renewable energy and energy efficiency—for instance, 100% renewable electricity production by 2040 and 50% more efficient energy by 2030 than in 2005. Although climate change is now a prioritized issue on the global agenda, for Sweden to be able to live up to its commitments made in the Paris Agreement, unprecedented changes are needed. Public policies focusing on the development and diffusion of energy-efficient technologies have fallen short of providing the means to achieve optimal levels of energy efficiency (Backlund et al., 2012). The most recent leaps in energy prices in Europe, along with sharp upward pressure on energy bills in industries directly exposed to those rising prices and to shortages and supply chain disruptions, not only increase the need to use alternative energy sources but also imply the importance of accelerating the improvement of energy efficiency as a source of energy itself.

1.1.1 The knowing -doing gap

Tremendous political, technological, economic, and societal changes brought about by recognizing the challenges of sustainable development have underscored the need to redirect sustainability-oriented efforts toward companies. To address such challenges, companies need to efficiently use resources and implement less costly processes while maintaining standards for workers' well-being. Although achieving sustainability has indeed been used to justify

corporations' strategic directions (Duygulu et al., 2016) and though literature on companies' strategic responses to climate change is extensive (Engert et al., 2016; Paul et al., 2017), practices geared toward sustainability in core organizational activities remain underdeveloped (Brandi and Thomassen, 2020). Consequently, "A significant gap remains between corporate sustainability aspirations and action" (Corbett et al., 2018, p. 262), and companies need more guidance in order to actualize corporate-level sustainability-related objectives in practice (Engert et al., 2016; Baumgartner and Rauter, 2017; Kiesnere and Baumgartner, 2019). In the words of Ball and MacBryde (2020), whereas the "know what" is well covered in the literature, the "know how" of cultivating conditions that encourage practicing sustainability in the workplace remains limited, especially regarding the empirical understanding of ways of realizing sustainability-oriented strategies in companies' operations (Hong et al., 2019).

Along with various process-oriented models seeking to explain the sequence of necessary decisions and existing trade-offs in such decision-making while implementing sustainability-related strategies (e.g., Epstein and Buhovac, 2010; Pagell and Wu, 2009; Schrettle et al., 2014), researchers have also focused on elucidating the relationship between sustainable operations and organizational performance (e.g., Zailani et al., 2012; de Burgos-Jiménez et al., 2013; Adebanjo et al., 2016; Graham and McAdam, 2016). Sustainability's impact on companies' performance and on factors of sustainability emanating from institutional and organizational levels—that is, sustainability as performance—has been addressed as well (Wesselink et al., 2015). Indeed, the literature includes "much on why companies should voluntarily adopt a responsible approach to business" (Klettner et al., 2014, p. 149) and on what should be improved. However, how those ends might be achieved in practice has not been thoroughly investigated (Ball and Lunt, 2018). According to Hong et al. (2019), although a sustainability orientation has clearly been initiated at the corporate level, operations have seldom been adequately engaged.

Confronting the lack of frameworks with the pacing and scaling needed to overshoot planetary boundaries, scholars have advocated using alternative research lenses to accelerate the shift from sustainability as performance toward sustainability as practice. Given the difficulty of activating the concept of sustainability, researchers have also recently encouraged "to study the processes of sustainability in a practice context that includes a more holistic and integrative approach" (Brandi and Thomassen, 2020, p. 213). Added to that, they have proposed expanding current normative theoretical perspectives to include approaches that view sustainability as practice (Silva and Figueiredo, 2017) and focus on how daily activities unfold. Moreover, they have called for abandoning the assumption that sustainability-related strategies are created only in planned, deliberate ways (Neugebauer et al., 2016) and instead using theoretical lenses that clarify intraorganizational activities, processes, and forms of agency (Williams et al., 2021). Last, they have advocated a shift from the triple-bottom-line perspective (Elkington, 2018) toward an interorganizational focus on the UN's Sustainable Development Goals (SDGs) as small, micro, or local practices in order to overcome barriers to sustainable development (Touboulic et al., 2018; Silva and Figueiredo, 2020; Sarkis and Ibrahim, 2022).

1.1.2 The extended energy efficiency gap

The demand for energy as input and as a source of power in the production of goods, services, and freight transportation, as well as socioeconomic development in general, is expected to rise as the production of goods and services continues to be upscaled. Since the 1970s, the industrial sector, including manufacturing and processing industries, has accounted for 38% (146 TWH/year) of all energy use, 84% of which has been electricity and biofuels used to run operational processes (Energimyndigheten, 2019). Beyond that, the freight transport of produced goods, as a fundamental logistics activity, is also energy-intensive (Halldórsson et al., 2019a). Therefore, to meet the challenges of climate change and societal demand for energy, increasing the energy efficiency of operations is pivotal.

However, companies still have little incentive to increase the energy efficiency of their operations (Cooremans and Schönenberger, 2019). The practical discrepancy between what is optimal, rational, and theoretically possible versus what cost-effective technologies implemented for real energy consumption can achieve has been dubbed the *energy efficiency gap* (Johansson and Thollander, 2018; Cooremans and Schönenberger, 2019). By extension, the even greater potential for improved energy efficiency via non-technological improvements and energy management practices has been called the *extended energy efficiency gap* (Backlund et al., 2012, Schulze et al., 2016). Addressing the extended energy efficiency gap in operations, this thesis argues that the gap can be addressed by engaging in and replicating improvement-oriented processes (Drew et al., 2016), constructed and enacted by multiple individuals within and across organizational levels. However, such an arrangement requires the strategic–operational alignment of the resources needed to embrace such engagement and replication, knowledge of which has remained limited in the context of energy efficiency in operations (Ball and Lunt, 2018).

1.2 Research scope and key concepts

This thesis's theoretical underpinning is the literature on operations management. Therefore, this section embeds the concept of sustainable development "into a wider context" of operations management (Christen and Schmidt, 2012, p. 401). Figure 1.1 illustrates the relationships between the three key concepts of the research's framework.

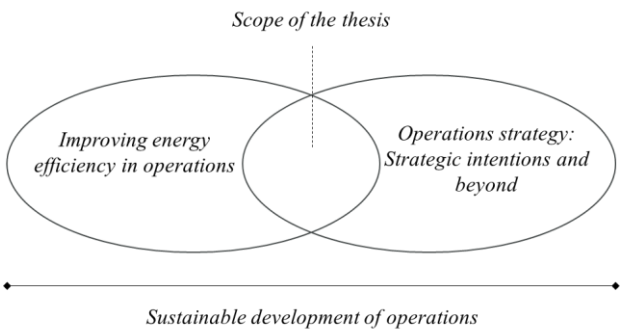

Figure 1.1: Relationships between key concepts in the research framework

Of the 17 SDGs adopted by all UN member states as part of the 2030 Agenda for Sustainable Development (UN, 2018), this thesis contributes to realizing specific SDGs but without abandoning the others: SDG 7 (i.e., achieving affordable and clean energy), SDG 9 (i.e., promoting sustainable industrialization), SDG 12 (i.e., achieving responsible consumption and production), and SDG 13 (i.e., combating climate change and halting global CO_2 emissions). The thesis takes the view that when efforts to achieve each SDG are established and maintained in enough places, then global sustainability can be achieved (Silva and Figueiredo, 2017, 2020).

According to Wang et al. (2019), trends in sustainable consumption and production differ from one economy to another, which has piqued interest in revealing the various meanings and material contexts mobilized around the issue of sustainability. Therefore, the focus on the mentioned SDGs is justified by the research's empirical setting—that is, Sweden—whose economy is built upon abundant natural resources (Ekonomifakta, 2013) and positions production as a foundation for employment (Production2030, 2018). In Sweden, the Swedish Governmental Agency for Innovation Systems (i.e., Vinnova), supported by Formas and the Swedish Energy Agency, has a vision "to work toward competitive and sustainable manufacturing industry in Sweden" (Production2030, 2018, p. 5). Therein, *resource-efficient production* is defined as an important item on the research agenda, with *resources* referring to "materials, people, energy, capital and time" (Production2030, 2018, p. 9). Moreover, the agenda highlights the vital role of people and the need to develop their potential in order to strengthen cooperation with automation and thereby not only boost productivity but also assure production's competitiveness amid major demographic challenges (Berlin et al., 2013).

1.2.1 Improving energy efficiency in operations

Directive 2012/27/EU of the European Parliament and the Council of the European Union (2011) defines *energy efficiency* as "the ratio of output of performance, service, goods or energy, to input of energy," meaning the delivery of more products and/or services with the same energy input or the same products and services with less input. By contrast, the Directive defines *energy efficiency improvement* as "an increase in energy efficiency as a result of technological, behavioral and/or economic changes," or what can be conceptualized as "the process of strategy implementation by utilizing resources and influencing individual and/or collective action toward energy-related objectives" (Schulze et al., 2016, p. 3705). That conceptualization allows considering the improvement of energy efficiency in operations as a way to realize an interorganizational focus on the challenges of sustainable development as both a strategic objective and as a path toward deliberate change.

Against that background, this thesis defines *energy efficiency improvement* as a qualitative term referring to the process of actualizing corporate-level objectives for energy efficiency in operations by utilizing resources and influencing individual and/or collective action. In conceptualizing the improvement of energy efficiency qualitatively, the thesis does not measure energy efficiency but instead addresses it as an improvement-oriented process. By extension, it

conceptualizes improving energy efficiency in operations as a means to address the extended energy efficiency gap.

1.2.2 Operations strategy: Strategic intentions and beyond

Associated with the structural and infrastructural decisions made in operations stemming from corporate and/or business strategy (Slack et al., 2010), operations strategy has been characterized as a means of aligning a firm's operations with its external environment (Slack and Lewis, 2011). Therefore, even when energy efficiency is embraced as a legitimate sustainability-related objective, actualizing it in operations requires studying it in relation to not only the existing sustainability-related corporate-level strategy but also operations strategy.

Along those lines, this thesis positions operations strategy as an analytical construct to analyze the alignment of a firm's operations with corporate sustainability-related strategies and objectives (i.e., strategic–operational alignment) to improve energy efficiency. Answering the call to abandon the assumption that operations strategy responds to corporate objectives and is communicated and integrated along with other functional strategies to achieve strategic fit with corporate-level strategy (Hayes and Wheelwright, 1984), the thesis seeks an in-depth understanding of operations strategy as an organizational process of micro-level practices in operations and other intra- and extra organizational units (Adamides, 2015).

1.2.3 Sustainable Development of Operations

Although the terms *sustainability* and *sustainable development* are often used interchangeably in the literature, they signify different concepts. On the one hand, *sustainability* "is the ability of a human, natural or mixed system to withstand or adapt to endogenous or exogenous change indefinitely" (Dovers and Handmer, 1992, p. 275), which suggests "that the existence of a work system has created a platform for the future existence of new work systems and processes" and that "its heritage is resource-regenerative instead of resource-consuming" (Docherty et al., 2009, p. 83). By contrast, *sustainable development* refers to a process of change in which the exploitation of resources, the direction of investments, and the orientation of technological developments and institutional changes are made consistent with future as well as present needs (Brundtland, 1987). In its parts, *sustainability* means "a certain favourable outcome" as a static corporate-level goal that is both difficult and distant, whereas *development* adds characteristics of an emerging process and delineates "the transition toward sustainability, and then the safe development thereafter" (Robèrt, et al., 2002, p. 198) and "a pathway of deliberate change and improvement which maintains or enhances [the sustainability] of the system" (Dovers and Handmer, 1992, p. 275).

Although improving energy efficiency in operations necessarily foster environmental sustainability and can be used as leverage to integrate energy-efficient measures into operations management, the idea of sustainability as practice, or practicing sustainability involves the deep comprehension of the values and purposes of sustainability among practitioners (Silva and Figueiredo, 2017). Instead, this thesis assumes that improved energy efficiency in operations is

not an end in itself and elaborates upon the evolution of the idea of sustainability as practice, the long-term development of which is ensured in three major ways:

1. Addressing organizations as work systems (Docherty et al., 2009) that depend upon being economically viable;
2. Activating the idea of bundles of practices (Schatzki, 2005, 2012), in which a set of actions and material arrangements form a bundle and a set of interrelated bundles form a constellation of practices; and
3. Addressing individuals as conveyers of decisions to be acted upon while considering the multilevel interdependencies among the different levels within organizations.

Throughout this thesis, the same conceptual logic of the sustainable development of operations is followed such that (1) the improvement of energy efficiency in operations is viewed as the process of actualizing corporate-level objectives for energy efficiency in operations by utilizing resources and influencing individual and/or collective action; (2) operations strategy is the analytical construct used to analyze strategic–operational alignment of the resources needed to allow engaging in and replicating such an improvement-oriented process; and (3) development occurs via changes in individual and collective actions and understandings to promote sustainability as practice by developing people's skills and competencies.

1.3 Purpose and research questions

Against the background provided, the purpose of the research conducted for this thesis is:

To investigate energy efficiency improvement in operations in order to facilitate sustainability as practice.

That purpose is operationalized in three RQs. First, given the nature of the research conducted, RQ1 is an explorative, descriptive question developed to extend current knowledge about improving energy efficiency in operations as a practice. To answer that question, improving energy efficiency in operations needs to be analyzed, according to its characteristics, as a phenomenon constructed and enacted by multiple actors. In that sense, a *practice* is a recurring pattern of action that can create a nexus of meaning among the people who perform it (Schatzki, 2012). By extension, improving energy efficiency as a process is understood according to the set of primary activities that it comprises. However, "featuring of practice as an ongoing process, made by many discrete actions that are recurrent over time" (Silva and Figueiredo, 2020, p. 6) the thesis also addresses how, why, and by whom activities have been interpreted and employed (Nicolini, 2012). To address the extended energy efficiency gap in operations by replicating acts of improvement, improving energy efficiency can be understood as a firm-based practice that results in actualizing objectives for energy efficiency, and identifying its characteristics can promote consensus on the practice's meaning and evaluation among scholars (Hong et al., 2018) as well as practitioners (Kluczek, 2019). By gathering empirical data from both top management and operations, the thesis seeks to ensure a consensus of meaning and the

close interaction of different stakeholders. As such, it seeks to broaden the focus of improving energy efficiency in operations from the dominant operational focus on technological measures related to production processes (May et al., 2017) to include both corporate and operations strategies and thereby explain the involvement of actors from different organizational levels. Considering all of the above, RQ is formulated as follows:

RQ1: What are the characteristics of improving energy efficiency in operations when viewed as a practice?

Although organizations may embrace energy efficiency as a legitimate sustainability-related objective, they struggle with its actualization due to two types of challenges in integration (Hengst et al., 2020); one, between corporate-level sustainability-related objectives and actionable practices available to implement them, the other between strategies for sustainability and other existing strategies. The first challenge, is addressed through RQ1. In order to address the second challenge, embracing the actualization of objectives for energy efficiency in operations requires it to be studied in light of both strategic intentions related to sustainability and operations. Therefore, RQ2 was designed to explore organizations' strategic–operational alignment for improving energy efficiency in their operations, chiefly according to actors' understanding of how energy efficiency is improved in operations and expressed in their activities and how the activities are ordered (Schatzki, 2012) in relation to other practices. Understanding actors' involvement can help to align strategic objectives for improved energy efficiency across and within operations via shared understanding (Longoni et al., 2019) and the alignment of achievements (González-Sánchez et al., 2018).

Despite the clear emphasis on sustainability-related objectives in corporate-level strategies, the real-world realization of such strategies into practice needs to be elucidated (Engert et al., 2016). In the limited literature addressing the realization of sustainability-oriented strategies (e.g., Egels-Zandén and Rosén, 2015; Linneberg et al., 2019), Fagerlind et al. (2019) discuss the distribution of decision-making authority related to economic, environmental, and social sustainability objectives between different organizational levels in multinational manufacturing enterprises. Beyond that, theoretical models focusing on factors of the successful top–down implementation of such strategies have been developed (Engert et al., 2016) that assume that sustainability strategies are pursued in planned, deliberate ways (Neugebauer et al., 2016; Luederitz et al., 2021). Nevertheless, the lack of any empirical understanding of how to realize sustainability-related strategies in general (Klettner et al., 2014) and in firms' operations in particular (Hong et al., 2019) persists. In response, RQ2 is:

RQ2: How is improving energy efficiency in operations practiced in relation to mainstream operations strategies and organizations' strategic intentions for sustainability?

Third and last, this thesis holds that practices develop over time as practitioners incorporate knowledge through the constant repetition of ordinary actions (Silva and Figueiredo, 2020).

Therefore, focusing on improving energy efficiency in operations as a practice can be used as leverage to integrate energy-efficiency measures into operations management and thus enable the actualization of specific corporate-level sustainability-oriented objective which foster sustainability. However, "the fact that different people carry them [actions] over time also precipitates spontaneous transformations" (Silva and Figueiredo, 2020, p. 4). Therefore, improving energy efficiency in operations as a practice has been shown to turn "from an abstract idea to a concrete entity when a constellation of practices resulted in the change of people's behavior" (Silva and Figueiredo, 2020, p. 6). Nevertheless, ensuring such continuity requires a multilevel process tied to the successful enactment of intended activities from the organization level to individuals via a feedback approach, as well as the realization of individual observations to enable actions via a feedforward approach (Crossan et al., 1999). Even so, according to Ball and Lunt (2018), the literature on resource efficiency, particularly energy efficiency, does not investigate organizational learning, while the literature on organizational learning neglects the operational aspects of replicating resource efficiency. Following suit, RQ3 is designed to illuminate the improvement of energy efficiency in operations as a mechanism to facilitate sustainability as practice by enabling organizational learning. In this thesis, those mechanisms are formal or informal, natural or established, and instrumental or activity-oriented; however, all are used to integrate and coordinate interactions between individuals within organizations (Cousins et al., 2006). In short, RQ3 is:

RQ3: How can improving energy efficiency in operations act as a mechanism to facilitate the practice of sustainability in the organizations?

1.4 Research delimitations

Although the theoretical scope of this thesis falls within the domain of operations management, it has borrowed references and analytical frameworks from other domains to explain how organizations can approach sustainable development. Even if that multidisciplinary approach is necessary to illuminate pathways to improvement through the lens of the individuals involved, concepts such as organizational behavior, sociology and cognitive psychology, motivation theory, and general strategic management are beyond the thesis's scope.

Moreover, to avoid studying operations strategy only at the operational level and thereby misunderstand the its contributions to corporate strategy and firms' competitive advantages (Slack, 2005), the thesis equally considers both the strategic and operational levels of operations strategy. Thus, it does not study strategy at the business level but considers business strategy to be the boundary for operations strategy. In that sense, operations strategy is regarded as organizations' strategic intentions for operations, which are not always formalized as documented strategies. However, because the implications of such strategic intentions can shape decisions to be acted upon, unlike the literature on strategic management that refers to as complementing operations strategy literature, this thesis does not aim to contribute to the literature on strategic management.

In the same vein, researchers have delineated the strategic business development pathways of firms at the business or corporate levels by defining their corporate and/or business strategies. At the strategic level, sustainability can thus be defined in terms of sustainability-targeted goals in view of changing market requirements in order to support business strategies. According to the literature, that end is achieved in reality by translating sustainability into effective actions by differentiating sustainable product and service options (Das and Joshi, 2007). However, because the literature on strategic management is beyond the thesis's scope, it does not analyze the perspective on sustainability as a business strategy of product and service differentiation. Last, because the thesis focuses on contributing to improvement within operations, strategic areas of product design and technological innovation are excluded as well.

1.5 Outline of the thesis

Following this chapter, which has presented the background of the research and introduced its purpose and research questions, Chapter 2 presents an overview of the frame of reference that guided the research. Next, Chapter 3 describes the research methodology, including the decisions made, how they were made, and their implications, after which Chapter 4 summarizes the five appended papers and presents their primary contributions to the thesis. After that, Chapter 5 explains the results and answers to the thesis RQs by analyzing the findings in the appended papers, while Chapter 6 discusses the findings in relation to the research's purpose and the literature, including its theoretical contributions. Last, Chapter 7 closes the thesis by presenting the conclusions of the research and its limitations, including its managerial implications, followed by an elaboration of recommended directions for future research.

2. Frame of reference

To establish a foundation for the research in this thesis, this chapter presents the thesis's theoretical background based on the current body of knowledge. To that end, Section 2.1 presents an overview of the literature on operations management concerning sustainability in general and energy efficiency in particular, as well as the literature on energy management related to operations management. Next, Section 2.2 examines the theoretical underpinnings of the literature on operations strategy, including by introducing different interpretations of operations strategy with respect to its use in theoretical debates and practice. In that way, the section also justifies using the analytical construct of strategic–operational alignment to activate improvement in operations. Last, in presenting the thesis's conceptual framework, Section 2.3 builds upon the key concepts of the research framework in Figure 1.1, the literature elaborated in Sections 2.1 and 2.2, and the different frameworks used in the appended papers.

2.1 Sustainability in management of operations

According to Jarzabkowski et al. (2021), definitions of *sustainability* "tend to be vague and often instrumental to the business-centric view of the interaction between organizations and the environment" (p. 229). In practice, companies nevertheless struggle to advance from top–down, management-level sustainability-focused activities toward more inclusive approaches for achieving sustainability-oriented objectives (Kiesnere and Baumgartner, 2019). Thus, per Ivory and Mackay (2020, p. 2058), it is crucial to understand "how sustainability is scaled within organizations to become a key strategic imperative such that it is integrated into all levels of organization (spatial scale) and reflects an integrated and ongoing commitment into the future (temporal scale)."

Scholars of management have acknowledged the importance of understanding how sustainability implicates the "practices, interactions and attitudes of managers" (Allen et al., 2019, p. 782). Among them, Mitra and Buzzanell (2018) have identified an array of titles and formal roles responsible for enacting sustainability within organizations. Responding to growing scholarly interest in what practitioners of strategy in fact do (Jarzabkowski and Balogun, 2009), researchers have also addressed those individuals' responsibility for "executing sustainability strategy" (e.g., Miller and Serafeim, 2014, p. 198). Addressing the lack of focus on individuals, Ivory and Mackay (2020) have additionally identified three micro-level strategies deployed by individuals to embed sustainability within their organizations: conforming, leveraging, and shaping. However, the designs of the mentioned studies were able to address only what sustainability managers within organizations do as part of their managerial routines. More recently, while examining sustainability-focused activities, Williams et al. (2021) have investigated the agency of corporate sustainability managers and identified three overlapping, co-occurring subsets of sustainability work: goal-directed, other-directed, and self-directed work. Building upon the need to address micro-level processes (Allen et al., 2019), this thesis argues for and represents cross-level research geared toward understanding the nature of enabling sustainability-focused intra-organizational activities, processes, and managerial

agency, namely by linking individual behaviors and attitudes and internal processes with sustainability as an organizational-level phenomenon.

2.1.1 Sustainability in operations management

Operations management inevitably intersects with decisions influencing socioenvironmental sustainability and their underlying economic implications (Hassini et al., 2012). Therefore, the field of sustainable operations management, rooted in the mainstream literature on operations management and sustainable development, is concerned with the efficient use of resources and less costly economic processes that maintain standards for workers' well-being at the operational level (Longoni and Cagliano, 2015).

The scope of research in the literature on sustainable operations management has ranged from the corporate level (e.g., Griffiths and Petrick, 2001; Naor et al., 2015) to internal operations (e.g., Jeffers, 2010; Walker et al., 2014), as well as from internal practices (e.g., product design and manufacturing processes; e.g., Abdul-Rashid et al., 2017) and sustainable production and consumption (e.g., Roy and Singh, 2017) to a wider system that encapsulates the entire supply chain (e.g., Koh et al., 2016). Based on Atasu et al.'s (2020) literature review on sustainable operations management, five major topics are covered in such literature: closed-loop supply chains, low-carbon economies, environmental management and performance, innovation, and social responsibility.

Supply chains have received sustained attention as a level of analysis (e.g., Cousins et al., 2004; Vachon and Klassen, 2007; Wu and Pagell, 2011; Blome et al., 2014; Dam and Petkova, 2014; Fabbe-Costes et al., 2014; Tachizawa et al., 2015; Dabhilkar et al., 2016; Fritz and Silva, 2018). Even end-of-life management by recycling and materials recovery or by ensuring products' reusability after their shelf life has been examined (e.g., Abdul-Rashid et al., 2017), as has engaging end consumers as prosumers (e.g., Halldórsson et al., 2019b) and customers (e.g., Lee et al., 2019). However, identifying a problem in atheoretical perspectives in the literature, Touboulic and Walker (2015) have called for other approaches able to address aspects of practice in the field, and in response, the use of theories of practice has arisen (e.g., Silva et al., 2018; Shaw et al., 2021). Even so, according to Silva et al.'s (2022) recent systematic literature review, the term *supply chain practice* is currently linked not only to discussions related to actions, initiatives, and issues focusing on daily operations but also to the indicators, factors, and items used in quantitative research. Therefore, to establish close interactions among stakeholders, scholarly consensus on both the meaning and evaluation of practice is needed (Hong et al., 2018).

The studies identified by Silva et al. (2022) primarily adopted a practice-based view and either developed their arguments based on Bromiley and Rau's (2014) work or used the concept of supply chain practice described by Carter et al. (2017). Applying the practice-based view has helped to explain differences in business performance and provided a useful foundation for practitioners for making decisions about environmental strategies and performance

measurements (e.g., Silva et al., 2018; Rehman Khan and Yu, 2021; Shaw et al., 2021). However, the practice-based view has also been criticized for overlooking the nature of practices, for not explaining what practice is or does, and for being unduly interested in the routinization of new social orders (Silva and Figueiredo, 2020). In response, following Schatzki's (2015) emphasis on the potential of theories of practice to support future transitions toward sustainability, a shift toward practice-based studies has been proposed (Silva and Figueiredo, 2020).

When moving from the corporate level to operations, sustainability becomes a complex, unfamiliar paradigm (Besiou and Van Wassenhove, 2015). Operations employees do not typically think in terms of sustainability or view their operations a sustainability-focused lens (Longoni et al., 2019). Even so, research on operations strategy, as a vehicle for translating corporate objectives and integrating competitive priorities, performance objectives, and action plans, has proposed that sustainability is a relevant aspect of operations thinking. Nearly 15 years ago, Martín-Peña and Díaz-Garrido's (2008) literature review on typologies and taxonomies of operations strategy heralded the new competitive priorities of innovation, aftersales service, environmental protection, advertising, widespread product distribution, and firm–customer relationships. Since then, other research has confirmed that sustainability as a new competitive priority (Gunasekaran and Spalanzani, 2012). On the other hand, environmental protection has long been regarded as both a competitive priority and an operations capability (Angell and Klassen, 1999; de Burgos Jiménez and Lorente, 2001; Avella et al., 2011). Integrating sustainability into operations strategy, Johansson and Winroth (2010) developed a framework for formulating operations strategy that incorporates environmental concerns, while Ocampo and Clark (2015) developed a conceptual framework that integrates concepts of operations strategy and sustainable manufacturing. Departing from that perspective, Macchi et al. (2020, p. 12) have posited that "the more a company is showing traits of an archetype that is advanced along the 'journey' toward a sustainable manufacturing strategy, the higher is the expectation of aligned behaviors as expected by the sustainable manufacturing strategy."

In their literature review focusing on production, Bonvoison et al. (2017) have classified the sustainable manufacturing solutions identified by researchers into four types:

1. Manufacturing technologies focusing on how things are manufactured, research on which addresses processes and equipment (e.g., machinery and facilities);
2. Product life cycles focusing on what is to be produced, research on which addresses product definition;
3. Value creation networks focusing on the organizational context of manufacturing activities, research on which addresses organizations; and
4. The global impact of manufacturing focusing on mechanisms to transition toward sustainable manufacturing, research on which exceeds the conventional scope of engineering.

Although the logistics sector, largely to comply with EU directives, began responding to climate change far more recently than production (European Commission, 2018), researchers in logistics have proposed and examined sustainability-oriented initiatives pursued by logistics service providers (Colicchia et al., 2013; Evangelista, 2014; Abbasi and Nilsson, 2016; Centobelli et al., 2017). According to Martinsen and Huge-Brodin (2014), environmentally oriented initiatives are essentially either transport-related initiatives (e.g., concerning fuel, vehicle technology, modal choice, behavioral aspects, and/or transportation management) or beyond-transport initiatives (e.g., concerning logistics system design, environmental management systems, and emissions).

The foundations for continuous improvement can be derived from principles and practices of quality management and lean management. Lean focuses on sources of waste in production processes (Brito et al., 2019), namely overproduction, waiting, transport, defects, inappropriate processing, unnecessary inventory, and unnecessary motion (Verrier et al., 2014), as well as the waste of staff capabilities (Brito et al., 2019). With that focus, lean has proven to be an effective philosophy for eliminating waste and been widely used in connection to resource efficiency and the use of energy and other resources (Kleindorfer et al., 2005; Piercy and Rich, 2015). Given lean and green operations' common focus on minimizing waste (Shokri and Li, 2020), eliminating environmental waste to improve environmental performance (Abreu et al., 2017) and even social performance (Bhattacharya et al., 2019) has been examined as well. Even though the literature reports a range of initiatives and tools (e.g., Faulkner and Badurdeen, 2014) for combining lean and green operations, not all methods are available for "prompt use" (Abreu et al., 2017, p. 852).

Meanwhile, models for evaluating how well an organization has managed the integration of sustainability into daily operations have been developed, including the maturity model on lean and green (Verrier et al., 2014) and a conceptual model of lean–green and sustainability tools for improving triple-bottom-line performance (Teixeira et al., 2021). Researchers have also applied organizational learning to investigate approaches for achieving sustainability, including developing knowledge and habits and aligning activities to the strategic intention (e.g., Davies, 2012; Ball and Lunt, 2018), and called for more empirical research on the topic. In response, this thesis applies the logic of the integrative approach to continuous improvement from lean, specifically the notion of transferring the maximum number of tasks and responsibilities to workers who in fact add value to the product or service (Womack et al., 1990). By extension, borrowing from the literature on learning and organizational renewal (e.g., Crossan et al. 1999) the thesis conceives energy efficiency to be a matter of waste reduction, albeit one that can enable learning through outcomes (Argote, 2011) to clarify how organizations engage in and replicate improvement.

2.1.2 Intersection of operations management and energy efficiency

This thesis's focus on improving energy efficiency as a means to foster sustainability is based first on the large volumes of energy consumed in operations, in terms of the end use of operational processes to produce products and services (Rasmussen, 2020), including production and support processes such as heating and lightning (Fleiter et al., 2012). Second, it is also based on the idea that energy efficiency is a promising strategy for improving sustainability (Abdul-Rashid et al., 2017) that affects industrial manufacturing plants, their technologies, and even production systems (Schrettle et al., 2014). Third, it responds to researchers' calls to target the stimulation of management practices, competence, organizational structure, and organizational capabilities along with the provision of economic incentives (Solnørdal and Foss, 2018). Fourth and finally, it maintains that practitioners need new approaches to enhance sustainability through energy efficiency (Kluczek, 2019). However, despite those underpinnings, the literature on the intersection of operations management and energy efficiency remains dominated by the technical perspective (Schulze et al., 2016), takes an operational focus on technological measures related to production processes (May et al., 2017), and lacks a strategic perspective.

Meanwhile, energy efficiency, aligned with the paradigm of strategies for preventing pollution, has gained ground in the literature on operations management. Thus far, such literature has addressed innovation and technology, including information and communication technologies, used to reduce resource consumption in operational processes (Hsu et al., 2016; Koh et al., 2016) and to identify new sources of energy in bids to reduce the carbon footprint of operations (Garetti and Taisch, 2012). According to Atasu et al. (2020), literature on sustainable operations management focusing on energy has covered three primary topics:

1. The effects and design of carbon emissions regulation, including the ways in which regulatory and information-based instruments influence producers' production decisions and carbon-reduction efforts;
2. The adoption of energy-efficient or clean production technologies; and
3. The analysis of renewable energy strategies.

In research on production, energy efficiency has been proposed as a key criterion in strategic decision-making about sourcing and location (Rudberg et al., 2013). Using energy efficiency in production planning and control to optimize operational processes has also been addressed (May et al., 2017), as has reducing the energy consumption and energy efficiency of operational processes as a means to improve sustainability in logistics (e.g., Browne et al., 2006). On all counts, implementing energy management in organizations has been acknowledged as a promising means of reducing energy consumption.

In parallel, the literature on energy management focuses on technical and technological approaches to improving energy efficiency in production, typically through technological solutions and equipment that promote eco-efficiency. The indirect consumption of energy by

operational processes has additionally been acknowledged (May et al., 2016), while barriers to and drivers of adopting energy management have been investigated (Brunke et al., 2014; Johansson and Thollander, 2018). Along with barriers to adopting energy management, researchers have also addressed tools to overcome said barriers (Johansson and Thollander, 2018); however, the barriers that the identified tools can help overcome are categorized as information barriers. For that reason, the literature on energy management calls for strategic and operational integration (Bui and de Villiers, 2017) able to bridge the strategic and operational levels within organizations (Virtanen et al., 2013).

While reducing energy use in core operations processes, including production and support processes, belongs to the operational dimension of energy management (Fleiter et al., 2012), other activities and decisions primarily relate to authorization and resource allocation, including strategic investment decisions regarding measures for energy efficiency (Bui and de Villiers, 2017). Scholars have acknowledged the importance of employees' competence and engagement in facilitating energy efficiency (Svensson and Paramonova, 2017), the importance of climate-friendly management practices toward it (Martin et al., 2012), and the motivation of managers and workers as a pivotal factor in improving it (Hasanbeigi et al., 2014). Despite all of that work, ways of engaging in improving energy efficiency in operations remain poorly understood (Ball and Lunt, 2018).

2.2 Operations strategy

According to Anand and Gray (2017, p. 53), *operations strategy* refers to "the interplay between the firm's strategic and the organization of its resources for developing, producing, and delivering goods and services." Whereas the term *manufacturing strategy* was once used to describe that interplay, *operations strategy* now coexists with it, and the concept, having been transferred to operations strategy in all contexts, including services, can be further extended to supply chains. Today, as in this thesis, both terms are used interchangeably.

Table 2.1 presents a selection of common definitions of *operations strategy*. This thesis, departing from the definition presented by Swamidass and Newell (1987), complements the term with a Mintzbergian view on strategy as a "pattern in a stream of decisions" that includes the people, practices, and dynamics therein. In that context, the thesis regards operations strategy as an analytical construct used to create coherence between a firm's hierarchal levels and as a vehicle for translating corporate-level strategic objectives into operations performance via the decisions made and practices engaged by operations functions.

Table 2.1: Common definitions of operations strategy

Source	***Definition***	***Emphasis***
Skinner (1969)	Exploiting manufacturing as a competitive weapon	The need for top management's control by involving them in manufacturing decision-making
Hayes and Wheelwright (1984, p. 85)	"A pattern of decisions [suggesting] criteria that might be used to evaluate the appropriateness of a given manufacturing decision"	The pattern of decisions made over a period as a manufacturing strategy to support business strategy
Swamidass and Newell (1987, p. 509)	"Effective use of manufacturing strengths as a competitive weapon for the achievement of business and corporate goals"	An internal focus and manufacturing strengths as competitive weapons
Platts et al. (1998, p. 517)	"A pattern of decisions, both structural and infrastructural, which determine the capability of a manufacturing system and specify how it will operate, in order to meet a set of manufacturing objectives which are consistent with the overall business objectives"	The manufacturing system's capability
Hill and Hill (2012, p. 245)	"A set of policies for using the firm's resources to support the business unit's strategy to gain competitive advantage"	A top–down view in setting policies but also taking both an outside–in perspective focusing on competitive advantages and an inside–out perspective focusing on resources

2.2.1 Content versus process in operations strategy

The most common theoretical distinction within operations strategy differentiates content from process (Leong et al. 1990; Dangayach and Deshmukh, 2001; Slack et al., 2010). Whereas *content* refers to the constituents of operations strategy, *process* refers to how the strategy is made and consists of ways of formulating and implementing manufacturing strategy (Dangayach and Deshmukh, 2001; Slack et al., 2010). The predominant construct of the content of manufacturing strategy consists of competitive priorities and strategic decisions (Leong et al., 1990). In that sense, *competitive priorities* are the "collection of goals pursued by the operation function of any organization" and "define the areas in which the operations must be focused on to be able to provide organizational competitive advantage" (Martín-Peña and Díaz-Garrido, 2008, p. 200). Studies on operations strategy generally agree on four major competitive priorities: cost, flexibility, quality, and delivery (Hayes and Wheelwright, 1984; Schmenner and Swink, 1998).

While the terms *competitive priority* and *performance objective* are interconnected and usually used interchangeably in the literature on operations strategy, scholars in the field (e.g., Wheelwright, 1985; Kim and Arnold, 1996; Kim et al., 2014) have regarded competitive priorities as a company's preferred dimension and intention derived from its business strategy. By contrast, performance objectives are regarded as objectives set by operations managers

based on the company's competitive priorities, which form the basis for their operations practices via a sequence of decisions about the structure and infrastructure of operations (Hayes and Wheelwright, 1984; Rudberg and Olhager, 2003). Decisions about the structure influence the physical resources and address aspects such as capacity, sourcing, vertical integration, facilities, information technology, and process technology (Hayes and Wheelwright, 1984; Slack and Lewis, 2011). Those decisions are usually difficult to unmake and require considerable investments. Meanwhile, decisions about infrastructure impact tactical activities within operations and are easier to undo; they address elements such as resource allocation and capital budgeting systems, planning and control systems, quality systems, and organization.

While the content of operations strategy primarily encompasses what the strategy concerns, the processes of operations strategy consist of formulation or deployment (i.e., focused on linking strategic decisions to capabilities and formalizing processes) and implementation—that is, how the decisions are transferred into actions at the operational level (Rytter et al., 2007; Rosén, 2011; Slack and Lewis, 2011).

2.2.2 Strategic alignment in operations strategy

Research on operations strategy has addressed strategic alignment according to different schools of thought. From early studies on operations strategy, the first school primarily includes intended elements in operations strategy, viewed as top–down management's conceptualization of strategic plans to be implemented in cascading fashion throughout the levels of the organization, such that lower-level actors align their decisions and actions with those intentions (Wheelwright, 1985). In line with the top–down view, the external consistency of overall business objectives with the competitive priorities of operations has been addressed with macro-level approaches (Barnes, 2002). Also in the school, plans for implementation are thought to be facilitated by certain structures, processes, systems, and controls, including key performance indicators and scorecards (Kaplan and Norton, 1996).

With the recognition of emergent strategy as a phenomenon, a second school of thought emerged that viewed strategy as a "pattern in a stream of decisions" of different forms (Mintzberg, 1978, p. 935). Such a view on strategy made three proposals: (1) that no strategy is purely deliberate, which would imply lack of learning, or purely emergent, which would imply a lack of control, whereas strategy has to be viewed as a learning process, (2) a shift should occur from a rational, discontinued mode of the "formulate-then-implement" approach toward strategy formation, and (3) a complementary bottom–up approach should meet the traditional top–down approach such that "strategy is gradually shaped over time and based on real-life experience" (Slack et al., 2010, p. 67). In line with the complementary bottom–up approach, the internal consistency of competitive priorities, performance objectives, and action plans in terms of improvement programs have been addressed as approaches to developing micro-level processes (Kim and Arnold, 1996; Kim et al., 2014; Adamides, 2015). In the same vein, scholars have addressed *strategic consensus* in the context of production (e.g., Sarmiento et al., 2008; Feger, 2014; Edh Mirzaei et al., 2016), defined as "the level of agreement within

an organization regarding the relative importance of cost, quality, delivery and flexibility to the organization's operational goals, as well as the relationships between those competitive priorities and operational policies" (Boyer and McDermott, 1999, p. 290).

The third school of thought positioned operations strategy within a broader context and established relationships between different operations strategy constructs, namely process, content, context, and performance (e.g., Kiridena et al., 2009).

Last, whereas the three other schools of thought addressed internal and external consistency across different organizational levels (i.e., corporate, operations, and intra-functional operations)—that is, *vertical strategic alignment*—Kathuria et al. (2007) have also addressed *horizontal strategic alignment*, which refers to the consistency of decisions cross-functionally while achieving synergy within each function.

2.3 Conceptual framework

Building upon the key concepts of the research framework in Figure 1.1 and different frameworks used in the appended papers, a conceptual framework was developed, as shown in Figure 2.1. While some parts of the framework are elaborated in the literature and the existing body of knowledge can be applied, other parts need further investigation with empirical data. Thus, in the research conducted for the thesis, the framework provided a conceptual guide for not only answering the RQs according to the literature and existing body of knowledge but also laying the groundwork for the analysis presented in Chapter 5.

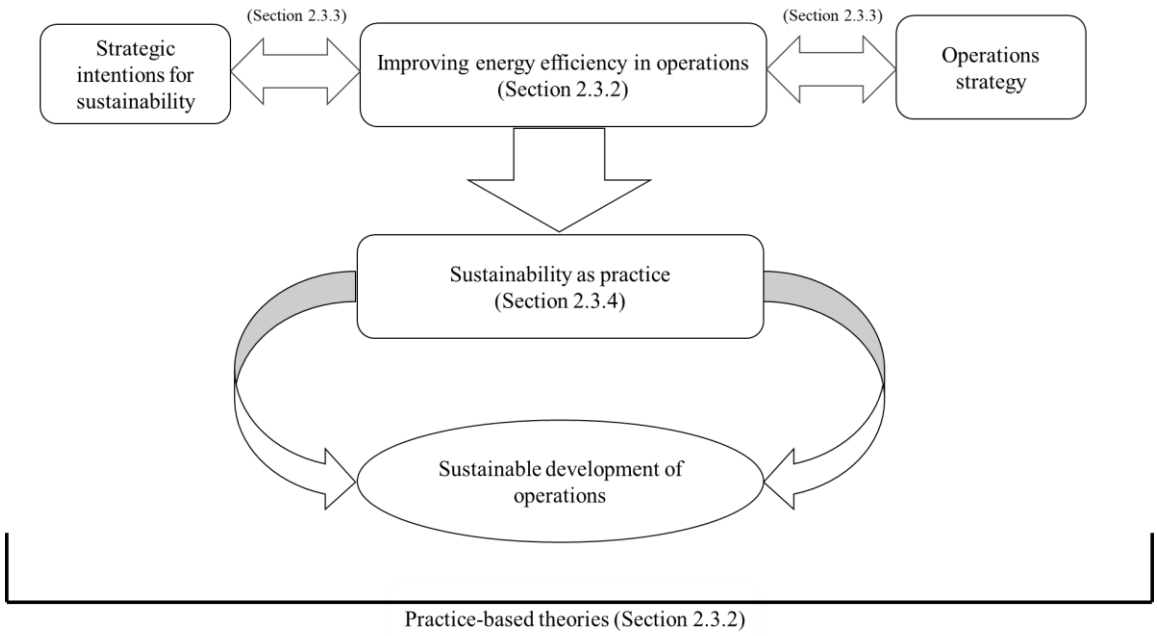

Figure 2.1: Conceptual framework

The literature that informed the conceptual framework was applied in two ways. On the one hand, practice-based theories, especially strategy as practice and sustainability as practice, were used to formulate the thesis's fundamental assumptions, as presented in Section 2.3.1. On the

other, referring to the integrative principle of sustainability (Christen and Schmidt, 2012) and with general goal of explicating integration (MacInnis, 2011), the three subsequent sections conceptualize improving energy efficiency in operations in terms of a framework of sequential, interdependent events (Felin et al., 2012). In particular, Section 2.3.2 outlines a set of primary activities supporting the improvement of energy efficiency in operations as well as interactions that create a nexus among practitioners. Next, Section 2.3.3 describes how such improvement, as a practice, interacts with other existing practices as part of an organization's bundle of practices. Last, Section 2.3.4 explains how such improvement, according to the conceptual framework, acts as a mechanism for creating a context for practicing sustainability that engages and embraces different actors and material elements in order to continually achieve firms' objectives and, in turn, the sustainable development of operations.

2.3.1 Practice based theories

Research on theories of practice has introduced studies addressing practice-based approaches into the literature on management and been used "for investigating and theorizing aspects of management and organizational practice in a more informed way" and thus to "provide more accurate accounts of the logic of practice" (Sandberg and Tsoukas, 2015, p. 188). According to Schatzki (2002), a *practice* is an organized nexus of actions in which chains of actions form activities. In turn, activities become practice "1) through understandings, …, 2) through explicit rules, principles, precepts and instructions, and 3) through ... 'teleoaffective structures embracing ends, projects, tasks, purpose, beliefs, emotions and moods'" (Schatzki, 1996, p. 89). Such literature has also adopted a practice-based approach to understanding various phenomena in which activities become ordered and explained, including strategy (e.g., Jarzabkowski et al., 2013) and organizational learning (e.g., Brandi and Thomassen, 2020), according to how the phenomena are understood (Sandberg and Dall'Alba, 2009). For example, Silva and Figueiredo (2017) have introduced an institutional logic of sustainability and adopted a practice-based perspective to examine how changes shift daily practices.

Using practice-based theories as a theoretical lens, this thesis builds upon theoretical perspectives on strategy as practice—that is, as "a situated, socially accomplished activity" constructed through actions and interactions of multiple actors (Jarzabkowski and Spee, 2009, p. 70). In particular, research on strategy as practice informed the conceptual framework by emphasizing the process of enacting strategy, shaping the articulated formal strategy as the "doings and sayings" (Nicolini, 2012) of the people implementing it, and coordinating strategy involving different organizational arrangements of roles, hierarchies, and structural mechanisms (Weiser et al., 2020). By the same token, the thesis considers an organization to be a social setting composed of bundles of practices and material arrangements (Schatzki, 2005) that are intertwined and connected. When organizations are viewed as such, practices can either connect or overlap (Schatzki, 2005). While the connection of practices implies their decoupled coexistence, their overlapping presumes their commonality.

2.3.2 Improving energy efficiency in operations as a practice

As mentioned in Chapter 1, improving energy efficiency in operations can be understood as a practice resulting in the actualization of firm's objectives for energy efficiency by engaging in and replicating improvement-oriented processes. The possibility of applying a practice-based theoretical lens to understand energy efficiency improvement in operations as a practice analyzed according to its own characteristics, not only what activities it consists of, needs to be investigated, as does how, why, and by whom those activities are interpreted and employed (Nicolini, 2012). Therefore, this thesis characterizes improving energy efficiency as a practice in operations as follows:

- A set of primary activities comprising "what" kinds of activities shape the process of improving energy efficiency in operations (see Section 2.3.2.1);
- Categories of development-focused efforts comprising how and why actions and meanings are embedded as practices and lead to improved energy efficiency in operations (see Section 2.3.2.2); and
- Approaches to ensuring actors' involvement—that is, by whom the activities are interpreted and employed (see Section 2.3.2.3).

2.3.2.1 A set of primary activities

Improving energy efficiency in operations as a practice can be characterized first according to the activities performed. Using process-based frameworks for environmental sustainability in operations management and energy management in manufacturing while also including both strategic and operations levels in organizations (Virtanen et al., 2013), improving energy efficiency in operations can be delineated as a process following a set of five primary activities: goal-setting, identification, financing, implementation and measuring, reporting and benchmarking. Each of those activities sets boundaries around chains of what is done and said as decisions and actions that shape the process of improving energy efficiency in operations.

As shown in Figure 2.2, the process of improving energy efficiency in operations starts with goal setting, in which top management formally expresses its intention and commitment regarding energy performance through an energy policy or strategy that includes targets for energy efficiency. According to Benedetti et al. (2017), targets can be set in terms of energy performance indicators at the aggregated company level, tactical plant level, or process or appliance level, the last of which relates to work units and is used to monitor efficiency and control the processes. Following goal setting comes identification, which involves generating improvement projects based on ideas and opportunities. To identify and analyze the potential to enhance improvements, the energy-related status quo is often determined through an energy audit (Schulze et al., 2016). Thereafter, resource allocation for the implementation of the assessed and approved action plans is performed in the financing step. Different methods used to evaluate investments in energy efficiency are addressed in the literature on energy management (e.g., Chiaroni et al., 2016). Next, based on the developed action plan, actions are implemented in operations. Last, elements of performance evaluation are controlled to evaluate

whether the operations have resulted in greater energy efficiency and to benchmark and report the results.

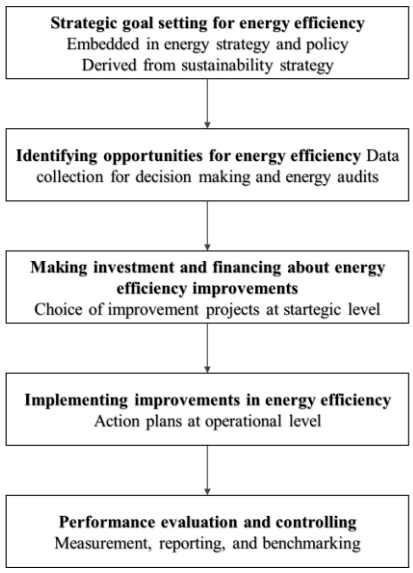

Figure 2.2: Process of improving energy efficiency in operations

The research for this thesis used the defined primary activities during the collection and analysis of empirical data to clarify what occurs within each step and who performs which action. Therefore, those activities are considered to be boundaries around chains of doings and sayings and around decisions and actions that shape the improvement of energy efficiency in operations as a practice.

2.3.2.2 Categories of development-focused efforts

The second step of characterizing the improvement of energy efficiency in operations as a practice, not merely an operational routine or managerial activity, is understanding why and how the actors who are responsible for and/or perform such improvements make sense of and enact their decisions (Jarzabkowski and Spee, 2009).

Improving energy efficiency in operations as a strategic interorganizational objective requires the strategic–operational alignment of the improvement process. Previous research has addressed energy efficiency according to the dominant operational focus on technological measures related to production processes (May et al., 2017) or in connection with the implementation of sustainability-oriented strategy, in which the focus has largely remained at the organizational level (Gagné, 2018)—that is, focused on top management without specifying other actors or considering organizations as a coalition of individuals (Weiser et al., 2020). Achieving the strategic–operational alignment needed to deploy strategic goals for energy efficiency requires strategic and operational decisions to be made by individual and teams of individuals with different backgrounds, interests, and value frames (Wesselink et al., 2015).

To address such strategic–operational alignment, development-focused efforts that lead to improved energy efficiency in operations were examined in the research for this thesis to

capture how and why actions and meanings are embedded as a practice. Development-focused efforts resemble but differ from improvement-focused projects; whereas the latter have well-defined start and end times and are more task-oriented (Saunders et al., 2008), the former start with recognizing an opportunity for improvement. Development-focused efforts can thus originate from different hierarchal levels within organizations, and after being recognized, they need promotion, approval, and resource allocation (i.e., capital and other assets) in order to be realized. If a development-focused effort originates in operations, then it should travel through the organization and be connected to an existing strategy of the firm through an improvement-focused project in order to have an strategic outcome. Otherwise, the impact of the effort will be operational, localized, short-term, and on day-to-day work only.

2.3.2.3 Approaches to involving actors

The third step of characterizing the improvement of energy efficiency in operations as a practice is identifying who employs the activities and connects them to each other. The importance of an organizational model for achieving sustainability goals as well as strategic alignment has been emphasized (Epstein, 2008), and this thesis departs from the idea that involvement affects the alignment of strategic goals and practices at different hierarchical levels and within functions (Papke-Shields and Malhotra, 2001; Joshi et al., 2003). Therefore, it investigates actors' involvement according to top–down and bottom–up vertical alignment across different organizational levels, as well as inside–out and outside–in horizontal alignment across operations, to analyze the pathways captured by empirical data through which organizations connect the mentioned set of primary activities presented in Section 2.3.2.1.

2.3.3 Interrelationship between improving energy efficiency in operations and other existing practices

According to Ligonie (2021), achieving peripheral sustainability practices is insufficient if those practices cannot affect other practices in the organization. To extend any improvement in energy efficiency in operations as a practice, it should be regarded as part of the organization's bundle of practices, which are interrelated to various degrees and mutually influence each other.

Figure 2.3 summarizes the relationships between energy efficiency in operations with corporate-level sustainability-related strategic intentions and operations strategies identified in the literature. The figure's left-hand side illustrates the process of realizing corporate-level sustainability-related strategic intentions, initiated at the corporate level and pursued by setting overall sustainability-related goals that entrench the organization's orientation toward sustainability (Hong et al., 2019). The corporate goal for energy efficiency, derived from the sustainability strategy, sets the amount of energy to be consumed by the functions, including operations (Adebanjo et al., 2016). According to that logic, corporate-level sustainability-related strategic intentions directly affect the energy efficiency of operations.

Meanwhile, the right-hand side of Figure 2.3 follows the logic of literature on operations strategy, in which action plans result directly from operations emphasizing competitive

priorities derived from business strategies and planned by top management (Kim et al., 2014). Therefore, the operations strategy sets performance objectives concerning cost, flexibility, lead times, reliability, and quality (Ferdows and De Meyer, 1990), all of which are linked to operational resources through a sequence of decision about the structure and infrastructure of operations. Thereafter, operations decisions and practices set the conditions for using energy through settings such as lead time and flexibility. Because those conditions affect energy consumption, they also affect the energy efficiency of operations.

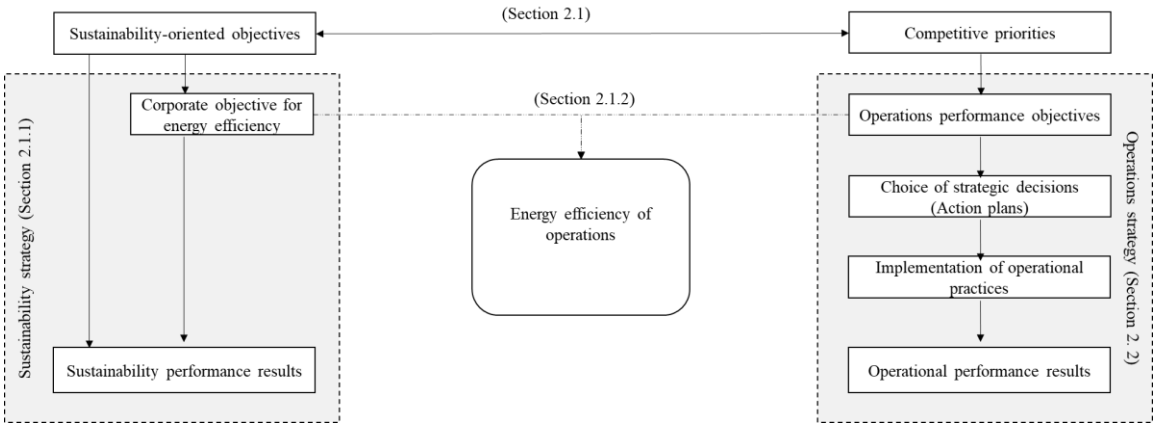

Figure 2.3: Energy efficiency of operations in relation to corporate-level sustainability-oriented strategic intentions and the existing operations strategy

Thus, to summarize the literature, traditional performance objectives directly affect operational performance, whereas initiatives in operations management can reduce the consumption of energy (Abdul-Rashid et al., 2017). At the same time, sustainability-related corporate-level goals directly affect sustainability performance while also informing energy consumption in operations (Adebanjo et al., 2016).

To date, the conception of energy efficiency in operations has primarily derived from attempts to address the synergies between operations management and energy management (e.g., Koh et al., 2016; Abdul Rashid et al., 2017). The direct impact of improving the energy consumption of operational processes on improving energy efficiency in operations has been identified by Abdul-Rashid et al. (2017, p. 183), who state that "positive environmental initiatives" are needed so that manufacturing will not overconsume energy. Operational processes also impact the energy efficiency of operations by energy-powering support functions, including internal technical building services such as heating, cooling, and ventilation (May et al., 2016). At the same time, other improvements in operations can also indirectly impact energy efficiency in operations—for example, improving existing services (Acur and Bititci, 2004), reducing inventory, enhancing reliability in production, reducing setup times in manufacturing (Longoni and Cagliano, 2015), conducting outreach activities such as partnering with other members of the supply chain (Hsu et al., 2016), engaging in joint product development with suppliers (Tachizawa et al., 2015), and using energy efficiency as a criterion in sourcing and location

decisions (Lu et al., 2008). In turn, outcomes of energy efficiency in operations can be driven by through operations performance objectives instead of by environmental factors.

Improving energy efficiency in operations also directly impact the management of operations through energy-saving benefits that affect costs in line with pollution-preventing practices in operations (Graham and McAdam, 2016). Meanwhile, the indirect impacts of improving energy efficiency in operations on the management of operations can create competitive advantage via value and reduced emissions, and decreased liability can create competitive advantage through risk management (Cooremans, 2012). For example, improving energy efficiency in operations can result in improved product quality and public image.

However, instead of focusing on energy efficiency as a condition or outcome of operations management, this thesis promotes strategic–operational alignment in organizations to improve energy efficiency in operations. To that end, the thesis considers improving energy efficiency in operations as a practice interrelated with corporate-level sustainability-related strategic intentions and existing operations strategy.

2.3.4 Transitioning toward sustainability as practice

Using the theoretical lens of sustainability as practice (Silva and Figueiredo, 2017), practicing sustainability can be understood as a range of actions and routines involving the arrangement of doings, sayings, and materials that interact over time as practitioners incorporate knowledge and domains over facts and things through the constant repetition of ordinary actions (Silva and Figueiredo, 2020). Bundles of practice for achieving one sustainability-related objective—in this thesis, energy efficiency—may evolve into a constellation of practices for responsible business among companies and even into a constellation of practices for supply chain sustainability (Silva et al., 2022). As such, while efforts driven to address energy efficiency may appear to be discrete activities to gain energy efficiency for a specific company, consolidating such discrete activities and repeatedly achieving them leads to practicing sustainability and can galvanize the sustainable development of operations by effecting changes in individual and collective actions and understandings to promote sustainability. Improving energy efficiency in operations can create formal or informal, natural or established, and instrumental or activity-oriented conditions and used to integrate and coordinate interactions between individuals within organizations to foster such changes as a means to promote sustainability. Doing so can be achieved by "sharing knowledge and keeping knowledge alive within the practices of a community, embedding knowledge in material practices and innovating as an ongoing process" (Figueiredo et al., 2020, p. 197).

To that end, RQs were added to the framework (see Figure 2.4).

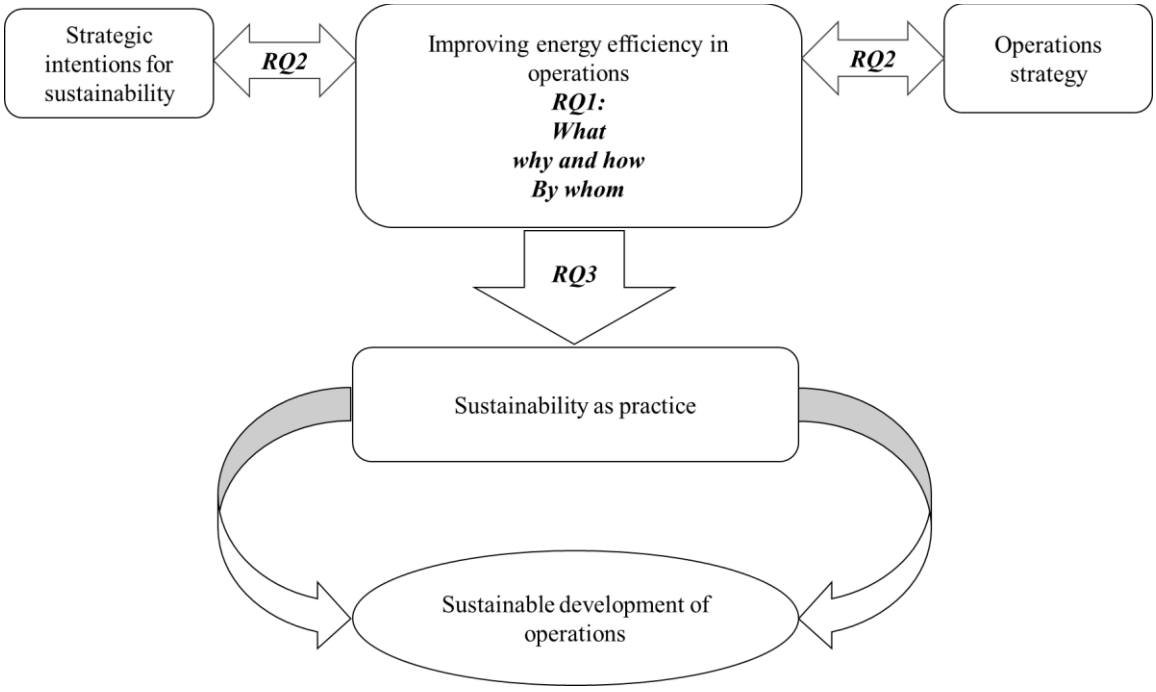

Figure 2.4: Research questions (RQs) in relation to the conceptual framework

First, RQ1 was designed to create consensus regarding both the meaning and evaluation of the improving energy efficiency in operations as a practice according to its characteristics as a phenomenon constructed and enacted by multiple actors. As such, it narrows the gap between the corporate-level objective for energy efficiency and the action level practices in operations. Second, RQ2 was designed to expand the conceptual framework horizontally to explore the strategic–operational alignment required to engage in and replicate improvements in energy efficiency. Following RQ2, the ways in which individuals deploy means of improving energy efficiency in operations as a practice alongside other practices in the organization, that is sustainability strategy and operations strategy, was investigated. Last, RQ3 was designed to expand the framework vertically in order to empirically understand how improving energy efficiency in operations enables formal or informal, natural or established, and instrumental or activity-oriented conditions and can be used to integrate and coordinate interactions between individuals within organizations. Altogether, improving energy efficiency in operations can be understood as a mechanism for facilitating practicing sustainability (Silva and Figueiredo, 2020) via the diffusion of practical knowledge in the individual-level process of becoming a practitioner (Gherardi and Miele, 2018).

3. Method

This chapter describes how the research for the thesis was conducted, including the motivations behind the research methods used and decisions made regarding the research design. After outlining the research process, the chapter explains as well as reflects upon the methods used to collect the data in the appended papers, which together form the empirical data for the research presented in the thesis. Whereas the procedures for coding and analyzing the data in each of the appended papers are detailed in the papers themselves, this chapter presents the procedures for the analysis of the empirical data used to answer the RQs in the thesis. The chapter also discusses what various aspects of the research's quality imply. Later in the thesis, Chapter 5 presents an analysis that elaborates on the synergy effects of the appended papers taken as a whole, and, closing the thesis, Chapter 7 reflects on the methodology chosen and how it affected the findings of the thesis.

3.1 Research process

The research process is depicted in Figure 3.1 and is described in the following section.

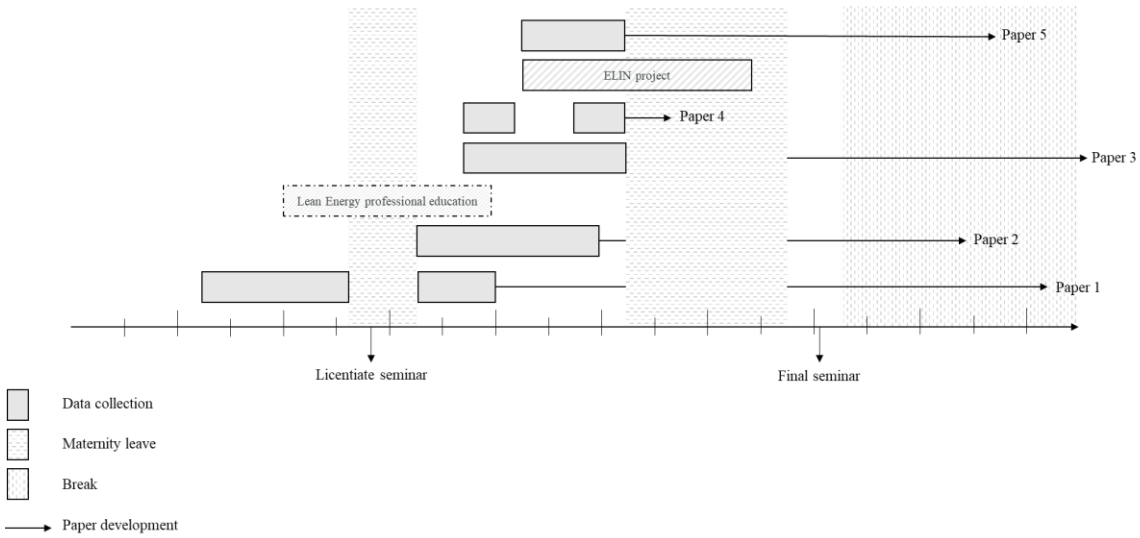

Figure 3.1: Research process

The research began as part of an initiative within the Chalmers Production Area of Advance, which generally seeks to explore new approaches toward achieving industrial competitiveness and resource-efficient product development and production processes. As termed by the Production Area of Advance, the "working purpose" of the research—called such to allow its modification mid-research while maintaining the same focus—was "to explore and increase the understanding of how sustainability can be integrated into manufacturing firms' strategies." Indeed, the research's purpose changed several times and consistently prioritized understanding *how* operations act upon the sustainability-related challenges that society faces. To that purpose, the research process began with a literature review to expand my personal knowledge about the subject area, the current state of knowledge therein, and the methodologies typically used as a basis for further investigation. Later, iteratively alternating between theory and empirical data (Maxwell, 2012) strengthened the research's explorative nature and ensured its credibility.

To gain a holistic view and shape an agenda for future research, the initial empirical data, which resulted in the licentiate thesis and Paper 1, were expected to capture how the literature and practice on manufacturing strategy has integrated the concepts of environmental and social sustainability. Although the literature was indeed found to address environmental and social sustainability within its general focus on traditional manufacturing strategy distinction between content and process, the findings of the licentiate thesis, added to discussions with respondents in the industry and other researchers as well as my own learning, interest and critical reflections, shifted the research's focus, resulting in Paper 2, in the following ways.

First, it became apparent that the traditional focus on the content and process within operations strategy cannot adequately address strategy-related complexities that operations business units face, particularly ones concerning sustainability. Thus, whereas operations strategy still served as an analytical construct used to create coherence between hierarchal levels within organizations, the research was reoriented from traditional formulate-then-implement operations strategy to the more dynamic view of strategy as practice, one that focuses on the people, practices, and dynamics involved in developing and implementing strategy.

Second, during empirical data collection with organizations, sustainability seemed fuzzy to practitioners when translated from the corporate level to operations, not least because each firm defines its own in-house terminology regarding sustainability, as captured in Paper 1. Thus, using the term *sustainability* only complicated data collection, because it evoked all concepts concerning environmental management and society-related activity (e.g., health and safety issues) without differentiation. At the same time, it also became apparent that sustainability was perceived as being less tangible than energy efficiency, which was clearly differentiated from general sustainability and concepts of environmental management, particularly in operations. Thus, the research's mediating construct for materializing sustainable development into operations shifted from sustainability to improving energy efficiency, which consequently deepened discussions at different organizational levels during empirical data collection.

The empirical data additionally reflected how the studied companies could not fully recognize their achievements in improved energy efficiency in operations through official improvement projects, captured as a performance indicator within sustainability reporting. Because those achievements could not be recognized, they could not be replicated. Therefore, to capture those unexamined achievements, focusing on energy efficiency improvement in operations allowed also focusing on improvement initiatives counterpart to operational improvements and the efficiency of the sociotechnical conditions of operations.

In mid-2016, I had the opportunity to engage with participants in the professional education program Lean Energy, designed to expand the skills and knowledge of individuals responsible for improving energy efficiency to include concepts of lean management and energy efficiency. In relation to my research, Lean Energy addressed individual-level improvement in operations

processes and using professional education to empower individuals. Although I was not involved in the program's development, my engagement with the participants was the foundation for Papers 3 and 4. Between them, Paper 3 investigates the transmission and acquisition of knowledge in the process of becoming a practitioner of energy efficiency improvement and how interactions between individuals foster the improvement of energy efficiency in operations. Paper 4, by contrast, focuses on professional education as a component in combining continuous improvement (i.e., lean management) and sustainable development (i.e., energy efficiency initiatives) at the individual level.

Later, in mid-2017, I joined the project titled "Energy Efficiency of Logistics Services: Inside–Out," or "ELIN," conducted as a starting point for research projects funded by the Swedish Energy Agency and focused on innovative, energy-efficient logistics services offered to customers by logistic service providers (LSP). The project's target sample initially consisted of large LSPs recently required to conduct energy mapping in accordance with Swedish law (2014, p. 266), which had previously targeted the manufacturing and processing sectors only. The opportunity allowed me to not only test transferability of the logic developed in past studies in manufacturing and processing sectors to a new context but also compare two operations contexts close to production—(1) manufacturing and processing and (2) logistics—the latter as a sector vulnerable to criticism regarding both environmental sustainability and energy efficiency. The involvement in ELIN project resulted in the development of Paper 5.

3.2 Research design

Research design should be guided by the research's purpose and operationalized in research questions (RQ) in order to ensure the suitability of all components (Maxwell, 2012). For this thesis, the research purpose and the evolving nature of practicing sustainability called for an approach that would enable the collection of rich empirical data as a means to further understanding and knowledge (Edmondson and McManus, 2007). Ultimately, the chosen approach also should have enabled the development of RQs based on knowledge generated and accumulated throughout the research. Beyond that, considering the problem statement in Chapter 1, the research was arguably problem-driven (Wickert et al., 2021) and aimed to impact practice, not to develop new theory (Williams and Whiteman, 2021). Therefore, the research required a design set in "a practice context that includes a more holistic and integrative approach" (Brandi and Thomassen, 2020, p. 213). For that reason, exploratory qualitative research was considered to be suitable for the research, especially following a design able to address the untapped dimensions of sustainability and inform analysis and interpretations (Touboulic and Walker, 2015). Consequently, such a qualitative research process required a sequence of decisions to be made about research questions, goals, theoretical frameworks and the selection of empirical material in light of available resources (Flick, 2018). Therefore, through continuous assessment, those decisions were under constant development throughout the research process according to current state of practice and the literature.

The rationale for collecting exploratory qualitative data was based on the nature of the RQs. Collecting qualitative instead of quantitative data is arguably more suitable for investigating evolving phenomena than establishing structures between existing theoretical constructs (Edmondson and McManus, 2007; Flick, 2018). In the research conducted for this thesis, such data collection allowed understanding (1) the phenomenon under study by taking a broad perspective capturing multiple sources of evidence in different settings, (2) the context and different people's interpretations and experiences in terms of their proximity, and (3) improving energy efficiency in operations as an emerging phenomenon. While collecting qualitative data primarily through semistructured interviews and participant observations facilitated proximity, multiple sources of evidence were consulted in different settings in order to gather a broad spectrum of data based on different contexts (Edmondson and McManus, 2007).

The decision to collect qualitative data also aligned with the lens of practice-based studies. Applying such a theoretical lens involves addressing the practice as being constructed through the actions and interactions of multiple actors, who operate as sources of information through subjective, "specific ways of seeing and experiencing" (Flick, 2018, p. 318). Qualitative data collection thus enables capturing subjective, often unquantifiable viewpoints.

3.3 Empirical setting, sampling, and data collection

Just as the research's setting—that is, Sweden—influenced the scope of the research (see Section 1.2), the theoretical framework influenced not only where to conduct the research but also various decisions about sampling for each of the five appended papers (see Figure 2.1)—that is, whom to include (Maxwell, 2012). Given the nature of the RQs, the method of data collection needed to afford an understanding of dynamic phenomena, allow an in-depth description of real-life events from different viewpoints, and be sensitive to context (Flick, 2018). Another aim was to form a stock of knowledge from experts (Flick, 2018). To that aim, the final sample included interviewees who are most relevant to improving energy efficiency in operations at different levels in their organizations and therefore connected to either or both strategic intentions for sustainability and operations. Although in-depth semistructured interviews were thus the most suitable method of primary data collection, different combinations of methods (Eisenhardt and Graebner, 2007) were used for the various papers in order to collect additional data, as summarized in Table 3.1, which provides an overview of how the data in each paper contribute to answering the various RQs in the thesis. The key contributions of each paper appended to the thesis are further elaborated in Chapter 4.

Table 3.1: Overview of collected data for the five papers of the thesis and interplay with the thesis RQs

	Primary data	Secondary data	Contributes to
Paper 1	Site visits and 14 semistructured interviews at three companies: • Four interviewees at the strategic level responsible for improving energy efficiency • 10 interviewees at the operational level responsible for improving energy efficiency	Business strategy Sustainability and environmental strategy Annual reports on sustainability Operations strategy Other internal and external reports or documents	RQ1 RQ2
Paper 2	Semistructured interviews at 19 companies	Company documents Internal presentations Internal and external sustainability and annual reports Websites and publicly available data	RQ1 RQ2 RQ3
Paper 3	Semistructured interviews and non-participant observations at 10 companies	Company documents Internal presentations Internal and external sustainability and annual reports Websites and publicly available data	RQ3
Paper 4	A structured online survey of 10 organizations from the second cycle of the course (see Appendix 1), participant observation at one workshop, and 19 in-person and phone interviews: • Nine at organizations from the first cycle of the course • 10 at organizations from the second cycle of the course	Documentation regarding the course design and content Minutes from meetings on the development of the course syllabus The course syllabus Reports to the funding agency Reports to the steering group about the development and results of the course	RQ3
Paper 5	Semistructured interviews at nine companies	Company-specific documents (e.g., presentations and reports)	RQ1, RQ2, and RQ3

Sampling for Papers 1, 2, and 5 was chiefly based on a purposeful strategy, as is suitable for "the identification and selection of information-rich cases related to the phenomenon of interest" (Palinkas et al., 2015, p. 533). In selecting companies to examine, extensive experience with the phenomenon was a criterion (Flick, 2018), one imposed to ensure participants' profound knowledge about improving energy efficiency in operations. To fulfill that criterion, three types of companies were targeted.

The first type of companies comprised firms that claimed to actively work toward improving energy efficiency in systematic ways and had a record of doing so. Therefore, sampling for Paper 1 began by identifying those companies. However, to ensure an in-depth understanding of development-focused efforts originating at different organizational levels that had improved energy efficiency in operations, the sample of interviewees included at least one individual

believed to be a key player at each level of the organization (i.e., top management and operations).

The second type of companies comprised firms obliged to implement certifiable energy management systems under Swedish law (2014, p. 266) in order to receive tax exemptions. Such companies are regarded as having a record of working with energy efficiency and systematically improving it even if only to observe regulations. Therefore, interviewees from companies obliged to uphold that law were added to the sample.

The third type of companies expanded the sample in order to reach theoretical saturation (Corbin and Strauss, 2008). For Paper 5, to reach theoretical saturation, other large logistics service providers that are candidates for future regulations due to their size and activities were included in the sample as well. During sampling for Paper 2, non-energy-intensive companies that voluntarily initiated work to improve energy efficiency in operations and had proven results of improving energy efficiency were also included. The expanded sample also included some participant companies in the professional education program Lean Energy.

The dynamic nature of the thesis's RQs and the need for continuous decision-making about expanding the sample during the research while developing the papers resulted in some overlaps in the sampling and data collection for Papers 1–3. Therefore, several participants were interviewed for more than one appended paper because the opportunity was convenient, albeit a separate interview guide and questions were asked for different papers. Overall, 41 unique interviewees were conducted, as presented in Table 3.2.

Table 3.2: Overview of the sample for Paper 1,2,3, and 5

NO.	Brief description of the company	Interviewee's role	Paper(s) included in			
			1	2	3	5
1	Renewable materials (i.e., pulp and paper)	Group-level energy efficiency manager	X		X	
2	Renewable materials	Business development manager and Global Business Excellence team member	X			
3	Renewable materials (i.e., pulp and paper)	Production leader	X	X		
4	Renewable materials (i.e., pulp and paper)	Energy technique manager and project leader	X	X	X	
5	Renewable materials (i.e., pulp and paper)	Plant manager	X	X		
6	Renewable materials (i.e., pulp and paper)	Energy controller	X	X		
7	Renewable materials (i.e., pulp and paper)	Development engineer		X		
8	Renewable materials (i.e., pulp and paper)	Operator	X	X	X	

9	Water treatment products	Environment and safety manager	X	X		
10	Water treatment products	Facility and ESH manager	X			
11	Water treatment products	Sustainability manager	X			
12	Water treatment products	Operation manager	X			
13	Automotive	Director of environmental, safety and quality	X			
14	Automotive	Energy manager	X	X		
15	Automotive	Energy coordinator at the plant level	X	X		
16	Chemical, metal powder	Energy coordinator		X	X	
17	Chemical, polyethylene	Energy manager		X	X	
18	Renewable materials (i.e., pulp and paper)	Energy technique manager and project leader		X		
19	Chemical manufacturing	Strategic energy manager		X	X	
20	Agricultural	Automation engineer working with process support		X		
21	Automotive	Production technical manager		X	X	
22	Automotive	Energy technique and development engineer		X		
23	Packaging	Managing director		X	X	
24	Aluminum	Quality and environment manager		X		
25	Water treatment products	Plant energy coordinator		X		
26	Home appliance	Global energy strategy director for operations		X		
27	Aluminum	Production and process development manager		X	X	
28	Automotive	Energy kaizen			X	
29	Freight forwarder by road and rail	Process and environment manager				X
30	Freight forwarder for express deliveries by road and air	Sustainability manager				X
31	Freight forwarder	Environmental manager				X
32	Third-party logistics provider	Environment, energy, and quality manager				X
33	Waste logistics provider by road	Logistics development manager and environmental manager				X
34	Freight forwarder by sea	Performance manager				X
35	Fourth-party logistics provider	Site manager and general manager				X
36	Freight forwarder by road and rail	Distribution manager				X
37	Third-party logistics provider	Transport manager and Sustainability manager				X
38	Freight forwarder by road and rail	Process and environment manager				X
39	Freight forwarder for express deliveries by road and air	Sustainability manager				X
40	Freight forwarder	Environmental manager				X
41	Third-party logistics provider	Environment, energy, and quality manager				X

As described in Section 3.1, for Papers 3 and 4 companies were sampled out of convenience (Flick, 2018). Nineteen participants in the mentioned Lean Energy professional education

program comprised the sample, as shown in Table 3.3. Those companies were considered relevant to the thesis's sample given their involvement in developing the skills and knowledge of their employees responsible for improving energy efficiency, as well as their combination of continuous initiatives for improvement (i.e., lean management) and sustainable development (i.e., energy efficiency) at the level of operations.

Table 3.3: Overview of the sample for Paper 4

Brief description of the company	Participants interviewed
Renewable materials (i.e., pulp and paper)	3
Automotive	1
Aluminum	1
Pharmaceutical manufacturing	1
Logistics service provider	3
Electric steel manufacturing	1
Energy consultancy	1
Industrial machinery manufacturing	2
Chemical manufacturing	3
Appliances, electrical, and electronics manufacturing	1
Civil engineering	1

The final sample that contributed empirical data to the thesis included companies in different sectors, including processing, production, and logistics. As such, the empirical context addresses both energy-intensive industries such as the pulp and paper, foundry, steel, and chemical industries, with their high energy costs and susceptibility to energy price increases, as well as non-energy-intensive industries that have energy costs in relation to only a percent of their added value. Such a sample allowed gaining insight into the commonalities and differences between various contexts (Flick, 2018) and an in-depth understanding based on a broad spectrum of data from those contexts, as recommended by Abdul-Rashid et al. (2017).

The primary source of data was key informants in the sampled companies, who were considered to be the practitioners most relevant to improving energy efficiency in operations, albeit operating within different organizational levels and roles, and thus experts on the phenomenon examined (Froschauer and Lueger, 2009). For all five papers, after providing their informed consent, the key informants were given information about the research's aims and told which topics would be discussed in order to ensure their relevance and confirm their cooperation. All interviews were arranged in advance. Research protocols and an initial interview guide were developed to ensure the validity of data collection, as proposed by Eisenhardt (1989) (See exemplified interview guides appended in Papers 1,3 and 5 and appendix 2 and 3 for Papers 2 and 4). The protocols outlined the topics to be covered during interviews, listed the questions to be asked, and indicated the specific data required in the form of secondary evidence. Although such a systematic approach to data collection by using an interview guide ensured

commonality and boundaries, such data were supplemented by implicit information that emerged from the qualitative data via probing questions and allowing concepts to emerge from the interviewees themselves. Later, to validate the findings, company-specific documents, the companies' websites, archival data, annual reports, formalized strategies, meeting notes, and presentations provided by the participants were used as secondary data to furnish new insights.

For Paper 1, site visits to the companies were arranged to complement the data collection. The site visits were used to conduct participant observations in order to gather insights and record field notes as data for analysis. The observational data from the visits allowed interpreting the actions of the companies in shaping their bundles of practices formed by doings and sayings (Schatzki, 2012)—for example, how energy efficiency targets were visualized at the plant level.

For Paper 4, participant observation at a one-day workshop with the professional education course participants from one company was also used to collect data on both learning and the implementation initiatives associated with lean energy at multiple locations of the company. During that part of data collection, notes on participation were taken, and later the description and synthesis of the day were sent to the company for validation.

3.4 Data analysis

The coding and analysis of data for each of the appended papers according to the specific purpose and RQs addressed in the papers, are detailed in the papers themselves. Chapter 4 presents the key contributions of each paper appended to the thesis. On top of an analysis in the appended papers, Chapter 5 presents the overall analyses conducted to answer the RQs in the thesis based on the identified synergies from all the appended papers. Whereas that analysis is built upon the analysis in the appended papers, additional analyses of the empirical data were performed to answer the RQs in the thesis, as presented in the following subsections.

The iteration between theoretical concepts in the literature and the empirical data supported the development of a theoretical background, data collection, and data analysis. All data collected from interviews were recorded and transcribed with the participants' permission. When participant observation was performed to collect data, field notes were taken to uphold the standards of qualitative research (Barratt et al., 2011). Subsequently, the field notes and the interviews were summarized in detailed narratives depicting each interviewee's individual story. Empirical data from all the interview transcripts and field notes, the detailed narratives, and other company-internal documents provided by the respondents were used in preliminary analysis while working with the data from the ground up, as proposed by Yin (2009). The initial coding of the data was performed to examine the process of improving energy efficiency in operations as a stand-alone entity .To that purpose, data were coded according to a priori codes representing various primary activities (i.e., goal-setting, identification, financing, implementation and measuring, reporting, and benchmarking) identified in Section 2.3.2 and used during the collection and analysis of empirical data to clarify what occurs within each step of the process in each organization. The challenge of balancing such a large amount of

qualitative data while ensuring that all important aspects of the data were captured was mitigated by using Microsoft Excel. However, to investigate the improvement of energy efficiency in operations as a practice according to its own characteristics and thus answer RQ1, subsequent cycles of coding were performed to identify emerging elements and additional common patterns, namely via the iteration of empirical data and by examining the literature.

3.4.1 Data analysis to answer RQ1

For the analysis in Paper 1, the data were thematically coded (Flick, 2018) at two predefined organizational hierarchal levels: top management and operations. Development-focused efforts by top management or operations employees were revisited to compare "specific ways of seeing and experiencing" (Flick, 2018, p. 318), and their differentiation allowed the between-group comparison of different ways of perceiving and experiencing the improvement of energy efficiency in operations.

For Paper 2, iteratively seeking out common themes and patterns based on evidence via axial coding (Corbin, and Strauss, 2007; Ellram and Tate, 2015; Flick, 2018) was performed. The data were categorized and assessed based on a thematic structure, regarding the actors' vertical and horizontal involvement. Building upon the analysis in Paper 2, an additional analysis of the setting of development-focused efforts was conducted in relation to the hierarchal level within the organization. Whereas the analysis presented in Paper 1 considered top management and operations employees to be two homogenous groups, respectively at the top and bottom of the hierarchy, reexamining the empirical data based on the analysis in Paper 2 generated two insights and resulted in answering the RQ1 of the thesis;

First, the findings distinguished two categories in the stages of top management's efforts: (1) creating formal aspects of strategic intentions for energy efficiency and (2) sharing such strategic intentions downward through the organization in cascading fashion. With reference to the literature, those two categories were respectively conceptualized as the goal deliberation stage and the goal implementation stage, as elaborated in Chapter 5.

Second, an intermediate level of actors was identified between the top and the bottom that suggested a layered approach. Those actors, addressed in the literature on operations management as "operational middle managers," can be defined as individuals with mandate in operations and in a position in the organizational structure that can both inform and be informed of the organization's strategic intentions. A broader explanation of those actors and how they affect the improvement of energy efficiency in operations appears in Chapter 5.

3.4.2 Data analysis to answer RQ2

For the analysis in Paper 1, the data were coded according to a priori codes concerning the strategy process in a bid to understand development-focused efforts leading to improved energy efficiency in operations according to strategic intentions for sustainability and for operations. To that end, the subdimensions examined were taken from the process model of operations

strategy (Kim et al., 2014). During initial coding, particular attention was paid to individual perceptions of improving energy efficiency in operations, efforts to develop such improvement, the underlying reasoning for their initiation, and how the efforts are associated with operations strategy and corporate-level sustainability-oriented strategy. Later, data analysis was expanded to identify emerging elements and additional common patterns, namely via the iteration of empirical data, and to examine the literature for comparable development-focused efforts via axial coding (Ellram and Tate, 2015) in a process that involved alternating between the data and the literature. More specifically, the (mis)alignment of perceptions and understandings between the two organizational levels was noted for a subsequent analysis of how the development-focused effort was treated on each occasion. The various sources of data were used to form a holistic picture of the dynamics of improving energy efficiency in operations. For example, some observations from the site visits and presentation materials provided by interviewees afforded insight into mapping approaches of implementing development-focused efforts. "Power quotes" (Pratt, 2008) were continually used to maintain the chain of evidence.

The analysis of empirical data from Paper 1, did not indicate the alignment of improved energy efficiency in operations in relation to strategic intentions for sustainability or for operations but that energy efficiency in operations was a continuous participatory process. Furthermore, the mentioned axial coding (Corbin, and Strauss, 2007; Ellram and Tate, 2015; Flick, 2018) for Paper 2 provided further empirical insight into the generation of iterative loops interrelating different practices and how they enable individuals to deploy improvements in energy efficiency in operations as a practice alongside other practices in the organization.

Last, analyzing the data for Paper 3, initiated another iteration between the data and literature to conceptualize empirically grounded findings. As a result, labels were made for the loops generated from the competing logics and underlying rationales of actors officially accountable for or personally interested in improving energy efficiency at their companies: taking advantage of a mutual language, creating common interpretations, and creating shared interest.

3.4.3 Data analysis to answer RQ3

The analysis performed in Paper 2 provided a conceptual integrated framework for improving energy efficiency in operations. The paper illustrates the value of ensuring development over time via feedback layers that enable organizational learning for continuous improvement. Therefore, RQ3 took an evolutionary perspective focused on the development and replication improvement. While Paper 2-5 provide empirical insight into such an evolutionary perspective, the analysis to answer RQ3, is primarily built upon the analysis for Papers 3 and 4.

Axial coding through content analysis (Ellram and Tate, 2015) was performed by comparing the findings to predefined patterns identified by Gherardi and Miele (2018) for dynamics of the emergence of practical knowledge: sharing knowledge between experts and novices, embedding knowledge in material elements and infrastructure, and innovating knowledge as an ongoing process. By contrast,, pattern identification and pattern matching (Yin, 2009) from

Paper 4, enabled distinguishing between learning at the individual versus the organizational level.

3.5 Research quality

Because the research presented herein followed a qualitative approach, the conventional quality criteria of internal and external validity, reliability, and objectivity could not be used to judge it (Flyvbjerg, 2006). Therefore, to evaluate and maintain trustworthiness, the criteria of credibility, transferability, dependability, and confirmability were applied to data analysis following Ellram (1996) and Halldórsson and Aastrup (2003).

The first criterion, credibility, considers how research represents the subjective views of interviewees portrayed in the data. To ensure the credibility of the findings, a chain of evidence was kept throughout the research (e.g., in the iterations of coding and data analysis) marked in "power quotes" (Pratt, 2008). Moreover, to prevent single-coder bias (Seuring and Gold, 2012), key informants were asked to review and validate the narratives and ensure that the realities purported were accurate. Added to that, to deal with the interviewees' inherent subjectivity, different sources and methods of data collection were used to triangulate the data. In Paper 1, data from the interviews were validated with observations from site visits. Moreover, in Papers 4 and 5, coauthorship also supported credibility. Last, after data collection and analysis, I participated in an energy seminar that afforded me the valuable opportunity to present and validate the research's results with CEOs and energy managers from large, energy-intensive organizations in Blekinge.

The second criterion, dependability, was ensured by developing research protocols and an interview guide with reference to the literature. Research-specific databases and a complete chain of evidence were also developed throughout the research to assure the consistency of the results over time. Recording and transcribing interviews and field notes were additionally undertaken to bolster dependability.

The third criterion, confirmability, considers how the researcher's bias impacts the research process and thus the findings (Halldórsson and Aastrup, 2003). Such bias can take effect during interviews, for example, in which interviewers may steer interviewees toward discussing certain topics. Thus, an awareness of the impossibility of complete objectivity in qualitative research (Bryman and Bell, 2015) helps to strengthen confirmability. For example, some of my potential biases should have been accounted for by verifying the findings during presentations, discussions, and seminars with both academics and practitioners. At the same time, obtaining participants' consent helped to reduce bias among the interviewees. Moreover, those efforts were accompanied by the constant comparison of the empirical data with the literature in order to (dis)confirm the research's findings in relation to published results. Last, multiple sources of evidence were used to reduce the risk of bias in the results.

The final criterion, transferability, concerns the generalizability of the findings. A potential challenge of generalizability given the research's applied theoretical lens, practice-based theories, as well as improved energy efficiency's heavy dependence on the industry and specific contextual aspects, is discussed in Chapter 6. That obstacle was partly overcome by collecting data across a larger sample of organizations and considering a broad spectrum of contexts.

4. Summary and contributions of the appended papers

The purpose of the research conducted for this thesis was fulfilled by answering three research questions (RQ), which were operationalized in the five appended papers. The RQs were answered to varying extents according to the findings in the papers. This chapter summarizes the appended five papers in terms of their key contributions in answering the RQs.

4.1 Paper 1 – "Improving Energy Efficiency in Operations: A Practice-Based Study"

4.1.1 Research design

Paper 1 aims to empirically investigate how development-focused efforts to improve energy efficiency in operations interact with existing corporate-level strategies for sustainability, as well as operations strategies, and whether they in fact improve energy efficiency in operations at the various organizational levels of the company. Following a qualitative, multiple-interview approach, the research presented in the paper was conducted to develop an understanding of real-life events from the viewpoints of key actors. It thus sought to answer the following RQ: *How do development-focused efforts improve energy efficiency in operations at the various organizational levels?*

The paper examined the efforts of top management to improve energy efficiency in operations, as illustrated by their decisions and actions, as well as the reported "doings and sayings" of operations employees in their daily work. Drawn from empirical data from the two hierarchal levels of top management and operations within three companies, the paper's findings broaden the traditional top–down viewpoint and the "formulate-then-implement" approach, namely by comparing "specific ways of seeing and experiencing" (Flick, 2018, p. 318).

4.1.2 Major findings

Paper 1 reveals that development-focused efforts to improve energy efficiency in operations, though varying in origin, can usually be attributed to the motivations of the actors initiating them—motivations that can differ and even conflict with each other. Therefore, the paper proposes that any improvement in energy efficiency in operations is determined by the cumulative effect of interactions between competing logics of actors who are officially accountable for or personally interested in improving energy efficiency in their companies. By extension, due to involving different actors in contributing to continually achieving improvement, the process of improving energy efficiency in operations can be regarded as a context for sustainability as practice. Along with a practice-based framework and propositions to be tested, the paper provides theoretical and practical implications for improving energy efficiency in operations.

4.1.3 Key contributions to the thesis

Paper 1 contributes to the thesis by first identifying the categories of development-focused efforts that precipitate improved energy efficiency in operations (i.e., induced development-

focused efforts and emergent development-focused efforts). Doing so enables understanding why the actors who are responsible for and perform the activities that shape the process of improving energy efficiency in operations makes sense and how they position their actions and decisions (RQ1).

Second, Paper 1 not only focuses on how daily activities occur and what personnel do in those activities but also provides empirical insight into real-life events from the viewpoints of various practitioners who are integral actors in the process of improving energy efficiency in operations. In that light, the paper expands the "formulate-then-implement" view on the top–down approach in the literature and thereby clarifies that actualizing corporate-level objectives for energy efficiency in operations is not an escalated top–down or bottom–up approach but a continuous participatory process (RQ2). The paper thus articulates propositions for enabling the improvement of energy efficiency in operations.

Last, Paper 1 describes the process of improving energy efficiency in operations and provides guidelines concerning where and how to identify the relevant practices of practitioners involved in those efforts relative to sustainability-oriented corporate-level and operations strategies. The findings emphasize that the process of improving energy efficiency in operations needs to be treated as a process involving iterative loops (RQ2). Far from being a linear sequence of induced development-focused efforts, the process entails different sets of activities, and the practitioners who execute them are central to the process's iterative loops (RQ2).

4.2 Paper 2 – "Sustainable Development of Operations: Actors' Involvement in the Process of Energy Efficiency Improvement"

4.2.1 Research design

Departing from the Paper 1's idea of enabling improved energy efficiency in operations by enforcing interaction and empowering iterative loops, Paper 2 empirically investigates the involvement of different actors in the process of improving energy efficiency in operations by focusing on their various development-focused efforts. As defined in the paper, actors influence the improvement process and enable the alignment of strategic sustainability goals regarding energy efficiency across and within operations. The research presented in the paper sought to answer the following RQ: *How do different actors engage in and shape the process of improving energy efficiency?* The paper is based on the analysis of empirical data from 19 companies in both energy-intensive and non-energy-intensive industries.

4.2.2 Major findings

Paper 2 shows that the process of improving energy efficiency in operations is a layered, double-loop approach consisting of four approaches to involving different actors. Therein, vertical involvement distinguishes top–down and bottom–up approaches and considers actors' positions in either top management or operations function while horizontal involvement distinguishes inside–out and outside–in approaches and relies on either internal resources or

actors in the external environment (e.g., stakeholders, energy service suppliers, and engineering consultants).

4.2.3 Key contributions to the thesis

Paper 2 contributes to the thesis by first analyzing the pathways that organizations take to connect the activities that shape their processes of improving energy efficiency in operations. It also illustrates "by whom" the activities are interpreted and employed (RQ1). Second, the paper provides additional empirical insight into the defined categories of development-focused efforts in Paper 1, which highlights an intermediate level of actors as initiators of a layered approach (RQ1). Third, the paper provides empirical insight into the generation of iterative loops interrelating different practices and how they enable individuals to deploy improvements in energy efficiency in operations as a practice alongside other practices in the organization (RQ2). Last, by providing a conceptual integrated framework for improving energy efficiency in operations and by combining the four identified approaches, the paper showcases the value of not only recognizing accomplishments by linking the individual parts but also ensuring development over time via feedback layers that enable organizational learning for continuous improvement (RQ3).

4.3 "Paper 3 – Improving Energy Efficiency in Operations: Practice-Based Learning via Initiatives"

4.3.1 Research design

Building on the ideas of the continuous participatory process in Paper 1 and enabling organizational learning to continuously improve energy efficiency in operations as described in Paper 2, Paper 3 investigates ways of practicing sustainability by improving energy efficiency as a result of becoming a practitioner. Against that background and following a qualitative, multiple-interview approach, the research in the paper was conducted to answer the following RQ: *How is knowledge transmitted and acquired in the process of becoming a practitioner of improving energy efficiency in operations?* The question was answered by probing companies' initiatives designed to improve energy efficiency and by analyzing how such initiatives can enable practical knowledge in the workplace.

4.3.2 Major findings

Paper 3 analyzes changes in individual and collective actions achieved by initiatives for enabling knowledge sharing between experts and novices, embedding knowledge in material elements and infrastructure, and innovating knowledge as an ongoing process. The findings show that learning is a fundamental condition for operations because knowledge is transmitted and acquired in the process of becoming a practitioner of improving energy efficiency.

4.3.3 Key contributions to the thesis

Paper 3 contributes to the thesis by conceptualizing organizations as social settings composed of bundles of interconnected practices and material arrangements and by applying practice-based theories as a theoretical lens. Moreover, the findings imply that improving energy efficiency in operations can act as a platform for knowledge exchange by placing individuals together and allowing them to share knowledge via formal and informal socialization mechanisms. Last, by focusing on sustaining improvements in energy efficiency in a social setting, the paper contributes to the continued improvement of energy efficiency in operations as a form of sustainability as practice and leverage for achieving the sustainable development of operations (RQ3).

4.4 "Paper 4 – Lean Energy: Turning Sustainable Development into Organizational Renewal"

4.4.1 Research design

To model the knowledge sharing between experts and novices mentioned in Paper 3, Paper 4 investigates the role of professional education with a twofold purpose: to explore the integration of practices of lean and energy efficiency and to provide practical examples of such integration. Primary evidence was collected from 19 participants in a lean energy course, and the efforts of one organization that aimed to explore the untapped potential in its own staff were investigated.

4.4.2 Major findings

Paper 4 reveals that by operationalizing sustainability through energy efficiency and combining it with the principles of lean, organizations can exploit continuous efforts toward improving sustainable development despite certain challenges. The paper illustrates that by participating in a professional education program, participants and their organizations can benefit from the development of competencies achieved by learning from peers and acquiring knowledge externally. However, while training employees induces individual learning and personalized knowledge as "a way of thinking" to create actions that impact organizations' sustainable development, for "ways of doing" organization-wide efforts are needed, and lean energy has to be scaled up. Building upon the framework for organizational learning and renewal, the paper relates lean energy practices to four learning processes: intuiting, interpreting, integrating, and institutionalizing. Thus, the paper suggests that to realize the synergistic potential of lean energy, two conditions are beneficial: professional education and organizational upscaling in which the organization encourages the use of principles and tools to identify and remove energy waste and supports the move from local practices to shared experience.

4.4.3 Key contributions to the thesis

Paper 4 showcases the synergistic relationship between lean and energy, in which energy efficiency promotes a focus on improvement initiatives. Moreover, building upon the logics in lean such as teamwork and empowerment, the paper provides insights into developing personal

skills and competencies that can sustain improvement in energy efficiency. Along those lines, the paper depicts a three-step process toward organizational renewal by upscaling lean energy from local practices to shared experiences (RQ3).

4.5 Paper 5 – "Logistics Service Providers' Energy Efficiency Initiatives for Environmental Sustainability"

4.5.1 Research design

Paper 5 investigates logistics service providers' (LSP) energy efficiency initiatives for sustainable development, both from an evolutionary perspective and based on a framework consisting of actions, processes (i.e., at the operations interface), and services (i.e., at the customer interface). The paper is based on qualitative interviews with sustainability managers at nine LSPs.

4.5.2 Major findings

Paper 5's findings imply that transitioning to sustainable development in LSPs occurs via operational processes, services at the customer interface, and actions that support processes and services. Moreover, in a maturity model using the three-pillar framework, the paper illustrates how transitioning to sustainable development via energy efficiency evolves through the alignment of those pillars. By extension, the proposed maturity model perspective on the transition of LSPs as well as and the emerged managerial implications, provide an approach to assessing LSPs to evaluate their sustainability initiatives in a structured way and their maturation towards sustainability.

4.5.3 Key contributions to the thesis

Beyond providing empirical insights into different parts of the thesis's conceptual framework, Paper 5 contributes by providing a new empirical context (i.e., LSPs) for testing the transferability of logics provided in Papers 1–4 to the manufacturing and processing industries.

5. Analysis

This chapter provides answers to the research questions (RQ) proposed in Section 1.3 by analyzing the findings from the literature and empirical data according to the logic developed in Section 2.3.

5.1 Characterizing the improvement of energy efficiency in operations as a practice

RQ1 was designed to reveal the characteristics of improving energy efficiency in operations as a practice, three of which were presented in this chapter:

1. A set of primary activities representing "what" kinds of activities that shape the process of improving energy efficiency in operations. With reference to the literature, Figure 2.2 outlines a set of primary activities, namely goal setting, identification, financing, implementation and measuring, reporting, and benchmarking.
2. Two categories of development-focused efforts representing "why" and "how" actions and meanings embedded as a practice. Scrutinizing the empirical evidence, Section 5.1.1 presents findings that elucidate why the actors who are responsible for and perform efforts that improve energy efficiency in operations makes sense and how they position their actions and decisions. Categories of development-focused efforts are defined as induced development-focused efforts and emergent development-focused efforts.
3. Four approaches of actors' involvement, presenting by whom the activities are interpreted and employed. Herein, Section 5.1.2 presents the pathways that organizations take to connect the mentioned set of primary activities and identifies the approaches of actors' involvement as top–down, bottom–up, inside–out, or outside–in.

To answer RQ1, the findings were analyzed with a focus on the middle-top of the conceptual framework shown in Figure 5.1 and are presented in the following sections.

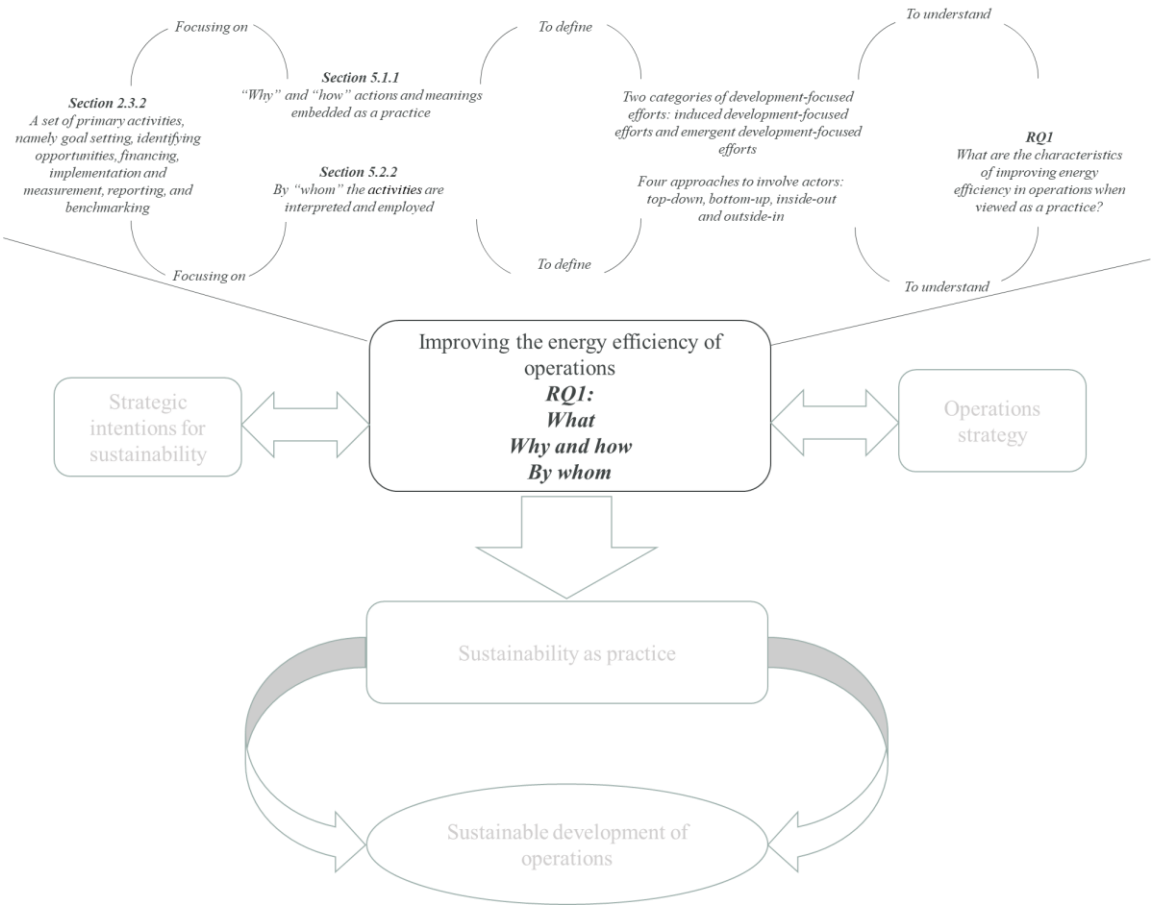

Figure 5.1: Characteristics of improving energy efficiency in operations as a practice in relation to the conceptual framework

5.1.1 Categories of development-focused efforts leading to improved energy efficiency in operations

Mapping the empirical data in Paper 1 according to the content of development-focused efforts leading to improved energy efficiency in operations revealed similarities between actors' understandings and within the phases in which the efforts have been initiated across the companies. The analysis suggested labeling the development-focused efforts as either "induced development-focused efforts" or "emergent development-focused efforts." Table 5.1 presents the similarities that justified grouping development-focused efforts derived from Paper 1.

Table 5.1: Similarities of induced versus emergent development-focused efforts leading to improved energy efficiency (derived from Paper 1)

Induced development-focused efforts	Emergent development-focused efforts
Initiated at top management	Initiated by operations employees
Motivated by economic benefits	Motivated by identified improvement opportunities
Involve large-scale improvements via technological solutions	Involve small-scale improvements via operations processes

Based on an additional analysis of the empirical data in the developed categories, a description of each category is provided in the following sections.

5.1.1.1 Induced development-focused efforts

Induced development-focused efforts predominantly originate from top management, meaning the company's owners or the board of directors as well as the centralized department accountable for sustainability. Such a centralized department has ad hoc responsibility for energy efficiency in the organization and reports directly to top management. Based on an extended analysis of the empirical data in the appended papers, two different, interacting stages of induced development-focused efforts are distinguished in the data, as reflected in the horizontal recursive arrows in Figure 5.2. Although goal deliberation leads to goal implementation, goal implementation can inform goal deliberation if feedback loops are in place. Because such feedback loops are not always present, they are represented as a dashed line in the figure.

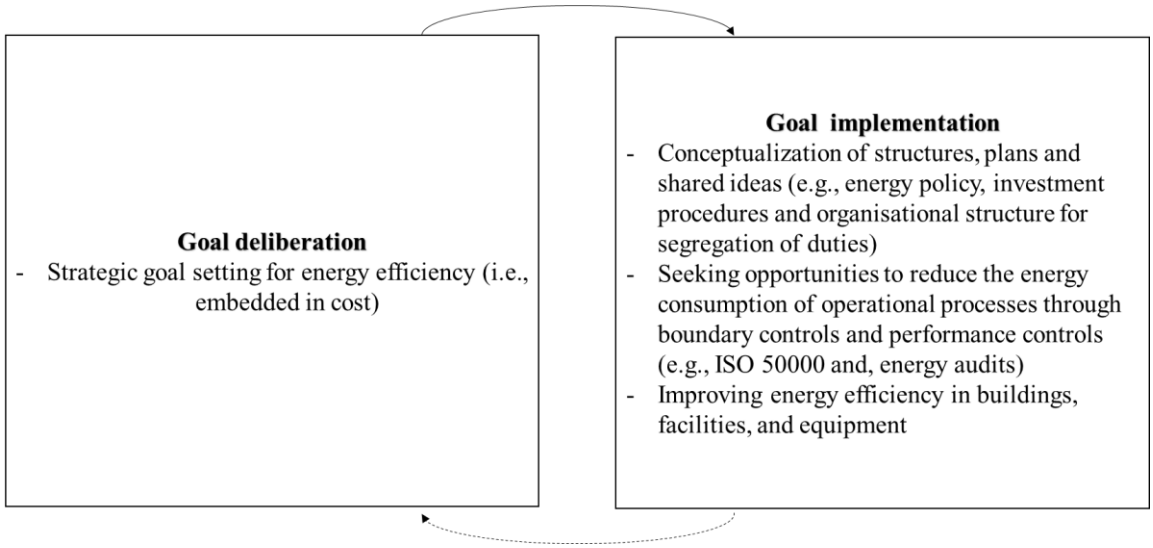

Figure 5.2: Two stages of induced development-focused efforts

Goal deliberation forms part of an organization's efforts to conceptualize its sustainability-related strategic intentions. Those efforts, sometimes motivated by legal compliance, also originate from a profit-seeking motivation among top management, which explains why they exist. The efforts focus on strategic decisions aiming to integrate sustainability, including energy efficiency, into corporate strategies. Because those efforts are undertaken by top management within the means of the organization to set strategic intentions, they are relatively rare.

The starting point of goal deliberation is the formulation of long-term goals for energy efficiency, which answers the question of how they come to be. Those goals are set to encompass sustainability-related objectives within sustainability-oriented strategy and are understood as supporting the organization's long-term financial viability. Examples of long-

term goals for energy efficiency, identified in all five papers, are expressed either as kilo- or megawatt hours per kilo or ton of product or as the percentage reduction in energy costs. For instance, Alpha in Paper 1 had a group-wide goal to reduce specific electricity and heat consumption per ton of produced product by 15% from 2010 to 2020. Papers 1, 2, and 5 provide evidence that cost-cutting is the dominant managerial motivation for setting strategic goals for energy efficiency. However, findings in Paper 3 illustrate that creating a sense of urgency in top management can be a tipping point for improving energy efficiency in operations. Examples of that dynamic include awareness of the European Union's energy objectives to decrease energy consumption and participation in Sweden's National Programme for Improving Energy Efficiency. Top management's engagement can have a snowball effect through strategic–operational alignment, such that the opportunistic improvement potential that once arose due to operations personnel's personal interest becomes part of the organization's strategic intentions and thus prioritized.

In contrast to goal deliberation, *goal implementation* includes efforts to extend the sustainability-related corporate-level strategy downward from top management through functions including operations. Three primary efforts have been identified for goal implementation.

The first are efforts to conceptualize structures and plans; examples include developing an energy policy, introducing energy efficiency-related criteria in investment procedures, and establishing an organizational structure that distinguishes responsibilities (i.e., accountability and funding) for implementing the formulated goals. Such efforts tend to assume that the organization will follow the mandated strategy and align with it.

Second, efforts directly seeking opportunities to reduce the energy consumption of operational processes are actualized by promoting formal boundary control and performance control systems both at the strategic level and in operations. Those efforts are prompted with the aim of motivating, if not compelling, the organization to behave in certain ways in order to achieve sustainability-related objectives. Therefore, such efforts chiefly emphasize measuring, monitoring, and reporting energy data to allow follow-up on the implemented process. Examples of common boundary control and performance control systems used by the companies are implementing an energy management system (e.g., ISO 50000) or conducting energy audits and/or mapping to monitor and analyze energy consumption and thereby identify opportunities for improvement. As the energy technique manager and project leader at the paper company in Paper 2 mentioned, "We expect a lot from our energy mapping, where we go through the whole factory and carefully obtain a picture of how we use energy. That way, we can see what is really possible."

Third, efforts for improved energy efficiency in buildings, equipment (i.e., office buildings, production sites and terminals), and facilities include converting to LED lights, geothermal heating, and solar panels and/or using new and innovative vehicle designs and production

equipment. Papers 1 and 5 identify such examples. One observation from the empirical data is that the opportunities identified for improving energy efficiency in operations from goal implementation typically require large investments in energy-efficient technologies and solutions with potentially long payback periods. On the contrary, as the empirical data suggest, because top management expects rapid results from induced development-focused efforts, large investments are not prioritized, and the short-term financial perspective is viewed as a major hindrance.

5.1.1.2 Emergent development-focused efforts

Answering why such efforts exist, the starting point of emergent development-focused efforts is an employee's advanced knowledge about or personal interest in energy efficiency such that they express their ideas, skills, and/or knowledge regarding the domain. Nevertheless, emergent development-focused efforts are primarily shaped by and limited to areas in which those individuals have expertise and tacit knowledge, do not exceed their responsibility, and usually take a long time to show results.

Emergent development-focused efforts start with the recognition of an opportunity to improve energy efficiency in operations via hands-on activities such as reducing waste, eliminating rework, and replacing inefficient routines and equipment within day-to-day operations work. Those efforts are mostly associated with operational improvements and result from practice-based learning in operations. Based on an extended analysis of the empirical data in Papers 1 and 2, once opportunities are recognized, emergent development-focused efforts are deployed in three ways.

First, they can be intertwined with day-to-day work. While operations employees perform their jobs to fulfill the management's expectations in line with predefined operational targets, if they identify opportunities that can be seized directly, then the impact of the development-focused effort will go unrecognized in the day-to-day work—for example, stabilizing processes to cultivate a better work environment.

Second, they can be intertwined with operations performance. Such emergent development-focused efforts require both resources that can be allocated directly from available operations resources and operations personnel able to implement them. Divergent work methods due to a lack of standardized processes, personnel who perform the same job differently during different shifts, seasonal variations due to differences in temperature, and the inconsistent quality of incoming raw materials are some examples mentioned in the appended papers of recognized opportunities for improving energy efficiency. During analysis, it was noted that the results of those emergent development-focused efforts on improved energy efficiency illustrated in the sustainability reporting could not be explained by top management. As the production manager in Paper 1 put it,

"If you only follow the key energy figures about how much energy has been used [as top management does], you don't see things happening immediately, but we actually achieve energy efficiency through stable processes."

Or, in the words of the energy technology manager at Paper 1, *"We hide energy waste within our processes."*

Third, they can be intertwined with induced development-focused efforts. Due to limited operations resources, emergent development-focused efforts, specifically ones requiring sizable investments, have to secure commitment by competing for resources with every other improvement proposal. If they can be deployed successfully, then they can directly impact the organization's sustainability-related strategic outcomes.

5.1.2 Actors' involvement in improving energy efficiency in operations

To clarify who has interpreted and employed the activities shaping the improvement of energy efficiency in operations, Paper 2 analyzes the several pathways that organizations take to connect the set of primary activities shown in Section 2.3.2.1. The paper also presents detailed information about which actors are involved in each set of primary activities shaping the improvement of energy efficiency in operations and how. Considering actors in the foreground as individuals who perform the practice, Figure 5.3 illustrates four approaches by which actors get involved in improving energy efficiency in operations.

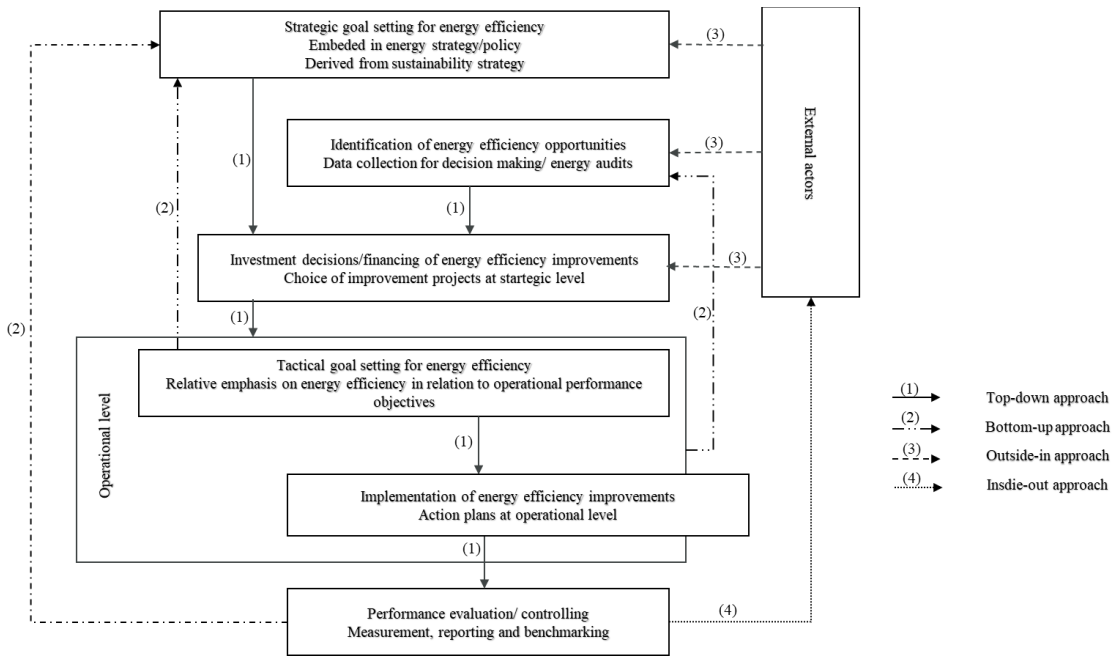

Figure 5.3: Conceptual integrated framework for improving energy efficiency in operations (Taghavi, 2021)

Findings in Paper 2 suggest that improving energy efficiency in operations occurs in people-intensive processes. Depending on where knowledge and competencies are located in the organization, the activities are connected through four different approaches of involving actors.

The top–down approach, illustrated as (1) in Figure 5.3, and the bottom–up approach, illustrated as (2), outline vertical involvement for improving energy efficiency in operations and distinguish actors' organizational level as either top management or operations. The inside–out approach, illustrated as (3) in Figure 5.3, and the outside–in approach, illustrated as (4), outline horizontal involvement for improving energy efficiency in operations and distinguish internal resources and actors within the organization from those in the external environment (e.g., stakeholders, energy service suppliers, and engineering consultants). For example, while individual operations employees have technical knowledge, intermediate-level production managers have an overview of the system. Moreover, while external actors have in-depth knowledge about alternative processes and methods, internal operations actors who are close to the processes have significant knowledge about the company's current processes and operations. By combining those approaches into an integrative approach, the process can benefit from those different types of knowledge and competencies.

5.1.2.1 Intermediate-level actors as initiators of a layered approach

The findings in Papers 1 and 2 not only question the "formulate-then-implement" view in the literature, but also extend the top-down duality of individuals involved. Moreover, they highlight an intermediate level of actors as initiators of an alternative layered approach. While several activities are performed by various individuals to foster improved energy efficiency in operations, a layered approach is initiated by the development-focused efforts of actors who attempt to create overlap between improving energy efficiency in operations as a practice and their own roles and responsibilities in the organization. Those actors are individuals with personal knowledge about and interest in energy efficiency and who have a position in the organizational structure that allows them to both be informed of and inform their organization's strategic intentions. At the companies studied, they occupy different roles and are represented as "change agents" or "champions" of enabling improved energy efficiency in operations. However, the empirical data presented examples of how those actors feel isolated and overpowered in realizing their intentions.

Although those actors are sometimes assigned task forces with duties delineated by top management, in other cases they have assumed the role unofficially based on their personal interest and knowledge. For example, some of the organizations studied had executive managers in operations (i.e., operation managers or plant managers) who assumed the role. Another organization has developed a decentralized, specialized energy service team in the form of a temporary cross-functional organization tasked with executing improvement projects for energy efficiency, whereas another has the maintenance function in the role. Because those roles can operate at different organizational levels, the development-focused efforts of those actors can radiate both downward or upward—that is, from top management to operations or vice versa. That dynamic explains why the distinction of those efforts has not been always clear in the companies, for they can be part of either induced or emergent development-focused efforts. In either case, they initiate a layered approach by intertwining energy-related issues with strategic and operational decisions in order to ensure that improving energy efficiency in

operations is not sidelined by other strategic and operational priorities. An example of such downward development-focused efforts is when actors translate the strategic goals for energy efficiency downward to operations by setting tactical goals in order to align what is in fact done in operations with the strategic intentions set by top management. By contrast, an example of such upward development-focused efforts is the attempt to transfer the identified potential for improving energy efficiency from operations to the corporate level in order to secure resources.

5.2 Interrelationship between improving energy efficiency in operations and other existing practices

Building upon the findings for RQ1, RQ2 was formulated to extend the improvement of energy efficiency in operations as a practice to the upper right and left of the proposed conceptual framework in Figure 5.4.

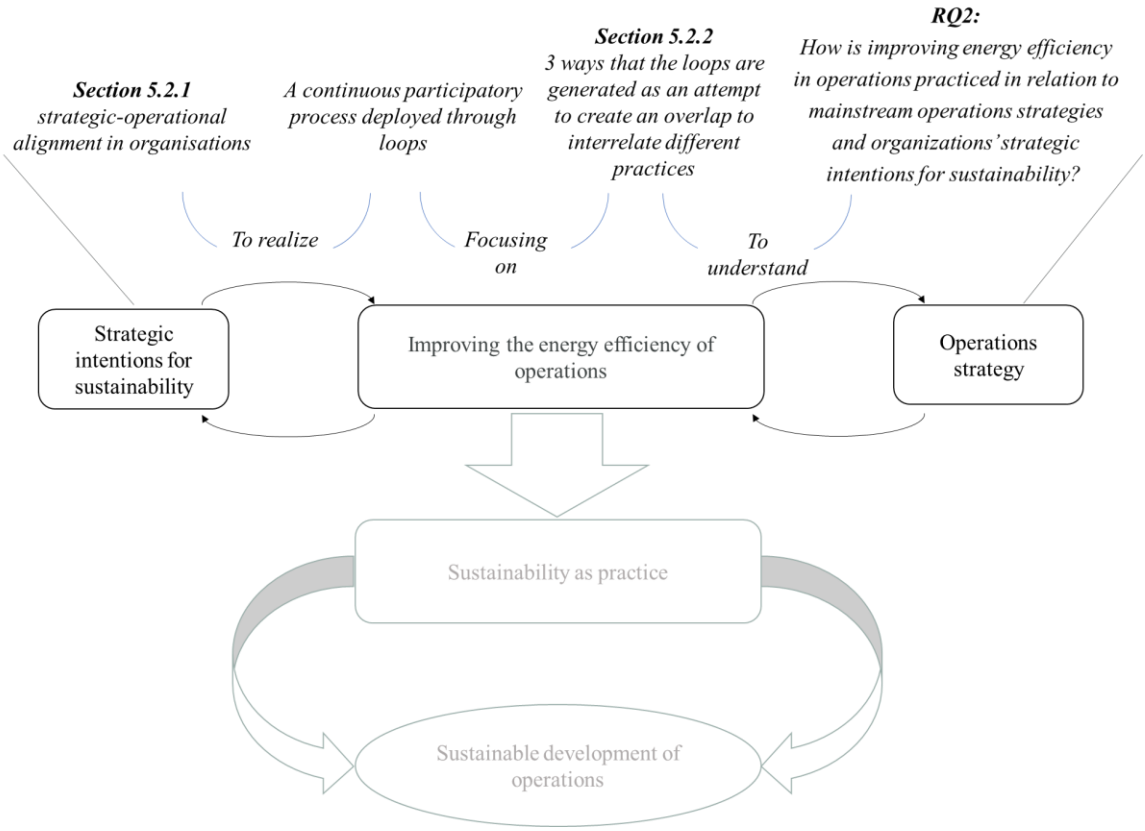

Figure 5.4: Interrelationship of improving energy efficiency in operations with other existing practices in relation to the conceptual framework

RQ2 was answered in two steps. First, instead of focusing on energy efficiency as a condition or outcome of operations management, the strategic–operational alignment in organizations for improving energy efficiency in operations was explored (see Section 5.2.1). The findings suggest that the process of actualizing corporate-level objectives for energy efficiency in operations, is not a top–down or bottom–up escalation of either the organization's strategic intentions for sustainability or its strategic intentions for operations but a continuous participatory process.

Second, that continuous participatory process was examined according to how individuals engage in improving energy efficiency as a practice in operations alongside other practices in the organization (see Section 5.2.2). The findings show that improving energy efficiency in operations is deployed via loops instead of sequential steps. Loops can be generated in three ways: taking advantage of a mutual language, creating common interpretations, and creating shared interest.

5.2.1 Analysis of alignment for improving energy efficiency in operations

Investigating organizations' strategic–operational alignment for improving energy efficiency in operations followed two pathways, presented in Figure 5.5. Those pathways were identified based on the nature of their origin, namely the actors' initiating development-focused efforts for such improvement.

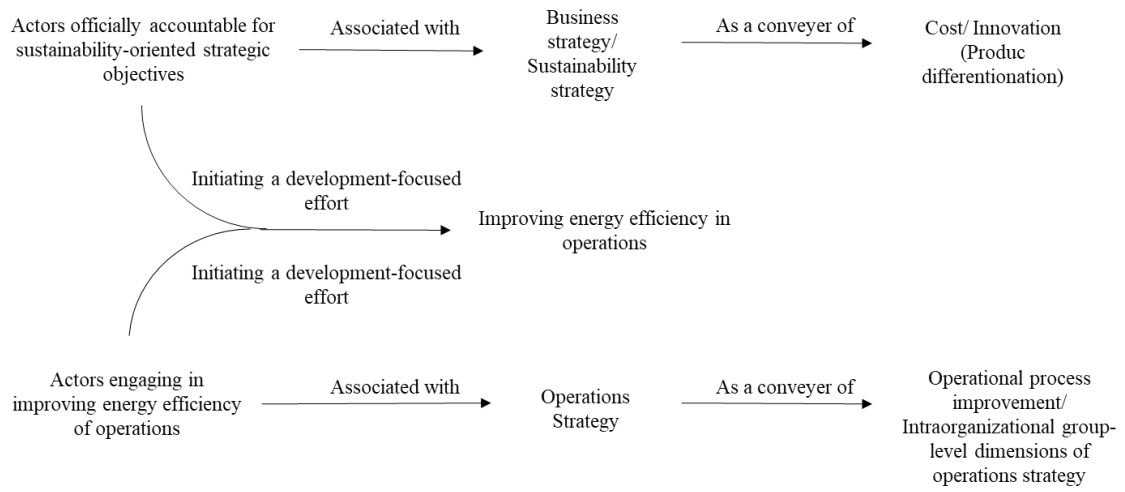

Figure 5.5: Two pathways for improving energy efficiency in operations

The upper pathway in Figure 5.5 is initiated by actors who are officially accountable for strategic intentions related to sustainability in the organizational structure. The centralized support function working with sustainability at the corporate level has oversight on all formal sustainability-related projects, including ones for improving energy efficiency in operations. Such is the case even in companies characterized by decentralized decision-making authority, which leaves operations employees little opportunity to tap into any potential for improving energy efficiency in operations. Such oversight stems from the centralized function's primary accountability for the organization's external communication via sustainability reporting. In relation to goal deliberation, for actors officially accountable for strategic intentions related to sustainability, improving energy efficiency in operations derives from the dimensions of cost and innovation in product development. As a result, and as expressed in the data, improving energy efficiency in operations is not the top priority of the centralized support function, as the following example illustrates:

"Although it has become trendy to maintain an environmental department and to have sustainability appear in all contexts of the organization, the department accountable for sustainability at the level of top management isn't involved with improving energy efficiency in operations or in operational decision-making unless there's an environmental disaster or a practice violates environmental laws." (Plant energy coordinator in the automotive industry)

At the same time, the organizational role of the interviewees was not always in the centralized support function working with sustainability at the corporate level. However, they have nevertheless been identified by their organizations as actors who improve energy efficiency in operations. Some of those individuals do not even have formal titles that would make them officially accountable for such work. Those actors initiate the lower pathway in Figure 5.5, with the prevailing motivation deriving from their perception of the importance of energy efficiency. Those actors' efforts are incorporated into intraorganizational group-level dimensions of operations strategy (e.g., quality or operational process improvement) that are closer to their own roles.

Because improved energy efficiency in operations is the cumulative effect of both pathways, the process of actualizing corporate-level objectives for energy efficiency in operations is not a top–down or bottom–up escalation of either the organization's strategic intentions for sustainability or its strategic intentions for operations but a continuous participatory process. Improving energy efficiency in operations is realized with top management's conceptualizing the sustainability-related strategic intentions of the organization as well as strategic intentions for its operations, in theory referred to as *operations strategy*. However, the findings distinguish the creation of formal aspects of such strategic intentions (i.e., via goal deliberation) from sharing such strategic intentions downward with the organization in cascading fashion (i.e., via goal implementation).

Strategic intentions for sustainability are connected to each firm's in-house terminology about sustainability, represented in formalized sustainability strategies. As the findings in Papers 1, 2, and 5 show, the empirical data contained no evidence that objectives for improving energy efficiency in operations are required by customers. Thus, improving energy efficiency in operations is not a competitive priority and hence not considered to be an operations performance objective. Furthermore, Paper 5 reveals that although companies have processes for customer interface to address the improvement of the energy efficiency of their products and services—for instance, in the case of logistics service providers (LSP), they are not reflected in their internal operations strategy. As a consequence, the primary motivation for setting objectives to improve energy efficiency in operations is incorporated into the dimensions of cost and innovation in product development. In that way, improving energy efficiency in operations originates from a profit-seeking motive in top management and is shared throughout the organization via induced development-focused efforts of a centralized support function working on sustainability. However, improving energy efficiency in operations also happens beyond long-term objectives for energy efficiency, namely by

articulating emergent development-focused efforts, which primarily emerge from the embedded experience of individuals and/or their personal interest.

5.2.2 Deploying the improvement of energy efficiency in operations in practice by creating loops

By capturing how individuals engage in improvements in energy efficiency as a practice in operations alongside other practices, the findings suggest that improving energy efficiency in operations is deployed via loops, not sequential steps. Loops are generated as a result of interactions between the competing logics and underlying rationales of actors officially accountable for or personally interested in improving energy efficiency in operations at their companies. Following the findings in Section 5.1.2.1, individuals with personal knowledge about and interest in energy efficiency attempt to create overlap between energy efficiency and their own roles and responsibilities in their organizations. As a result, those attempts not only initiate a layered approach in improving energy efficiency in operations as a practice but also generate loops that interconnect different practices. Loops connect operational and technical aspects of improving energy efficiency in operations to procedural and behavioral changes in organizations because the newly acquired knowledge from the process is reapplied into the process itself, thereby creating a cycle of continuous improvement. The findings in Paper 3 reveal that such loops are generated in three ways.

First, loops can be created by taking advantage of a mutual language, which refers to finding energy-related elements hidden in other practices and taking advantage of them without changing their syntax. For example, in one of the companies in Paper 3, the maintenance strategy was changed from emergency maintenance to preventive maintenance. In that case, maintenance personnel did their own job. However, instead of performing maintenance only when something went wrong and thereby creating energy inefficiency, they introduced, documented, and planned the maintenance of all equipment and machinery. By taking advantage of a common maintenance-based language, improving energy efficiency in operations was expanded to the actions and decisions of maintenance personnel.

Second, loops can be built by creating common interpretations, which refers to creating detailed descriptions that qualify actors in other practices to improve energy efficiency through their own actions and decisions. That end can be achieved by, for example, expanding different governance mechanisms to include energy efficiency. For instance, some companies in Paper 2 added a criterion for the assessment of energy efficiency in all investment proposals. In another example in Paper 3, purchasing routines and instructions were redefined to include a risk analysis of energy consumption. Therein, the purchasing department was obliged to request supplemental documentation regarding the energy performance of all equipment to be purchased, and all buyers were educated in methods such as life cycle cost and best available technique. In those examples, by creating common interpretations, improving energy efficiency in operations was expanded to the actions and decisions of different groups.

Third and last, loops can be created by creating mutual interest, which refers to overcoming divergent interests caused by a lack of knowledge by means of presenting the shared value between the practices. For example, Paper 3 illustrates initiatives for a more systematic approach toward identifying the potential for improvement by involving actors from operations in identifying the discrepancy between what is done on a daily basis and how it can be done. The employees learned the routes of energy consumption in the operational processes not only through the enrollment of operations employees in energy mapping; by adding energy knowledge to their own expertise and knowledge, they also reduced the risks of suboptimization. As such, under a feedforward approach, those discrepancies became more than the realization of opportunities and enabled the renewal of activities and routines.

5.3 Improving energy efficiency in operations as a mechanism for facilitating sustainability practice in organizations

RQ3 was formulated to investigate the possibility of extending the improvement of energy efficiency in operations as a practice vertically within the proposed conceptual framework and thus creating a context for practicing sustainability (see Figure 5.6). Whereas energy efficiency created the focus on the improvement in the analysis for answering RQ1 and RQ2, RQ3 focused on replicating such improvement and creating a constellation of practices that ultimately change people's behavior. Achieving such continuity creates a context for practicing sustainability and gaining leverage toward accomplishing the sustainable development of operations. In other words, RQ3 took an evolutionary perspective focused on the development that occurs as a result of evolution through changes in individual and collective actions and understandings to promote sustainability and develop people's skills and competencies.

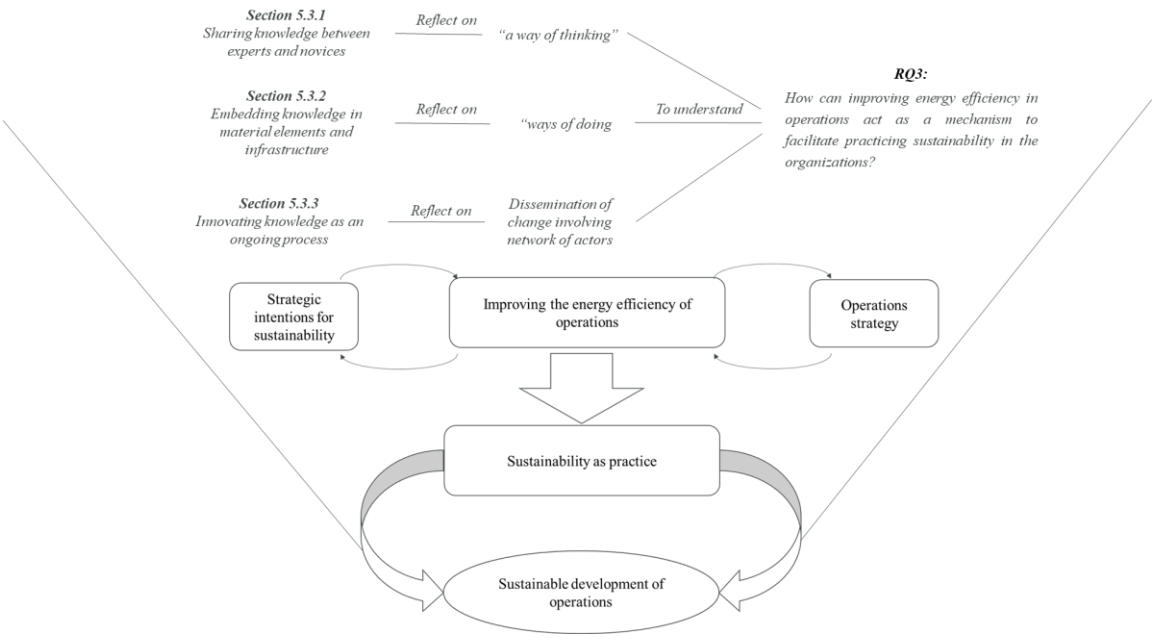

Figure 5.6: Improving energy efficiency in operations to enable development

Such an evolutionary perspective is addressed in different ways in the appended papers. For example, Paper 2 proposes that although the commitment of top management and a structured,

systematic, standardized way of working (e.g., an energy management system) create momentum for improving energy efficiency, developing competencies enhances empowerment and engagement among actors and creates continuity. Paper 3 further investigates practicing sustainability in terms of how knowledge is transmitted and acquired in the process of becoming a practitioner of improving energy efficiency. Paper 4, by contrast, depicts a three-step progression toward organizational renewal by upscaling lean energy to move from local practices to shared experiences. Paper 5, proposing a maturity model for LSPs, implies that even if actions, internal processes, and services are currently managed primarily in isolation, LSPs need to continue maturing toward external institutionalization. The following subsections present an extended analysis from all five papers to illustrate the improvement of energy efficiency in operations as a practice by enabling organizational learning through formal or informal, natural or established, and instrumental or activity-oriented integration, by coordinating interactions between individuals within organizations, and, as a result, by fostering changes in individual and collective actions and understandings through three processes.

5.3.1 Sharing knowledge between experts and novices

Knowledge sharing between experts and novices not only empowers individuals by teaching them the best practices, tools, and methods to master and implement but also creates a sense of urgency and makes novices identify and rethink how energy is used in their daily activities. The analysis identified multiple ways in which novices learn by interacting with experts. For example, pinpointing opportunities for improvement is primarily regarded as an induced effort in which organizations primarily apply an outside–in approach and use external consultants for energy audits. However, Papers 1, 2, and 5 show that some interviewees recognized a lack of external consultants' expertise about technology and processes in the manufacturing and processing industries, along with a lack of experience with evaluating LSPs' vehicles and transport activities. They also emphasized that the lack of systems overviews risked suboptimal proposals for improvement using the outside–in approach.

On the contrary, when operations employees were recruited for energy mapping, as shown in Paper 3, it not only empowered them to understand routes of energy consumption but also benefited from their knowledge, which reduced the risk of suboptimization. In such forms of participation, learning occurs gradually as novices, previously passive, become able to reproduce their observations over time. Paper 5 also offers examples of how employees' behavior can be regulated by stimulating their knowledge about energy efficiency. As presented in one interview:

> "There are a lot of examples that we've identified when someone gets to work an hour earlier that everyone else because they think that it's good to be there and to prepare, which requires lighting up the entire warehouse. But we won't have any operations there for maybe an hour, so it costs a lot of money and energy over the course of a year." (Environment, energy and quality manager at a third-party logistics provider)

As that example illustrates, awareness is assumed to be associated with being attentive and rethinking behavior.

Paper 3 also reflects the importance of treating management personnel as novices in improving energy efficiency in operations and the necessity of creating a sense of urgency among them. The need to educate management was also expressed by the interviewees in Paper 4.

Last, Paper 4 investigates the role of professional education in detail as a formal model for knowledge sharing between experts and novices. As shown, participating in a professional education program benefited both the participants and the organization by developing competencies while learning from peers and acquiring knowledge externally. However, as also shown, facilitating such formal expert–novice knowledge sharing mostly impacts individuals, namely by equipping them with a mindset geared toward improving energy efficiency reflected as "a way of thinking."

5.3.2 Embedding knowledge in material elements and infrastructure

Embedding knowledge in material elements and infrastructure induces behavioral change by engaging multiple individuals, increasing their interactions, and providing a stable reference point for them to reflect on their respective domains, perceive similarities and differences in their personal experiences, and develop insights into improving energy efficiency in operations. By forming a common mindset and vocabulary, such individuals can develop cognitive maps and thereby facilitate practices of sustainability.

Connecting improvement of energy efficiency in operations with logics already known by others and embedding energy efficiency in methods and tools used in other practices are bi-directionally linked. As for the former, for example, Paper 4 shows how in building a shared context for action between lean and energy efficiency, the common term of "finding waste" helped the individuals to describe what was possible to change. Paper 5 also presents examples of LSPs' taking advantage of lean models to enhance their capabilities in integrating energy efficiency into their logistics operations.

The latter, by contrast, is connected to the loop generated by creating common interpretations (see Section 5.2.2.2). In those examples, by creating detailed descriptions about improving energy efficiency in operations using tools and methods applied in other practices, actors in those practices are empowered to translate improvements into their own actions and decisions.

During site visits, the companies' representatives showed how energy data were visualized in the interfaces that operators use as well as in company-internal information boards. One of the companies in Paper 3, for example, has implemented a live dashboard system that continuously monitors energy consumption and the type of energy consumed per cell. Discussing such visualization with the interviewees revealed that although such visualizations initially act as simple reminders, over time they allow not only incorporating improvements in energy

efficiency in operations into daily practices and routines but also shifting the ownership of improving energy efficiency to operations:

> "Many initiatives have died out simply because we couldn't shift the responsibility to the respective departments and the people who work there ... [In response, we need] to get people to feel confident about working with energy efficiency to create conditions for everyone to facilitate energy efficiency and to feel sure that they actually know how they can have impact." (Energy efficiency manager in pulp and paper industry)

Last, referring to the findings in Paper 4, embedding knowledge in material elements and infrastructure enables shifting the improvement of energy efficiency in operations from abstract sustainability-related objectives at the strategic level to its practice among multilevel individuals who understand what it is and how they can perform it. That dynamic reflects "ways of doing" that increase interrelationships with existing practices by creating more iterative loops and allowing the repetition of actions.

5.3.3 Innovating knowledge as an ongoing process

Innovating knowledge is an ongoing process aimed at disseminating change from the individual level across the organization, one enabled by influencing decisions and actions involving a network of actors. As presented in Paper 3, a dynamic learning process, operationalized via initiatives, can facilitate individual interactions through arrangements of resources. As a result, those initiatives can facilitate practice-based learning and enable individuals to incorporate new knowledge into their daily processes and into sequential learning loops in order to enhance the practice of sustainability.

For example, when a company in Paper 3 identified critical roles for improving energy efficiency in operations (i.e., managers in production, maintenance staff, the property manager, buyers, project managers, and process technicians), formed a team representing their competencies, and made them accountable, their attention to energy use made their entire functions concerned about energy use. Moreover, by involving them in energy mapping, the company benefited from internal experts' concrete knowledge and bridged gaps in energy–process improvement via an overview of the system while avoiding suboptimization.

6. Discussion

This chapter discusses the results in terms of their contributions to the scope of the thesis within the theoretical domain of operations management, namely by integrating the results presented in Chapter 5 with the conceptual framework proposed in Chapter 2. The following subsections detail the revised conceptual framework and offer some observations about what the revisions imply. By extension, what the results confirm from previous research in the domain and which new factors were revealed are discussed.

6.1 Improving energy efficiency in operations as a practice

Building upon Fritz and Silva's (2018) findings, the results suggest that consulting the triple bottom line is insufficient for addressing the complexity of sustainable operations. Emphasizing the need to pay closer attention to other aspects connected with the UN's Sustainable Development Goals, the research for this thesis involved investigating the literature and empirical data in order to conceptualize the improvement of energy efficiency in operations as a practice. Providing such a conceptualization can foster consensus on both the meaning and evaluation of the practice for scholars (Hong et al., 2018) as well as for practitioners (Kluczek, 2019). Moreover, by analyzing empirical data from the levels of both top management and operations within the organizations, the research responded to the call to connect operational and strategic priorities (Rudberg et al., 2013) as a means of enabling consensus on the meaning of the practice and close interaction among different stakeholders. Those contributions expand upon Antonacopoulou's (2015) observation that practice adds value to organizations by connecting operational and strategic priorities between business units, functional teams, and/or working groups and by deriving useful practical and theoretical implications.

The research also responded to the call from Corbett et al. (2018, p. 283) to consider individuals who work with sustainability "as not only existing within a defined and static role" and to consider more broadly how such work can emerge and grow by linking individuals and internal processes with development-focused efforts as an organization-wide practice (Williams et al., 2021). As a result of such cross-level research, the thesis broadens the traditional top–down viewpoint and the "formulate-then-implement" approach to sustainability-oriented strategic intentions in organizations.

6.2 Strategic–operational alignment

While examining the improvement of energy efficiency in operations as a practice in relation to organization's strategic intentions for sustainability as well as existing operations strategy, the appended papers provide examples of the bidirectional perspective on synergy between operations management and energy management presented in Section 2.3.3.1. Although that perspective is not a general theory of how operations strategies or sustainability-oriented strategies are developed, it provides an analytical lens for approaching efforts to improve energy efficiency in operations and how they relate to strategic intentions. Representing an enabled impact as being mediated by a bidirectional link facilitates the description and analysis of how practice-influenced efforts undertaken by individuals, as the bearers of development-

focused efforts, are connected to strategic processes and content. As such, it enables more informed decision-making, especially when investment decisions need to be made regarding ways of achieving and sustaining energy efficiency (Cooremans, 2012).

The findings of the thesis also offer insight into operations strategy as well as into the literature on sustainable operations management. In that regard, previous research has generated conceptual frameworks for formulating operations strategy that address sustainability (e.g., Ocampo and Clark, 2015) in alignment with the argument that sustainability should be integrated into the content of an operations strategy (e.g., Macchi et al., 2020). At the same time, research problematizing the purpose of sustainability-oriented work has illustrated that sustainability has generally existed outside "business as usual" and that agents of sustainability have to convince others about their work's significance and actively entice people to contribute to following the sustainability agenda (Williams et al., 2021). By examining how individuals engage in improvements in energy efficiency in operations alongside other practices in their organizations, this thesis confirms the same problematization while also extending the findings of Williams et al. (2021). The results illustrate that energy efficiency improvement in operations is a cumulative effect of two pathways derived from competing logics and the underlying rationales of actors officially accountable for or personally interested in improving energy efficiency. Improving energy efficiency as a strategic sustainability-oriented objective is justified by its function as arguably having the greatest impact on that objective. However, improving energy efficiency connected to operational improvements happens simultaneously in operations. As a result, while alignment between operations and strategy takes time to develop, adaptation and arrangement are needed for operations to engage without directly aligning with the sustainability strategy. Differences in actors' underlying rationales for prioritizing the same corporate-level sustainability-related objective presented in the empirical data reveal that corporate-level strategic intentions can be incorporated into multiple dimensions of performance objectives in operations. As such, actors personally interested in improving energy efficiency often need to legitimize their work in their own specific contexts. The thesis's findings thus corroborate past results concerning operations strategy and highlight the importance of understanding practical tensions between organizational values, product features, and strategic goals as enablers of action cycles (Hengst et al., 2020). According to Hengst et al. (2020), beyond determining the legitimacy of any new strategy as an organizational objective, strategies should be considered in relation to other strategies to make them legitimate in action.

Second, in traditional literature on operations strategy, the ability of operations to promote strategic success is shown to be determined by numerous decisions that, to be effective, have to be interpreted similarly across the organization and generate action (Skinner, 1969; Wheelwright, 1978). However, such an interpretation of the strategic factors across all levels of an organization, or *strategic consensus*, is seldom addressed in the literature on operations strategy (e.g., Edh Mirzaei et al., 2016; Veloso Saes et al., 2022). Differences in perceptions and interests have been acknowledged as hindering strategic success in operations (Zanon et

al., 2013). Moreover, complexity in implementing operations strategy has been acknowledged by Edh Mirzaei et al. (2016), who showed that even when strategic consensus exists between operators and managers, their underlying rationales often differ. As a result, they proposed a different division of the content of operations strategy by concentrating on the organizational levels of its dimensions. By extension, the thesis's findings question the assumption of linear, straightforward views on the deployment of strategic objectives, for both sustainability-oriented strategies and operations strategies, and offer a somewhat messier viewpoint on the realization of such strategies.

Third, evidence generated by the thesis supports past findings showing the presence of alternative forms of developing operations strategy alongside the dominant top–down planning process (e.g., Jagoda et al., 2016) and highlights the complex, evolving nature of developing operations strategy (Adamides, 2015). Although Jagoda et al. (2016) investigated alternative processes of operations strategy (i.e., forced, opportunistic, and evolutionary) and how they relate to certain organizational contextual conditions (i.e., formalization and centralization) and operations performance, the findings of this thesis propose that alternative processes can exist when actors need to co-enact strategies within the same organization. Moreover, contrary to the traditional top–down dual perspective on operations strategy and focus on vertical top-down coordination between management and operations, the thesis's findings emphasize on the importance of understanding of how the layered approach generates multitude of interactions across diverse actors. By building on the concept of enacting strategic intentions (Weiser and Jarzabkowski, 2020), the thesis suggests that improving energy efficiency in operations involves the actions of those diverse actors and their interactions to makes sense of energy efficiency and accommodate it in their own contexts. It also involves the co-enactment of corporate-level sustainability-related objectives alongside other corporate-level sustainability-related strategic intentions as well as intentions already existing in operations. In those ways, the thesis expands the literature on operations strategy, to encompass the actualization of two or more strategic intentions relative to each other and within people's decision and actions.

6.3 The evolution of sustainability as practice as a means to the sustainable development of operations

As a practice, improving energy efficiency in operations embraces many actors and material elements and is a nexus of doings and sayings (Schatzki, 2012). Although improving energy efficiency in operations as a practice enables sustainability, the idea of sustainability as practice involves a more profound comprehension of sustainability-related values in order to effect and continuously sustain change in practitioners' behavior (Silva and Figueiredo, 2020). Enabling practitioners as agents who can incorporate knowledge over facts and things by constantly repeating ordinary actions (Silva and Figueiredo, 2020), as well as embracing people and material elements (Schatzki, 2012), is one way to achieve that end. However, to enable actions through a feedforward approach, the approach requires a multilevel process tied to the successful enactment of intended activities from the organization level to individuals via feedback and the recognition of individual observations (Crossan et al., 1999). Along those

lines, this thesis presents an evolutionary perspective focused on development that occurs through changes in individual and collective actions and understandings as a means to promote the practice of sustainability and develop people's skills and competencies.

The thesis's findings also imply that improving energy efficiency in operations can act as a launchpad for facilitating the exchange of knowledge by placing individuals together and allowing them to share knowledge via formal and informal mechanisms of socialization (Cousins et al., 2006). In the context of sustainable consumption, promoting more responsible behavior among employees at work has been proposed as a direction for sustainable consumption (Süßbauer and Schäfer, 2018). Past research at the level of the supply chain has also shown that sustainability cannot occur without learning and has highlighted that practicing sustainability can be enhanced by implementing sequential learning loops for incorporating sustainability-related knowledge into daily business processes (Gong et al., 2018). Similar to those findings, and in line with practice-based learning, the thesis implies that improving energy efficiency as a practice facilitates situated learning (Gherardi, 2012) and, during interactions over time, empowers individuals to add new knowledge to what they already know (Grant, 1996). The thesis's findings thus contribute to the third layer of the proposed framework for sustainable manufacturing solutions proposed by Bonvoisin et al. (2017) which addresses the integration of value creation modules into value creation networks to help ensure the development of infrastructure in organizations which facilitates sustainable production.

7. Conclusion

This chapter presents the concluding remarks, reflects on the methodological choices made for the research, and offers some suggestions for future research. The chapter concludes with an overview of the managerial implications of the findings.

7.1 Concluding remarks

The research conducted for this thesis investigated improving energy efficiency in operations in order to facilitate sustainability as practice. The research resulted in five appended papers and further operationalized in three research questions (RQs) in the thesis. By building on the findings in the appended papers, as well as elaborating on the synergy effects of the papers to answer the RQs of the thesis, the research has addressed its stated purpose in three ways.

First, the findings suggest conceptualizing the improvement of energy efficiency in operations as a means to narrow the extended energy efficiency gap and thereby actualizing an organization's objectives related to energy efficiency. Those results were obtained by applying a practice-based theoretical lens to understand the improvement of energy efficiency in operations as a practice analyzed according to its own characteristics, its constituent activities, and how, why, and by whom those activities are interpreted and employed (Nicolini, 2012).

Second, instead of positioning energy efficiency as a condition or outcome of operations management, the results recommend promoting strategic–operational alignment in organizations to improve the energy efficiency of their operations.

Last, focusing on development that occurs through changes in individual and collective actions and understandings to promote sustainability, as well as by developing people's skills and competencies, the results illuminate the evolution of sustainability as practice and ensure development over time as a means to realize the sustainable development of operations.

7.2 Reflection on methodology

A recent structured literature review on practices of sustainability in supply chain management (Silva et al. 2022) has revealed an imbalance in the research designs used and the relatively high use of quantitative methods, primarily surveys. The review's findings suggest that research has tended to apply the practice-based view following Bromiley and Rau (2014) instead of conducting practice-based studies. The authors also observed that using quantitative methods has been criticized for not considering the nature of practices and that using qualitative research designs can better contribute to defining and understanding practices of sustainability (Silva et al., 2022). By applying a practice-based theoretical lens and collecting qualitative data, this thesis responds to that imbalance.

The findings of the thesis confirm that energy efficiency's complexity partly explains the extended energy efficiency gap (Schulze et al., 2016), which itself stems from wide variation

and specific contextual aspects and thus complicates generalizability. In that light, the findings suggest that both improving energy efficiency in operations as well as practicing sustainability are constructed by organizations as social settings composed of bundles of practices and material arrangements (Schatzki, 2005), various subcontexts, and the enactment of multiple individuals within and across organizational levels. Conducting interview studies in the research for the thesis was considered to be an advantage that rests on the possibility of obtaining the complex stock of knowledge of an expert or group of experts (Flick, 2018), along with firsthand experience and perspectives of experts on the topic being studied. However, unlike case studies, interview studies overlook the analysis of contextual factors in the organizations sampled. Moreover, though applying a practice-based theoretical lens supports the comprehension of both explicit and hidden elements inherent in practicing sustainability and has the power to strengthen foundations for developing theory and practical guidance (Silva and Figueiredo, 2020), further research conducted across larger samples of organizations is needed to test and generalize the findings. Beyond that, for theory to be constructed, scholars and practitioners need to begin using the same, or at least similar, terminology (Silva et al., 2022). Once a practice is clearly defined, its applicability increases the linkage between theory and practice. Therefore, this thesis can be regarded as a first step toward that conceptualization.

Semistructured interviews and site visits were conducted as primary methods of data collection because they allow greater proximity than surveys and enable in-depth analyses. At the same time, because the descriptive and emerging nature of improving energy efficiency in operations required investigating a range of research subjects, the breadth of the empirical data viewed in terms of replication logic (Edmondson and McManus, 2007) was ensured by studying the large number of companies sampled. Targeting both energy-intensive and non-energy-intensive industries, as suggested by Rohdin et al. (2007), and by including the manufacturing industry, the processing industry, and logistics service providers (LSP), an in-depth understanding across a broad spectrum was formed based on different contexts (Abdul-Rashid et al., 2008) and guaranteed comparability (Flick, 2018). However, given the limited representation of sample companies, to better guide further research on the topic, opportunities remain for replicating studies and maturing the field based on the thesis's findings.

The target sample for Paper 5 differed from the samples for the other papers by consisting of LSPs. Including research on LSPs was considered to be valuable for the thesis both for testing the transferability of the logic developed in the manufacturing and processing sectors and because logistics is vulnerable to criticism regarding environmental sustainability and energy efficiency. Exploring initiatives for energy efficiency in LSPs from an evolutionary perspective, Paper 5 captures formal and informal initiatives related to both internal operations and external markets. Later, providing insight into a particular range of actions, processes, and services and elucidating the degree of advancement therein, the paper proposes a maturity model for LSPs' sustainable development. In that model, *actions* are defined as general efforts toward achieving energy-efficient outcomes and considered to form the basis for processes and services, *processes* refer to efforts affecting internal operational settings, and *services* shaping the

customer-company interface are conceived as efforts toward improving energy efficiency via market offerings.

The investigation into both contexts suggest that whereas the manufacturing and processing industries have long been obliged to conduct energy audits, that obligation is new for LSPs. Based on the empirical data in the thesis, organizations tend to rely on consultants to conduct energy audits if they perceive that the organizations lack the required skills and competencies to do so. Although LSPs have also attempted to use the same consultants, the LSPs in Paper 5 emphasized their current inexperience with evaluating vehicles and transport activities, which highlights another opportunity for practitioners.

Energy efficiency is part of the strategic agenda in both industries, with cost reduction stated to be the primary motivation for working toward that end. Improvements in energy efficiency in operations do not derive from customers' and market requirements. The high energy consumption of the internal processes in the manufacturing and processing industries is also not directly projected into the prices that customers pay for products. For LSPs, by contrast, part of the energy consumption of their operational processes is directly associated with the services provided to customers (e.g., transport), and the interviews revealed that initiatives for improving energy efficiency will affect the price of their services. However, whereas the manufacturing and processing industries realize improved energy efficiency in innovation and product development as a strategic dimension, addressed by differentiating sustainable product and service offerings (Das and Joshi, 2007), such a willingness to "pay and push" was not recognized by the LSPs. A final reflection is that part of LSPs' transitions to sustainable development have already occurred in the manufacturing industry, namely in improved energy efficiency in the forms innovation and product development (e.g., truck technology). However, the findings from Paper 5 and the proposed maturity model can be further explored in and transferred to many different sample sets and contexts.

7.3 Implications for future research

To further expand understandings of sustainability as practice in relation to improving energy efficiency in operations as a means to facilitate the sustainable development of operations, additional research would be beneficial. With reference to this thesis's findings, the following avenues for future research are suggested.

First, one opportunity relates to communication as a primary target for using practice-based theories. The findings in the papers repeatedly reveal the interviewees' lack of understanding about their organizations' strategic intentions even though effective means of communication and information-sharing channels exist. Therefore, future research should investigate the efficiency of communication about developing practices of sustainability between various different levels of the organizational hierarchy and how it can influence that practice.

The second opportunity corroborates Touboulic and McCarthy's (2020) proposal to consider sustainability as practice according to contextual characteristics, which suggests that best practices are irrelevant given the nonexistence of a single optimal scenario. However, scholars and practitioners can apply benchmarking and adapt practices to their own contexts if good practices and initiatives are discovered in future research in various settings. Moreover, it may be possible to ensure transferability in order to generalize sustainability as practice from organizations upstream through supply chains and to form chain-wide sustainability by combining sets of practices. Even so, it bears repeating that as the level of complexity moves from activities to practices, it also moves from the organization's practices to the practices within the supply chain.

Third, concerning the amount of time spent at each organization, while the decisions made regarding methods of data collection have been presented in Chapter 3 and reflected on in Section 7.2, the thesis's findings as well as the findings in Papers 1 and 2 could be extended by longitudinal ethnographic studies. Data collection for Papers 3 and 4 addressed that possibility to some extent, for the data were collected long after participants had completed a course, which afforded them the time to reflect on their experiences and the impact of their own learning and its impact on their organizations. However, the conditions and processes of learning outlined in those papers can be better understood by analyzing the formation of practices occurring over longer periods of time. The maturity model for LSPs' sustainable development, proposed in Paper 5, can also be explored over time to better understand not only the evolution of the studied companies but also the interdependency between the key dimensions of the maturity model.

7.4 Implications for practitioners

By addressing how organizations can continue engaging in improvement instead of engaging in what they have already improved, this thesis can guide practitioners in their evolution toward sustainable development. The following 9 points can enable organizations to engage in improving the energy efficiency in their operations:

1. Although abstract, long-term targets for energy efficiency can serve as key performance indicators for an organization's energy footprint, they do not consistently encourage the improvement of energy efficiency in operations as a practice. Tangible operational targets connected to potential room for improvement in operations discovered through outcomes and capabilities can undergird interventions to encourage such improvement. However, setting such targets can be difficult for less developed, less experienced companies.
2. Managers should be regarded as novices in improving energy efficiency in operations. Creating a sense of urgency within management to improve energy efficiency can generate a snowball effect, such that management's increased engagement can increase their organization's commitment to such improvement.
3. In practices, improving energy efficiency in operations is not an top–down or bottom–up escalation of an organization's strategic intentions for sustainability or for operations but a continuous participatory process.

4. Individuals with personal knowledge and interest in energy efficiency at the intermediate level in an organization (i.e., close to operations) and with access to top management can enable the continuous participatory process through a layered approach. The organization can thereafter benefit from consistently identifying and empowering such champions of energy efficiency and agents of change.
5. Overlaps between improving energy efficiency in operations as a practice and other practices can be created in an organization by taking advantage of a mutual language, creating common interpretations, and creating shared interest.
6. Knowledge sharing between experts and novices primarily impacts individuals by encouraging a mindset geared toward improving energy efficiency in operations.
7. Embedding knowledge in material elements and infrastructure allows shifting the improvement of energy efficiency in operations from an abstract sustainability-related objective at the strategic level to a practice applied among individuals at multiple levels of an organization. That dynamic reflects ways of doing that increase interaction with existing practices by creating iterative loops, allowing the repetition of actions, and promoting ownership of improved energy efficiency in operations. As a result of the alignment of operations and strategy, embedding the improvement of energy efficiency in roles beyond the central sustainability and energy management functions is valuable. An array of competencies and professional roles are potentially critical for improving energy efficiency in operations , including operations managers, maintenance staff, property managers, buyers, purchasers and procurers, project managers, and process technicians and operators. Identifying such competencies and creating a network of actors can enable sustained improvement.
8. The dissemination of change from the individual level to other levels in an organization can be enabled by influencing decisions and actions involving a network of actors engaged in innovating knowledge as an ongoing process.
9. As an organization matures in improving the energy efficiency of its operations, external knowledge once shared only between experts and novices (Gherardi and Miele, 2018) can be converted into practical knowledge in the workplace (Figueiredo et al., 2020).

Amid growing efforts to professionalize the accountability of agents of sustainability and equivalent roles in organizational structures, past studies have highlighted how managing sustainability and energy use requires support functions and certain organizational structures (Bui and de Villiers, 2017; Rotzek et al., 2018). However, the findings of this thesis suggest that improving energy efficiency in operations not only requires the involvement of individuals at different levels but also remains difficult to institutionalize in roles that lack decisive power and proximity to operations. Therefore, the thesis advocates sharing elements and accountability across domains while at once integrating competencies (Siva et al., 2018).

Although the findings do not suggest that the outside–in approach is ineffective, they do underscore a problem with confidence in using an outside–in approach to identify the potential for improving energy efficiency. That problem is threefold:

1. The risk of suboptimal proposals for improvement because external actors lack system overviews and technological knowledge about company-specific processes;
2. The limited identification of opportunities to improve energy efficiency in operations, particularly by using technological measures related to production processes that typically require large investments in energy-efficient technologies and solutions; and
3. The challenge that external experts cannot address and install soft(er) aspects of improving energy efficiency in operations (i.e., behavioral change).

In response to those problems, the thesis encourages taking advantage of in-depth knowledge generated by following an outside–in approach, particularly regarding alternative processes and methods and during the early stages of improving energy efficiency in operations. Moreover it advocates taking a practice-based perspective on the synergy that represents the impact enabled, both directly and indirectly, by bidirectionally linking operations management and energy efficiency. Doing so can enable better-informed decision-making, especially when investment decisions need to be made, regarding ways of engaging in and replicating improvements of energy efficiency.

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Appendix 1

Web survey - Paper 4

Enkät - Färdvägar till energieffektivisering

* Required

Ditt namn: *

Vilket företag representerar du? *

1. Att sätta mål

Till vilken grad sätts målen för energieffektivisering enligt ett "top down" perspektiv i ert företag? (1-5)*

Med ett "top down" perspektiv menas att företagets ledning sätter ett mål utan omfattande analyser gjorda av experter eller andra delar av organisationen.

Stämmer inte alls	1	2	3	4	5	Stämmer helt och hållet

Till vilken grad sätts målen för energieffektivisering enligt ett ”bottom up” perspektiv i ert företag? (1-5)*

Med ett ”bottom up” perspektiv menas att underhållspersonal, produktionspersonal eller fabriksledning sätter målen.

Stämmer inte alls	1	2	3	4	5	Stämmer helt och hållet

Övriga kommentarer

2. Att identifiera möjligheter för energieffektivisering

Till vilken grad arbetas möjligheterna för energieffektivisering fram i ett ”inside-out” arbetssätt? (1-5) *

Att ha ett ”inside-out” arbetssätt innebär att man förlitar sig på aktörer internt inom den egna verksamheten. Det klassiska exemplet är ”treasure-hunt” där tvärfunktionella team identifierar möjligheter till energieffektivisering.

Stämmer inte alls	1	2	3	4	5	Stämmer helt och hållet

Till vilken grad arbetas möjligheterna för energieffektivisering fram i ett ”outside-in” arbetssätt? (1-5) *

Att ha ett ”outside-in” arbetssätt innebär att man förlitar sig på externa aktörer för att identifiera möjligheter till energieffektivisering. Exempel på externa aktörer kan vara konsulter, energibolag, FM aktörer etc.

Stämmer inte alls	1	2	3	4	5	Stämmer helt och hållet

Ge gärna exempel på olika typer åtgärder som har lett till energieffektivisering och/eller reducerad energiförbrukning i er organisation

3. Att finansiera energieffektiviseringen

Till vilken grad används traditionell investeringsbedömning vid beslut av finansiering av åtgärder för energieffektivisering? (1-5) *

Med traditionell investeringsbedömning avseende både investering i utrustning och resurser används tex återbetalningstid, nuvärdesberäkning, IRR, ROI.

Ovan nämnd finansieringsmetod förekommer inte	1	2	3	4	5	Finansiering sker enbart med ovan nämnda finansieringsmetod

Till vilken grad används avsättning av medel vid beslut av finansiering för åtgärder av energieffektivisering? (1-5) *

Vid avsättning av medel avsätts en summa pengar för energieffektiviseringsåtgärder. Det kan utgöra en fast summa eller en procentandel av företagets årliga budget.

Ovan nämnd finansieringsmetod förekommer inte	1	2	3	4	5	Finansiering sker enbart med ovan nämnda finansieringsmetod

Till vilken grad används avsättning av intjänade medel vid finansiering för åtgärder av energieffektivisering? (1-5) *

Med avsättning av intjänade medel menas företag som avsätter den summa man tjänat in vid tidigare åtgärder för vidare effektiviseringar.

Ovan nämnd finansieringsmetod förekommer inte	1	2	3	4	5	Finansiering sker enbart med ovan nämnda finansieringsmetod

Till vilken grad används finansiering av extern part vid finansiering för åtgärder av energieffektivisering? (1-5) *

Finansiering av extern part kan vara finansiering från Energimyndigheten, EU, Energitjänsteföretag etc.

Ovan nämnd finansieringsmetod förekommer inte	1	2	3	4	5	Finansiering sker enbart med ovan nämnda finansieringsmetod

Övriga kommentarer

4. Att implementera energieffektivisering

Till vilken grad används tvärfunktionella team vid implementering av åtgärder för energieffektivisering? (1-5) *

Rollen för ett tvärfunktionellt team är huvudkontakt för företags energisystem. Teamet består oftast av ingenjörer kunniga inom de olika produktionsanläggningarnas energisystem. Teamet är ansvarigt för att identifiera energieffektiviseringsprojekt inom hela företaget och arbetar nära högsta ledningen.

Företagsövergripande team används inte alls	1	2	3	4	5	Företagsövergripande team används enbart

Till vilken grad används fabriksteam vid implementering av åtgärder för energieffektivisering? (1-5) *

Fabriksteam är lokaliserade till en produktionsanläggning. De är ansvariga för identifiering och implementering av åtgärder. Fabriksteam rapporterar till fabrikschefen. Dessa är oftast mycket kunniga inom den specifika produktionsprocessen.

Fabriksteam används inte alls	1	2	3	4	5	Fabriksteam används enbart

Hur integrerat är energi i ert arbete med ständiga förbättringar i processförbättringar?*

Inte alls integrerat	1	2	3	4	5	I högsta grad integrerat

Övriga kommentarer

5. Belöning till anställda

Det finns olika sätt att motivera individer, det kan finnas ekonomiska incitament för individen eller uppföljning av resultat för energieffektiviseringsåtgärder mm.

Finns något belöningssystem? Om det finns beskriv hur det ser ut. *

6. Uppföljning, benchmarking och rapportering

Uppföljning, benchmarking och rapportering till interna och externa parter är viktigt för att följa utvecklingen samt ett sätt att marknadsföra sina ansträngningar inom sustainability området.

Till vilken grad mäter och rapporterar ni er energianvändning på produktnivå? *

Inte alls	1	2	3	4	5	I högsta grad

Till vilken grad mäter och rapporterar ni er energianvändning på företagsnivå? *

Inte alls	1	2	3	4	5	I högsta grad

Till vilken grad använder ni bransch-gemensamma energiprestanda vid rapportering, utvärdering och benchmarking?*

Inte alls 1 2 3 4 5 I högsta grad

Rapporterar ni energiprestanda enbart internt? *
Ja
Nej

Om ja - Rapporterar ni energiprestanda både internt och externt? *
Ja
Nej

Övriga kommentarer

7. Försörjningskedjan
Till vilken grad involverar ni er i leverantörers energianvändning och effektivisering? (1-5) *
Det kan exempelvis vara i form av kompetensöverföring, direkta projektresurser etc.

Inte alls 1 2 3 4 5 I högsta grad

Till vilken grad involverar ni kunder i energianvändning och effektivisering? (1-5) *

Inte alls 1 2 3 4 5 I högsta grad

Till vilken grad använder ni mätmetoder och jämför leverantörer för att påverka? (1-5) *
Det skulle kunna vara en parameter vid upphandling eller kvalitetsuppföljning

Inte alls 1 2 3 4 5 I högsta grad

Kräver ni tredjepartscertifiering av era leverantörer för att säkerställa era krav på leverantörens energiledning? (1-5) *

Aldrig 1 2 3 4 5 Alltid

Övriga kommentarer

8. Övrigt
Övriga kommentarer och synpunkter

Appendix 2

Interview guide - Paper 2

NR.	CATEGORY	POSSIBLE QUESTIONS	Code
0.	INTRODUCTORY QUESTIONS	-- directed to each interviewee individually – (Energy intensity- closeness to customers)	
1.	Motivation	What are the motivators for energy efficiency investments? Does your company have a vision for energy efficiency? Is energy efficiency part of companies strategy?	1.1 1.2 1.3
2.	Goal-Setting	How are the goal for energy-efficiency set? How do the goals transfer to the lower/higher levels in the organisation? Would increasing employees knowledge and developing their competence lead to more bottom-up approach? How? Can you as an expert help the company setting the goals?	2.1 2.2 2.3 2.4
3.	Identification	How does energy efficiency projects get initiated in your company? How are the energy efficiency projects evaluated? (any difference to other projects?) Would increasing employees knowledge and developing their competence lead to more inside-out approach? How? How can you as an expert help the company identify energy efficiency opportunities?	3.1 3.2 3.3 3.4
4.	Financing	What is the time horizon for energy efficiency investments and returns? How are the energy efficiency projects funded? How would increasing employees knowledge and competence affect this? How can you as an expert help the company regarding financing?	4.1 4.2 4.3 4.4
5.	Implementation	To what extend is energy efficiency integrated in your improvement processes? What are the main challenges/ barriers to implement energy efficiency projects? How are they addressed in the company? Are cross-functional teams used for implementing energy-efficiency projects? To what extend (1-5)? Are production people/ operators involved in implementing energy-efficiency projects? How and to what extend (1-5)? What are the drive forces for energy efficiency projects? How do you get employees motivated into energy efficiency goals and strategies?	5.1 5.2 5.3 5.4 5.5

		How can employees be more involved and motivated in implementing energy efficiency goals?	5.6
		How would increasing employees knowledge and competence lead to a better implementation?	5.7
		How can knowledge of corporate strategy goals regarding energy efficiency affect the implementation process?	5.8
		How can you as an expert help the company implementing energy effect goals and strategies?	5.9
6.	Measurement/ Reporting/ Benchmarking	Do you measure and report the energy-use on product level?	6.1
		Do you measure and report the energy-use on factory level?	6.2
		Who is energy-related issues reported to?	6.3
		How is energy-related issues reported ?	6.4
		Is energy being measured and reported in a same way in different branches?	6.5
		Are the employees trained on how to measure, report and use measured items?	6.6
		How would training employees lead to better measurement and reporting process?	6.7
		How can you as an expert help the company in measuring and reporting energy issues?	6.8
7.	Supply chain	Are the suppliers involved in the energy-efficiency improvement projects? To what extend (1-5)?	7.1
		Are customers involved in the energy-efficiency improvement projects? To what extend (1-5)?	7.2
		Do you use metrics and compare vendors to operate on ? to what extend (1-5)?	7.3
		Do you require third-party certification of your suppliers to ensure calm your supplier's energy management ?	7.4
		Would training employees lead to a more energy efficient supply chain? HOW	7.5
		How can you as an expert help the company have a more energy efficient supply chain?	7.6

Appendix 3

Interview guide - Paper 4

TEMA 1: BAKGRUND FÖRETAG OCH INTERVJUPERSON
1.1. Namn, roll på företaget, anställd hur länge, utbildning, ålder, tidigare arbeten? Företagets verksamhet? Ålder och storlek på företaget?
1.2. Varför gick du kursen? Vems initiativ?

TEMA 2: PERSONLIG PÅVERKAN AV KURSEN
2.1. Engagemang – personliga emotionella reaktioner. Berätta om hur du personligen har blivit berörd.

TEMA 3: KUNSKAPER OCH LÄRDOMAR
3.1. Hur hanterar informanten kunskapen om klimathotet? Hur använder informanten kunskap, insikter, verktyg från kursen?
3.2. Vad tyckte du att du redan kunde sedan tidigare?
3.3. Stäm av läromål – uppnåddes de?

TEMA 4: EFFEKTER AV KURSEN PÅ FÖRETAGET
4.1. Ökade kursen informantens möjligheter att påverka sin organisation i riktning mot ett ”Lean Energy”---arbetssätt? Vilka möjligheter har informanten att själv påverka? På vilket sätt? Vad skulle informanten behöva utöver det hon/han fick från kursen för att kunna påverka?
4.2. Tillhör informanten målgruppen för kursen? Tycker han/hon att hen var rätt person att gå den eller skulle någon annan inom organisationen ha gått den i stället?
4.3. Finns ledningens stöd att genomföra förändringar enligt LE?
4.4. Finns andra inom organisationen som har anammat lärdomarna? Vilka? På vilket sätt?
4.5. Hur ser man på sparpotentialen i företaget? Hur har kursen påverkat dig i detta?
4.6. Identifierad sparpotential och Förverkligad sparpotential? Sparade kWh?

TEMA 5: HEMUPPGIFTENS RELEVANS
5.1. Berätta om hemuppgiften. Har informanten gått vidare med att genomföra resultatet från hemuppgiften? Fick informanten tillräcklig handledning när hen genomförde hemuppgiften?

TEMA 6: HINDER OCH DRIVKRAFTER FÖR FÖRÄNDRING
6.1. Om man inte kan införa förändringarna, vilka är de huvudsakliga hindren?
6.2. Vilka är de största drivkrafterna som stöttar förändring?

TEMA 7: UTVÄRDERING KURSEN
7.1. Det bästa med kursen?

7.2. Det sämsta med kursen?
7.3. Stämde överens med förväntningar?
7.4. Vilka nya frågor har kursen gett upphov till? På vilket sätt? Hur tar man itu med dessa frågor?
7.5. Finns det något i kursen som absolut inte bör förändras?
7.6. Under hur lång tid hade de nytta av insikter från kursen?

TEMA 8: AVSLUTANDE FRÅGOR
8.1. Fick du någon reflektion när du fyllde i enkäten?
8.2. Blev du inspirerad att jobba med något specifikt när du såg enkätfrågorna?