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Naghmeh Taghavi

Division of Service Management & Logistics, Chalmers University of Technology, Gothenburg, Sweden

ABSTRACT

This article describes a practice-based framework for analysing how development efforts to improve energy efficiency in operations interact with corporate-level strategies for sustainability, as well as operations strategies, and whether they in fact improve energy efficiency in operations at the various organisational levels of the company. To develop the framework, a qualitative study following a multiple interview approach was conducted. Based on an analysis of such efforts at three companies, this article suggests that improving energy efficiency in operations is a dynamic process and involves interactions between the competing logics of actors. The findings reveal that development efforts to improve energy efficiency in operations, though varying in origin, can usually be attributed to the motivations of the actors initiating them. Therefore, this article 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, by engaging 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.

KEYWORDS

Improving energy efficiency; operations strategy; practice-based study; sustainability as practice; sustainable operations management

Introduction

In recent decades, due to tremendous political, technological, economic, and societal changes brought about by recognising the challenges of sustainable development, companies in the manufacturing and processing industries have integrated objectives for sustainability into their corporate strategies. In turn, a great deal of research has leveraged strategic management theories to explain the phenomenon (Engert, Rauter, and Baumgartner 2016). Integrating sustainability into strategic management has offered an approach for confronting environmental and social challenges, one that involves formulating and implementing sustainability-oriented strategies. However, despite the clear emphasis on sustainability-oriented objectives in corporate-level strategies, that is sustainability-oriented strategy formulation, a gap remains in knowledge about the real-world implementation and actualisation of sustainability-oriented strategies in practice (Engert, Rauter, and Baumgartner 2016). As shown in the literature, research to date has chiefly produced theoretical models focusing on factors of the successful top-down implementation of such strategies (Engert, Rauter, and Baumgartner 2016) and assumed that sustainability-oriented strategies are developed and pursued in a planned, deliberate way (Neugebauer, Figge, and Hahn 2016; Luederitz et al. 2021). According to Kiesnere and Baumgartner (2019), companies nevertheless struggle to advance from top-down sustainability management activities towards more inclusive approaches (i.e., involving different organisational units) for achieving sustainability-oriented objectives. While such companies have recognised the need 'to know how to approach the barriers to actions against climate change, and how solutions get implemented' (Accenture Strategy and United Nations Global Compact, 2019), studies to date have failed to address that need (Lopes de Sousa Jabbour et al. 2020). Furthermore, the current body of knowledge lacks an empirical understanding of implementing sustainability-oriented strategies in general (Klettner, Clarke, and Boersma 2014) and in companies' operations in particular (Hong et al. 2019). Consequently, companies still struggle to actualise sustainability for core organisational activities (Brandi and Thomassen 2020), and, as a result, 'a significant gap remains between corporate sustainability aspirations and action' (Corbett, Webster, and Jenkin 2018, 262).

The non-actualisation of sustainability-oriented strategies at the different organisational levels of companies, especially ones seeking to better contribute to achieving sustainability-oriented objectives (Kiesnere and Baumgartner 2019), requires research on 'the processes of sustainability in a practice context that includes a more holistic and integrative approach' (Brandi and Thomassen 2020, 213). At the same time, though the literature recognises sustainability's impact on companies' performance and on factors of sustainability emanating from institutional

CONTACT Naghmeh Taghavi naghmeh.taghavi@chalmers.se Division of Service Management & Logistics, Chalmers University of Technology, Gothenburg 41296, Sweden

and organisational levels, that is, sustainability-as-performance (Wesselink 2015), it needs to shift towards approaches that view sustainability-as-practice (Silva and Figueiredo 2017) and focus on how practitioners perform their daily activities. To close those gaps in the literature, as Silva and Figueiredo (2020) have proposed, researchers can apply the findings of problem-driven studies (e.g., Wickert 2021) on the phenomenon of sustainability-as-practice using practice-based theories. Doing so would also respond to Williams and Whiteman's (2021) call for academic research on sustainability that focuses on ways of impacting practice instead of developing new theories. To that purpose, approaches for exploratory qualitative propositional research are needed, especially ones that can address the untapped dimensions of sustainability and inform analysis and interpretations (Touboulic 2015). For example, Elkington (2018) has proposed abandoning the triple-bottom-line perspective (Elkington 2018) in favour of an interorganisational perspective that prioritises meeting sustainable development goals in small, micro, and/or local practices as a means to mitigate challenges of sustainable development (Touboulic, Matthews, and Marques 2018; Silva and Figueiredo 2020).

The applicability of a sustainability-as-practice approach in relation to this article's focus is twofold. On the one hand, the article focuses on improving energy efficiency in operations as a sustainability-oriented strategy for companies and as a means to cultivate an interorganisational focus on the challenges of sustainable development. As an environmental practice, energy management, known to be a determining factor of managers' environmental sustainability concerns (Yacob, Wong, and Khor 2019), has long received attention in operations, particularly in relation to reducing the consumption of resources in operations processes (Koh et al. 2016). Therefore, with reference to Directive 2012/27/EU on energy efficiency, improving the energy efficiency of operations can contribute to meeting Sustainable Development Goal 7 (i.e., affordable, clean energy) as well as Sustainable Development Goal 12 (i.e., responsible consumption and production) (Directive 2012/27/EU on energy efficiency). Thus, focusing on improving the energy efficiency of operations can support interorganisational attention towards facing the challenges of sustainable development, because the achievement of each goal is in itself the partial achievement of sustainability (Silva and Figueiredo 2020). However, even if energy efficiency is embraced as a legitimate sustainability-oriented objective, it needs to be studied in relation to other sustainability-oriented corporate-level strategies, as well as operations strategies, to identify how operations can be convinced to pursue its actualisation.

On the other hand, when energy is conceived as a unit of resource consumption, the energy efficiency of operations can be improved as a result of not only operations decisions regarding core operations processes (e.g., production) and/or support processes (e.g., lighting and heating) but also strategic actions and decisions related to resource allocation, including about investment (Schulze et al. 2016). Therefore, improving energy efficiency in operations is a continual process that embraces human resources and material elements (Schatzki 2012) and is exposed to unique horizontal and vertical intraorganizational influences. In that light, improving energy efficiency in operations can be understood not only as a process involving a set of activities intended to achieve a company's sustainability-oriented objective (i.e., development efforts) but also as a context for sustainability-as-practice that engage different actors in contributing to continual improvement.

Along those lines, the purpose of this article is to provide a practice-based framework for analysing 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 organisational levels of the company. Following a qualitative, multiple-interview approach, the study presented here was conducted to develop an understanding of real-life events from the viewpoints of key actors. It thus sought to answer the following research question: how do development efforts improve energy efficiency in operations at the various organisational levels? To answer that question, the study 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' (Schatzki 2012) 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 study'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, 318). In turn, the study has answered the call for cross-level research that links individual behaviour and internal processes with sustainability as an organisational-level phenomenon (Williams et al. 2021). The study also facilitated a description of the process of improving energy efficiency in operations by providing guidelines on where and how to identify the activities of individuals involved in development efforts for sustainability-oriented processes and operations strategy. Applying theories of practice as a theoretical lens, the article offers empirical evidence and an in-depth

description of how different actors understand the practical process of improving energy efficiency in operations, as expressed in their activities, and how the activities involved are ordered (Schatzki 2012).

Based on an analysis of such efforts at three companies, this article suggests that improving energy efficiency in operations is a dynamic process and involves interactions between the competing logics of actors who are officially accountable for or personally interested in improving energy efficiency at their companies. The findings reveal that development 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. Top management considers improving energy efficiency in operations to be the ad hoc responsibility of a centralised support function, developed explicitly in light of corporate-level sustainability-oriented objectives, as a means to reduce costs by following a top-down approach. By contrast, operations employees consider development efforts to improve energy efficiency in operations to include initiatives integrated into daily operational improvements, alongside other operations performance objectives. Although those development efforts are differentiated from sustainability-oriented objectives and do not derive from the formulated corporate-level sustainability-oriented strategy, they can ultimately influence it. Organizational structure and managerial intentions (e.g., accountability arrangements and capital investment decision-making) can not only promote the successful deployment of development efforts to improve energy efficiency in operations but also ensure practices of sustainability by enabling a dynamic, participatory process in which improvement is continually achieved. In view of those results, this article argues that one way of practicing sustainability is by improving the energy efficiency of operations as the result of a dynamic, participatory process exposed to the influences of horizontal and vertical inter- and intraorganizational units.

Theoretical background

The strategy process: strategic intentions and beyond

Scholars have characterised operations strategy as a vehicle capable of aligning a company's operations resources with its external environment (Slack and Lewis 2011), typically by prioritising the achievement of operations objectives that represent corporate-level objectives and strategic intent (McCardle, Rousseau, and Krumwiede 2019) and by assuring internal consistency in strategic decisions and practices in operations (Szasz and Demeter 2014). From that perspective, a useful way to study the actualisation of sustainability-oriented objectives is to examine the integration of sustainability-oriented strategies into operations strategies, in an effort to create internal and external consistency as proposed by Skinner (1969). Yet, instead of the traditional division of operations strategy dimensions into competitive priorities and decision categories, the division of operations strategy content focusing on organisational levels proposed by Edh Mirzaei, Fredriksson, and Winroth (2016) allows better addressing the strategic role of operations. According to Edh Mirzaei, Fredriksson, and Winroth (2016), performance objectives for operations strategy can be structured at the intraorganizational group level (i.e., quality, information and process technology) that operations employees have daily contact with, the interorganisational group level (i.e., delivery and flexibility) that relate to suppliers and customers but remain connected to operations employees' work environment, and the intraorganizational level above the group level (i.e., cost, human resource systems, and organisational aspects) that affect strategic decisions. While examination of trade-offs and synergies of operations strategies and decisions across multiple dimensions of value related to the challenges of sustainable development has been studied, more practical research is needed to help managers to overcome trade-offs (Samson and Kalchschmidt 2019).

The literature on strategy, including corporate sustainability-oriented strategy and operations strategy, agrees that strategies are developed as a blend of planned and emergent strategies (Neugebauer, Figge, and Hahn 2016) that is constantly shifting and involves activities distributed among multiple practitioners (Jarzabkowski, Dowell, and Berchicci 2021). Even so, studies have most often been concerned with deliberate sustainability-oriented strategies (Neugebauer, Figge, and Hahn 2016) pursued by top management. Although some studies have examined the actualisation of sustainability-oriented strategies (e.g., Egels-Zandén and Rosén 2015; Linneberg, Madsen, and Nielsen 2019), the lack of focus on the practitioners who carry strategies out has created another gap in the literature, one in which the emergent aspects of sustainability-oriented strategies are rarely considered. For decades, research has likewise taken a top-down perspective, one assuming that action plans result directly from operations emphasising for competitive priorities derived from business strategies and planned by top management (Kim, Sting, and Loch 2014) and that thus rely on normative conceptualisations (Kiridena, Hasan, and Kerr 2009; Adamides 2015). In particular, research on operations strategy has conceptualised the relationship between strategic decision-making and operations resources as unilateral (Edh Mirzaei, Fredriksson, and Winroth 2016). More recently, researchers in the field have adopted

a relatively dynamic view on strategy formation, one that focuses on people, practices, and dynamics within them instead of the mentioned 'formulate-then-implement' paradigm (Kim, Sting, and Loch 2014; Edh Mirzaei, Fredriksson, and Winroth 2016). Nevertheless, few have sought to provide more holistic, alternative perspectives on the iterative strategy formation process (e.g., Kiridena, Hasan, and Kerr 2009; Kim, Sting, and Loch 2014; Adamides and Adamides 2015; Edh Mirzaei, Fredriksson, and Winroth 2016). In response, researchers have called for more studies on the strategic role of operations and its contributions to overall organisational effectiveness as a result of using sustainability as a resource while achieving economic profitability (Samson and Kalchschmidt 2019). Responding to that call requires eliminating the assumption that operations strategy is a response to corporate objectives communicated and integrated with other functional strategies to achieve strategic fit with corporate-level strategy (Hayes and Wheelwright 1984).

Integration of sustainability in operations

Sustainability has come to occupy a distinct position in operations management. Scholars have long emphasised the environmental challenges that companies face and examined how solutions to those challenges can be integrated into companies' corporate strategies (e.g., Bansal and Roth 2000; Sharma 2000; Albino, Balice, and Dangelico 2009). On top of that, researchers have also integrated principles of environmental management into decision-making processes about converting resources into products (e.g., Gupta and Sharma 1996; Angell and Klassen 1999). The literature regarding sustainability in operations management is, however, diverse in scope, ranging from the corporate level (e.g., Naor et al. 2015) to internal operations (e.g., Walker et al. 2014). It also encompasses work on internal practices such as product design and manufacturing processes (e.g., Abdul-Rashid et al. 2017), sustainable production and consumption (Roy and Singh 2017), and systems encapsulating entire supply chains (e.g., Koh et al. 2016). Adjacent literature also includes studies on sustainability in relation to supply chains (Fritz and Silva 2018) and end-of-life management in relation to recycling and materials recovery (e.g., Abdul-Rashid et al. 2017). The literature on corporations' strategic responses to climate change is similarly extensive (Paul, Lang, and Baumgartner 2017) and includes studies addressing the role of sustainability control tools to integrate sustainability into corporate strategies (Ligonie 2021). Yet, 'definitions of sustainability tend to be vague and often instrumental to the business-centric view of the interaction between organizations and the environment' (Jarzabkowski, Dowell, and Berchicci 2021, 229).

To date, research on sustainability in operations in particular has primarily focused on the relationship between environmental management and operations strategy (e.g., Rusinko 2007), the impact of sustainability management on companies' performance (e.g., Abdul-Rashid et al. 2017), or factors affecting or enhancing sustainability emanating from the institutional and organisational levels (Wesselink et al. 2015). In that particular context, operations strategy as a vehicle for translating corporate objectives and integrating competitive priorities, performance objectives, and action plans has described sustainability as a new phenomenon and even a new competitive priority (Gunasekaran and Spalanzani 2012). Of course, environmental protection has also long been regarded as a competitive priority as well as for operations capability (Angell and Klassen 1999; De Burgos Jiménez and Lorente 2001; Avella, Vazquez-Bustelo, and Fernandez 2011). Despite those inroads, the literature on the topic demonstrates a lack of knowledge about how sustainability manifests within organisations (Williams et al. 2021) and in their operations in particular (Hong et al. 2019). Building on Williams et al. (2021) to understand those who purposefully enact sustainability within organisations have enabled sustainability as occurring in the social-symbolic realm, this study contributes to a better understanding the sustainability work in the context of operations. Moreover, drawn from empirical data from the two hierarchal levels of top management and operations, this study elaborated on similarities and differences in 'sustainability work' of different 'sustainability agents' (Williams et al. 2021).

Sustainability as practice: improving energy efficiency in operations

The stream of research applying theories of practice has made practice-based approaches mainstream in literature on management and literature on sustainability (Silva and Figueiredo 2017). In the former, practice-based studies have been used 'for investigating and theorizing aspects of management and organizational practice in a more informed way, and, thus, provide more accurate accounts of the logic of practice' (Sandberg and Tsoukas 2015, 188). Research adopting practice-based approaches to examine various phenomena in which activities become ordered and explained around how the phenomena are understood (Sandberg and Dall'Alba 2009) can be found in the literature on strategy (e.g., Jarzabkowski et al. 2013) as well as the literature on organisational learning (e.g., Brandi and Thomassen 2020). Previous studies in operations management and operations strategy that have adopted practice-based approaches signal growing attention to operations strategy as a practice, as justified by its dynamic association with corporate and business strategy (Adamides and Adamides 2015).

Addressing sustainability, Egels-Zandén and Rosén (2015) have applied practice theory in light of literature on strategy as practice to examine how sustainability strategies should be formed in contrast to how they are formed in practice. As a result, they identified four types of strategic activities that contribute to sustainability strategies, with particular focus on micro-processes that constitute day-to day strategy making. More recently, Silva and Figueiredo (2020) have applied a practice-based approach to analyse empirical data and, for their part, identified five practices of sustainability along supply chains: cooperating, understanding, deeming, improving, and changing the logic. In another study, Ligonie (2021) offers a practice-based perspective showing how actors have enacted sustainability control tools through reassembling, expanding or rippling. In other work, Figueiredo et al. (2020) applied a practice-based approach in the context of organisational learning to analyse change towards sustainable consumption in the workplace, while Brandi and Thomassen (2020) have outlined a conceptual model for organisational learning and corporate entrepreneurship that promote sustainability practices within organisations.

As mentioned in the introduction, whereas the triple-bottom-line perspective makes putting the concept of sustainability into action difficult, practice-based approaches focusing on the accomplishment of goals can afford a more concrete view on ways to practice sustainability and allow an orientation towards actions able to contribute to the sustainability performance of organisations (Silva and Figueiredo 2021) and enable sustainability. Given all of the energy used in the manufacturing and processing industries, chiefly the use of electricity and biofuels, to run operations processes, improving energy efficiency is a crucial step in the transition towards sustainable development in operations. However, the chief targets of the literature on energy efficiency in operations have thus far been innovations and technology, especially information and communication technology, that can reduce energy as a resource used in operations processes (Koh et al. 2016) or help to identify new sources of energy in order to reduce the carbon footprint of operations (Garetti and Taisch 2012). More specifically, research on energy management in production has often pinpointed energy efficiency as a key criterion in strategic decision-making about sourcing and location (Rudberg, Waldemarsson, and Lidestam 2013) and in considering energy efficiency in production planning and control to optimise operations processes (May et al. 2017). Barriers to and drivers of the adoption of energy management practice have also been investigated (Brunke, Johansson, and Thollander 2014; Johansson and Thollander 2018), while other streams of literature have focused on technical and technological approaches to improving energy efficiency in production (Anderson and Newell 2004; Thollander, Danestig, and Rohdin 2007). Notwithstanding the contribution of previous research and the importance of technological solutions and equipment that promote eco-efficiency, the large, untapped potential for further improving energy efficiency (Schulze et al. 2016) calls for more studies on the process of improving energy efficiency in operations. That process entails various actors who execute various actions linked in certain ways over time, all of which influence and are influenced by sustainability-oriented and operations strategies in the company. Therefore, studying the process of improving energy efficiency in operations according to the 'doings and sayings' (Schatzki 2012) in operations, particularly the activities and interactions that occur therein, complements the nature of practice as a recurring pattern of actions that collectively create a nexus among practitioners and can contribute to practice-based studies.

Method

The study aimed to empirically investigate how development 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 organisational levels of the company. To facilitate a profound understanding of the real-world problem under study, the research entailed the in-depth analysis of empirical data following the methodology of qualitative multiple interview study (Flick 2018). That method was deemed applicable because knowledge and experiences are important factors for understanding and describing the big picture of how companies translate strategic objectives for improving energy efficiency into practice in their operations, principally by engaging in the process of improving energy efficiency. The method was also deemed applicable because it can allow understanding how the practice of improving energy efficiency within operations informs companies' strategies (Flick 2018). *Improving energy efficiency*, as defined according to European Union directives, refers to an increase in energy efficiency as a construct as a result of technological, behavioural, and/or economic changes. Therefore, for the study's purpose, development efforts to improve energy efficiency in operations, as illustrated by decisions and actions as well as the mentioned 'doings and sayings', were chosen as empirically observable entities.

Sampling

The phenomenon under study is an emerging, arguably nascent, one in which best practices remain unknown. For that reason, semi-structured interviews

Table 1. Characteristics of the sampled companies.

	Alpha	Beta	Gamma
Number of employees worldwide	26,000	12,900	105,000
Revenue in 2020	EUR 8.553 million	EUR 213 million	EUR 33.956 million
Industry	Processing	Manufacturing	Manufacturing
Products of plants whose employees were interviewed	Renewable materials	Water infrastructure, pumps, and mixers	Automotive

and site visits were considered to be most relevant methods of data collection, because they allow greater proximity than surveys to the practices being investigated. Moreover, to allow a breadth of data according to replication logic (Edmondson and McManus 2007), three companies were studied. In total, 14 individuals considered to be key players in the process of improving energy efficiency in operations at their companies were interviewed. The sampling of companies was purposive and selective (Bryman and Bell 2015) and set a high level of experience in improving energy efficiency as an inclusion criterion. Such relevance was ensured in sampling by selecting companies that both claimed to actively work towards improving energy efficiency in systematic ways and had a record of doing so, such that they can be regarded as highly experienced organisations when it comes to improving energy efficiency. Moreover, to guarantee comparability, provide different contexts, and allow a deeper examination of the phenomenon under study, sampling targeted both the manufacturing and processing industries (Flick 2018). Table 1 summarises the characteristics of the sampled companies, which were given the pseudonyms 'Alpha', 'Beta', and 'Gamma' for the purpose of anonymity.

Data collection

Data collection proceeded in three phases and involved a combination of different methods (Eisenhardt and Graebner 2007), including the collection of documents from companies, semi-structured interviews, and participant observations during field studies. In the first phase of data collection, informal dialogues with key informants at the companies were pursued as to test the research design. As part of the process of obtaining their consent to participate, those individuals were given information about the study's aims and told which topics would be discussed. Next, to ensure the validity of data collection, a study protocol (see Appendix 1) and an initial interview guide were developed (see Appendix 2) as proposed by Eisenhardt (1989). The protocol outlined the topics to be covered during interviews, stated the questions to be asked, and indicated the specific data required in the form of secondary evidence. Key informants were asked to identify the individuals within their companies who are most relevant to improving energy efficiency in operations at different organisational levels – that is, individuals whom Froschauer and Lueger (2009) call 'expert interviewees'. Thereafter, every effort was made to host interviews with at least one individual believed to have knowledge about improving energy efficiency in operations at each organisational level (i.e., top management and operations).

Using the study protocol, the second phase of data collection consisted of in-depth, face-to-face semi-structured interviews with people identified as key players in improving energy efficiency in operations, followed by site visits to the plants where they worked. The site visits were used to conduct participant observations in order to gather insights and data for analysis. For example, observations were performed on how energy efficiency targets are visualised at the plant level within the companies. In that way, the data from observations can be thought to specifically capture the actualisation of development efforts in everyday work and were used as such to interpret the activities of the companies in shaping practices based on the observed doings and sayings.

In keeping with the standards of qualitative research (Barratt, Choi, and Li 2011), notes taken during the site visits and interviews were considered to be the primary source of evidence. Each interview lasted 1 to 3 hours and was audio-recorded and transcribed with permission from the interviewee, after which the field notes and interviews were summarised in the form of detailed case narratives. Additional data were collected from the companies' websites, archival materials, annual reports, formalised strategies, and, when available, meeting notes. Collecting data from different sources ensured the triangulation of the empirical data. Table 2 presents the requirements for data collection based on the study protocol as well as data gathered from each company during the study.

Data coding and analysis

Achieving the study's purpose called for an in-depth understanding of development efforts to improve energy efficiency in operations, both as induced by top management and as emergent among operations employees. To that purpose, the unit of analysis was development efforts in form of doings and sayings as well as decisions and actions that lead to improved energy efficiency in operations, all derived from technical, behavioural, or economic changes.

The first cycle of coding the data involved initial coding through examining each case as a stand-alone entity (Eisenhardt 1989). Field notes and transcripts were

Table 2. Requirements for data collection based on the study protocol and data gathered from each company.

Required data		Accessed data		
Interview	Interviewee's role	Alpha	Beta	Gamma
	Person responsible at the strategic level for improving energy efficiency	Two interviews	One interview	One interview
	Person responsible at the operations level for improving energy efficiency	Five interviews, including one with an operations manager and another with an operator	Three interviews, including one with an operations manager	Two interviews
Additional information	Business strategy	Yes	Yes	Yes
	Sustainability and environmental strategy	Yes	Yes	Yes
	Annual reports on sustainability	Yes	Yes	Yes
	Operations strategy	Not applicable	Yes	No
Secondary data	Other internal and external reports or documents	Yes	Yes	Yes
	Website and publicly available data	Yes	Yes	Yes
Site visits		Yes	Yes	Yes

used primarily in the initial analysis, and the data were processed from the ground up, as proposed by Yin (2009). The data were coded according to a priori codes focused on the strategy process in a bid to understand development efforts geared towards improving energy efficiency in operations in relation to sustainability-oriented corporate-level strategy and operations strategy. To that end, the subdimensions examined were taken from the process model of operations strategy (Kim, Sting, and Loch 2014). During the initial coding, particular attention was paid to individual perceptions of the process of improving energy efficiency in operations, efforts to develop such processes, the underlying reasoning for their initiation, and the association of the efforts with operations strategy and corporate-level sustainability-oriented strategy.

In a second cycle of coding, 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 efforts through axial coding (Ellram and Tate 2015). By going back and forth between the data and the literature, organisation-specific characteristics were found to have the potential to affect development efforts. To investigate that dynamic, two subdimensions were used to understand organisational structure: accountability for improving the energy efficiency of operations, categorised as centralised or decentralised regarding the decision-making authority across the organisational level (Siggelkow and Levinthal 2003), and the capital investment decision-making structure for improving energy efficiency in operations.

Thereafter, two predefined organisational hierarchal-level of top management and operations employees were used in the thematic coding of the data (Flick 2018) from interviews and from other internal company documents provided by the respondents, which were grouped according to the interviewees' places within the company hierarchy – that is, as top management or operations employees. To understand the nature of development efforts at the companies, such efforts induced by top management or initiated by operations employees were revisited to compare 'specific ways of seeing and experiencing' (Flick 2018, 318). That grouping allowed the comparison of different ways of perceiving and experiencing the same process of improving energy efficiency. Of particular interest was finding similar and different perceptions and understandings between the two groups. More specifically, the alignment and misalignment of perceptions and understandings between the two organisational levels were noted to analyse how the development effort has been treated in each case. The various data sources were used to form a holistic picture of the dynamics in the process of improving energy efficiency in operations. For example, some observations from the site visits and presentation materials provided by interviewees afforded insights for mapping some approaches to implementing development efforts. 'Power quotes' (Pratt 2008) were continually used to maintain the chain of evidence.

Research quality

To maintain the trustworthiness of the study and due to the subjective nature of the research, aspects of credibility, dependability, confirmability, and transferability were assessed (Miles et al. 2020). To ensure the credibility of the findings, a chain of evidence was kept

throughout the iterations of coding and data analysis through 'power quotes' (Pratt 2008). Moreover, to prevent single-coder bias (Seuring, Gold, and Wilding 2012), key informants were asked to review and validate the case narratives and ensure that the realities purported were accurate. Meanwhile, dependability was ensured by developing a study protocol and interview guide with reference to the literature. A study database and a complete chain of evidence were also developed throughout the study to assure the consistency of the results over time. To ensure confirmability, the findings of the investigations were verified during presentations, discussions, and seminars with both academics and practitioners. Those efforts were accompanied by a comparison of the empirical data with the literature in order to confirm or disprove the findings in relation to past results. Furthermore, multiple sources of evidence were used to reduce the risk of bias in the results. Last, the transferability of the study was achieved by collecting data from multiple respondents whenever possible, which also ensured the richness of detail in the empirical data.

Results

Company descriptions

This section presents the three studied companies as stand-alone entities. The company descriptions emphasise the companies' objectives for improving energy efficiency as derived from their business strategies, as well as how energy efficiency is practiced at the companies via efforts to promote sustainable development induced by top management. The descriptions are followed by explanations of the motivations of such efforts as revealed by operations employees. Table 3 presents the findings regarding the organisational structures for improving energy efficiency at the companies.

Alpha

The sustainability agenda at Alpha is captured in the company's vision: 'Do good for people and the planet'. Beyond that, one of the messages communicated by the company's image is 'Everything that's made with fossil-based materials today can be made from a tree tomorrow', which expresses the importance of sustainability, according to one of the interviewees. Sustainability is embedded in the company's strategy as part of a group-level sustainability-oriented strategy incorporated into the business strategy. The company's overall approach and its governance model are also described in a group-level sustainability policy. Detailed guidelines on specific topics are elaborated in the company's code of conduct, which according to the company functions as 'a tool to make the right decisions in your work while promoting transparency, ethics, and sustainability'. In the code of conduct, energy efficiency is even implied as an overall abstract goal. Speaking on behalf of the company, one of the plant's quality managers stated, 'We want to be world-class in our line of business, which means that we want to reach a world-class level in energy efficiency'.

In 2005, top management at Alpha decided to join the voluntary, 5-year Swedish Programme for Improving Energy Efficiency in Energy-Intensive Industries (PFE). As a participant, the company was required to conduct an energy audit, implement an energy management system and have it certified, and identify energy-saving measures. In return, it has been exempted from the European Union's minimum tax on electricity. To fulfill the PFE's requirements, the company set a group-wide target to reduce specific electricity and heat consumption per ton of produced product by 15% from 2010 to 2020. The group-level manager of energy efficiency stated that Alpha 'sets targets primarily based on a top-down perspective, and objectives are based on industry performance and inspiration from other companies'. However, the business development manager, working on the global business excellence team, had detected some advantages and disadvantages of that arrangement:

> There are gaps between the levels of the company. We have a top-down target, which has weak roots down to the plant level, where the idea is to make it a reality. But there are good drivers at the plants and, in some cases, good bottom-up objectives that support the target.

Alpha has a decentralised, specialised energy service team managed by the group-level manager of energy efficiency. The interviewees at the operations level,

Table 3. Organisational structures for improving energy efficiency.

	Alpha	Beta	Gamma
Actor in top management who is accountable for improving energy efficiency	Centralised sustainability management team	Centralised integrated environmental health and safety department	Centralised sustainability management team and a global director of energy management
Actor in plant operations who is accountable for improving energy efficiency	Cross-functional team belonging to the decentralised specialised energy service team	Plant-level worker in the operations facility department responsible for energy	Energy *kaizen* facilitator who reports to the global director of energy management
Capital investment decision-making structure for improving energy efficiency	Specific fund for improving energy efficiency by 20 million SEK per year	Simple payback competition	Saving monetary gains from previous improvement projects

who were considered to be the most relevant players in improving energy efficiency, all belonged to the specialised energy service team and were working to improve energy efficiency due to their personal interest in the effort. For example, the operator described acting as a part-time 'local change leader' in her daily work. When asked about her motivation to assist with improving energy efficiency, she replied, 'My daughter has to have a future'.

Beta

Beta's vision is to devote its technology, time, and talent to advancing the smarter use of water. Likewise, the company's mission is simply 'To solve water', the underlying argument of which responds to the global shortage of clean, safe water. The company believes that being in the water technology business adds to the urgency of thinking about sustainability. As the environment and safety manager put it, 'The need to include sustainability on the agenda used to derive from the bottom, but now it comes more from the top'.

Beta claims that its products serve a sustainability purpose simply by performing their functions as part of the water cycle. Despite that primary motivation, the company has also sought to develop energy-efficient products that afford long-term use and come with aftermarket services – repairs and updates, for instance – to extend their lifespans even further. The company reports its sustainability performance every year and has been listed in the Dow Jones Sustainability Indices, meaning that it follows a best-in-class approach in numerous sustainability metrics. The company also observes an integrated quality-and-sustainability policy, formalised in a document, that contains the organisation's interpretation of its core values regarding sustainability: respect for the environment, respect for internationally proclaimed human rights and working conditions, responsibility for how its activities influence people and the environment, integrity in acting ethically and according to the company's code of conduct, and creativity in developing innovative energy- and water-efficient solutions that contribute to sustainable development. By explaining the content and benefits of the goals and visualising individual contributions, the policy also aims to ensure that everyone at Beta shares an understanding of the sustainability goals and strategies.

At Beta, the top management's goal related to improving energy efficiency is a 15% reduction in annual energy costs as calculated in energy audits. However, the plant-level worker in the operations facility department responsible for energy did not express the same goal when asked. Instead, he believed that the goals were set at the group level by a sustainability manager without the involvement of operations personnel. Thus, actors who set the goals have no idea about the potential for improving energy efficiency at each level. Instead, an energy management system has been implemented to make decisions about new production processes or investments in new machinery. Financial aspects, however, remain the principal criteria for making any decisions regarding the improvement of energy efficiency, unless the effects harm people. All told, top management is involved in improving energy efficiency by making important decisions about significant investments, not about operations.

Beta has a documented operations strategy. Therein, the top drivers are the depletion of the water supply, tightened regulations, ageing infrastructure, an increased need to reuse water infrastructure, population growth, urbanisation, sustainability, and energy efficiency in water-intensive applications. The plant-level worker in the operations facility department responsible for energy reported having a background in teaching energy courses at the high-school level. His personal motivation for working to improve the company's energy efficiency is the massive potential for such improvement at Beta. At the same time, he admitted that the current level of personal interest in and awareness of energy efficiency as well as environmental sustainability is greater among employees compared with before:

> Compared with 10 to 15 years ago, 80 to 90% of people [at Beta] are already aware of greenhouse gas effects. It's a completely different working environment with energy-efficiency improvements today than it was in 2003, when I started in this position.

Gamma

As the first automotive manufacturer in the world approved by the World Wide Fund for Nature (WWF), Gamma is committed to taking action to combat climate change. However, according to the plant energy coordinator at the company,

> WWF, as a trademark, was a motive for top management: only a logo for the brand that didn't spur any engagement in production. … It's far removed from production. They talk about it to the new employees, but that's it. Then, people perform their tasks in a completely different way but don't see any sign of WWF in the factory. It only creates a good image for the company.

At Gamma, the driver of change for improving energy efficiency has been cost, as communicated to the company as: 'We make savings, but we also do good things for the environment'. In 2004, an ambitious strategic goal for improving energy efficiency was set by the

global energy manager, who targeted a 50% reduction in energy use per produced unit. Later, in 2009, the company became a climate saver based on its collaboration with the WWF, which further intensified the corporate goals, namely to reduce energy use by 20% of megawatt hours by 2020. Although that goal was relayed to operations as 'how much each unit of production should cost in energy' and monitored at the plant level, operations employees did not realise that it was a goal in their work and, in turn, did not know how they could have affected its achievement. According to the plant energy coordinator, plant personnel count only total energy consumption, including energy used directly in operations processes or used indirectly by buildings, as well as energy used to test drive vehicles. However, because they divide that number by the total of finished products, the relative measure means that increased production can falsely indicate efficient energy usage. Moreover, lower or higher levels of energy used do not always imply improved energy efficiency, because factors such as weather and operations rate (e.g., operators' decisions, lack of materials, and lower production during some shifts) can give misleading results. An example of a practice for improving energy efficiency induced by top management at Gamma was the creation of a competition between the company's plants for most energy efficiency based on a certain key performance indicator (KPI). However, the competition was later cast aside as a failure, for the KPI was affected by the temperature of the climate, the difference in the type of products made, the variety of running shifts in plants, and cultural differences. After the competition, according to interviewees at the operations level, the plants thus felt as though they had been played with by top management.

According to the plant energy coordinator at Gamma's operations, the improvement of energy efficiency is either driven by the maintenance manager or is an ad hoc responsibility of the environmental department. In particular, the maintenance manager drives the improvement of energy efficiency, which affects the company's processing equipment and energy utilisation in manufacturing.

Organisational structure for improving energy efficiency

To investigate the potential of organisational structure to affect the process of improving energy efficiency, two subdimensions were used to understand organisational structure: accountability for improving energy efficiency and the capital investment decision-making structure for improving energy efficiency.

Alpha, Beta, and Gamma have all reconfigured their organisational structures to make room for sustainability accountability at the level of top management. Alpha and Gamma position sustainability as a centralised department, whereas Beta has a centralised, integrated environmental, health, and safety department. Interviewees indicated that at the level of top management, improving the energy efficiency of operations was the ad hoc responsibility of the centralised department accountable for sustainability at the level of top management. At the same time, interviewees from top management did not differentiate improving energy efficiency, environmental management, or sustainability but even used those terms interchangeably and considered them to be one and the same. As the plant energy coordinator at Gamma reported, although it has become trendy to maintain an environmental department and to have sustainability appear in all contexts of the organisation, the centralised department accountable for sustainability at the level of top management is not involved with improving the energy efficiency of operations or in operations decision-making unless there is an environmental disaster or a practice violates environmental laws. According to the coordinator, 'Energy consumption does not violate any law. . . . In the worst-case scenario, the operations may not meet the target, but so what? We can explain why it happened'.

Operations employees stated that their organisation's ways of managing the improvement of energy efficiency at the organisational level were complicated and had persuaded them to interpret the importance of working to improve energy efficiency in a negative light. For example, the energy technology manager at Alpha reported being excluded from the centralised sustainability structure of the organisation and not being made at all responsible for reporting energy figures to the specialised decentralised energy service team at the top level of the organisation. Instead, energy measures are reported by an environmental engineer in environmental reports to the centralised sustainability department. Furthermore, people in that department are not known by operations employees. Thus, even though interview data indeed reveal an environmental, health and safety department at the top level, the plant energy manager at Beta stated, 'We don't have any global unit. It's frustrating, because I see enormous potential all over the plants, but nothing's happening'. Further still, the interviewees reported that people appointed to the accountable roles change positions quite often, or else positions remain long vacant. According to the operator at Alpha, 'The work with energy is different depending on who's in the [relevant] roles, and those people have changed many times'.

Thus, the centralised department accountable for sustainability at the level of top management at the companies did not seem to encourage emergent development efforts from operations employees. However, Alpha also had a decentralised specialised

energy service team headed by the group-level manager of energy efficiency, who does not belong to the centralised department accountable for sustainability at the level of top management. The findings revealed that due to the existence of such an expert specialised energy service team for maintenance, process development, production development, and other efforts, the team acts as a network that enables the successful deployment of emergent development efforts for improving energy efficiency initiated by operations employees. Members of the team who belong to operations have set their own tactical goals for improving the energy efficiency of operations and strive to meet them. They have also identified a new KPI, namely 'specific energy', which is product specific and measured by comparing a recent operations process with the last time it was run under the same conditions. About the KPI, the development engineer at Alpha stated, "Energy knowledge is not great at the level of production. ... It's hard for the operators to know what to do to affect energy use and how to do it. For that to happen, we need KPIs that are closer to the operators and that they can influence".

As the operator in the same company argued, 'We get information about the goals once a year, talk about energy once a month, but we're affected by those decisions every day'.

The empirical data also revealed that the companies had allocated funding to efforts to improve energy efficiency by following three approaches. For one, Alpha has created a specific fund for improving energy efficiency (i.e., SEK 20,000). By contrast, Beta's top management has adopted a simple payback method of prioritising proposals for improvement, including ones for enhancing energy efficiency. Last, Gamma channels monetary gains from previously deployed efforts to improve energy efficiency into a fund for investing in future development efforts to the same purpose initiated by operations employees. The analysis of interviews, especially of the underlying reasoning of interviewees, revealed that the capital investment decision-making structure for improving energy efficiency was more complex than allocating funding. Whereas all interviewees in top management seemed to agree that induced development efforts to improve energy efficiency originated from a need to lower costs, personnel in operations interpreted such cost-saving goals as stemming from the company's need to profit. As the operator at Alpha argued, 'Money is good for the company, but I don't earn anything extra from it'. Moreover, operations employees argued that when simple payback is used to fund proposals for improving energy efficiency, which require investments that may not pay off for decades, those proposals are the last to be allocated funds and the first to be cut in long-term decision-making.

Synthesis of how the process of improving energy efficiency in operations is practiced

The examination of the process of improving energy efficiency in operations suggests that it is a dynamically occurring process involving interactions between competing logics of actors who are officially accountable for or personally interested in improving energy efficiency in their companies. Therefore, it is proposed that any improvement in energy efficiency in operations is determined by the cumulative effect of those interactions and that operations can be considered as a context for sustainability as practice by engaging different actors to contribute to achieving continual improvement. Presenting the process of improving energy efficiency in operations relative to the existing sustainability-oriented corporate-level strategy and operations strategy at the three companies, Figure 1 displays a practice-based framework for describing and analysing the process of improving energy efficiency in operations, in which development efforts to improve energy efficiency in operations are not only considered to be discrete, one-time actions but can be disseminated throughout the organisation as a set of practices to be repeated over time.

Personnel at all three companies recognised a consistent, hierarchical, top-down approach towards sustainability-oriented strategies at their companies, presented on the left-hand side of Figure 1, starting with top management and including a centralised support function responsible for sustainability that sets sustainability-oriented objectives at the companies. They also acknowledged sustainability in their business strategies and linked sustainability to the visions of their companies to support a sustainability-centred culture. The reason why sustainability is part of the companies' business strategies, as explained by the interviewees, is because the business strategy is heavily influenced by applicable governments that issue laws and regulations in which sustainability is already a major part.

The long-term strategic objective for improving energy efficiency, expressed either as kilo- or megawatt hours per kilo or ton of product or as the reduction of energy cost by some percentage, is set by top management and incorporated into the business strategy under the sustainability-oriented strategy umbrella but not translated as an operations performance objective in operations strategy. As presented in Table 2, the findings show that the companies do not distinguish business from operations strategies; although all of the companies have a strategic intention for their operations, it is not always formalised as a formulated, documented operations strategy. However, the implications of such strategic intention have been observed, for they shape the operations strategy, as illustrated on the right-hand side of Figure 1. Even so, none of the companies include the objective of improving energy efficiency in their operations strategic decision-making. None of the interviewees

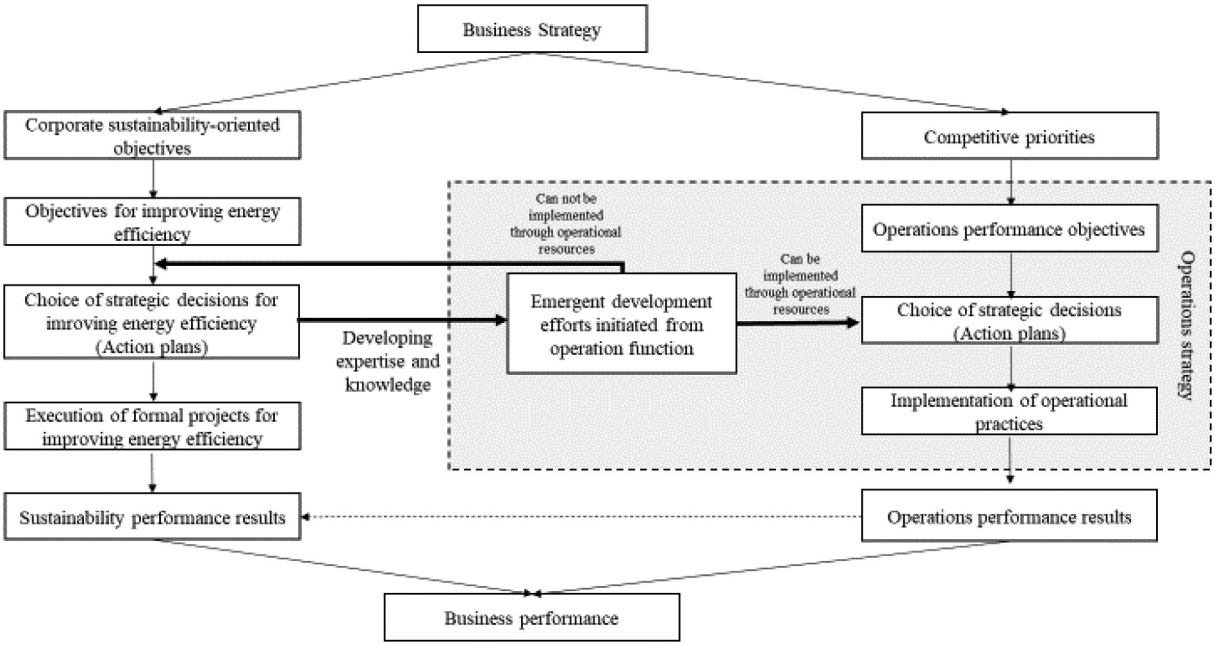

Figure 1. A practice-based framework for describing and analysing the process of improving energy efficiency in operations.

considered sustainability or improving energy efficiency in operations to be a requirement of customers, therefore it is not a competitive priority from a market-based perspective. However, at Beta and Gamma, corporate-level strategies and policies have emphasised improving energy efficiency in product research and development as well as for product users. Beta's environment and safety manager provided one rationale as to why:

'We're not that cheap, but we have good quality, and we can make more money by explaining to our customers how much energy they can save by using our products for longer than if they went to one of our competitors'.

At all three companies, top management's justification for induced development efforts to improve energy efficiency in operations was cost reduction. Thus, even if improving energy efficiency affects the companies' environmental performance directly, efforts to improve energy efficiency in operations seek to lower costs and thus boost economic performance. For energy-intensive companies such as Alpha, the cost of energy is a matter of survival, whereas for companies that are not as energy intensive, including Beta and Gamma, energy is a small cost. Regardless, and even if energy prices are not high, economic reasoning continues to principally motivate companies to work towards improving energy efficiency in operations. Therefore, induced development efforts to improve energy efficiency are carrier of cost as a performance objective.

Although improving energy efficiency has not been translated as an operations performance objective, it can nevertheless affect other performance objectives through operations decisions and practices related to reducing resource consumption in operations processes and setting operations conditions for energy utilisation. After setting the objectives for improving energy efficiency, top management considers conceptualising formal aspects of an action plan and ensuring that appropriate structures, processes, and control activities for improving energy efficiency in operations are in place, as shown on the left-hand side of Figure 1. Top management at the interviewed companies requires energy audits to be performed and reported on by external consultant firms or an in-house energy team. Whereas Alpha has been mandated since 2005 to conduct an energy audit and analyse it based on its PFE agreement, Beta only recently received that mandate as an outcome of Swedish legislation. In either case, the energy audits have facilitated the identification of opportunities for improvement. From there, it is top management's responsibility to select strategic action plans and allocate required resources to them. According to the interviewees, action plans for improving energy efficiency in operations following the described approach are typically related to projects that seek to directly reduce the energy consumption of operations processes in which energy is an input resource or a resource used to support facilities and influence sustainability performance directly. Those action plans also typically require investments in energy-efficient technologies. However, the perception and understanding among operations employees was that the energy audits at their companies were not incisive enough for accurately identifying opportunities for improving energy efficiency in operations. As mentioned by the plant-level worker at Beta,

> Global consultants and academics from universities are involved only to produce reports to show to outsiders. Those people have very good technical skills but no systems thinking. We [in manufacturing] have been doing the same thing ourselves for

> many years. … When you do it in-house, you'll follow it up later. … The reports from outsiders make the management think that they know what's going on in the plant. … Sometimes we use the consultants' reports to pass along data that we want to reach management.

If proven to generate value, then a determined action plan for improving energy efficiency will be addressed as any other action plan. The action plans labelled as formal projects, resulting from induced practices from top management, will compete for monetary and human resources from the same pool. Upon their approval, the action plans for improving energy efficiency in operations will be implemented through a temporary, cross-functional project organisation.

Iterative process loops

Whereas the previous mapping of data according to the interview guide revealed development efforts to improve energy efficiency intended to directly reduce the energy consumption in operations processes, grouping data according to the content of efforts and in relation to organisational structure revealed further insights into some iterative loops in the process of improving energy efficiency in operations at the companies. The analysis of development efforts to improve energy efficiency in operations revealed similarities among actors involved and in the phases in which the efforts have been initiated across the companies, which led to labelling them as either 'induced development efforts' or 'emergent development efforts'. Table 4 presents the similarities that justified grouping development efforts to improve energy efficiency in operations as either induced or emergent.

Throughout the data, the interviewees also revealed examples of emergent development efforts to improve energy efficiency in operations initiated by operations employees, presented down the centre of Figure 1, who invariably recognise opportunities for improvement. The starting point for those autonomous activities is often an employee's advanced knowledge about or personal interest in energy efficiency. For example, operations employees with an educational background in energy or with related work experience, including Alpha's energy technology manager and project manager and Beta's plant energy coordinator, act to improve energy efficiency in operations activities and processes on a daily basis. The energy *kaizen* facilitator at Gamma, by some contrast, is a maintenance manager who works to improve energy efficiency as part of his job and who reported taking the position due to personal interest.

The plant-level worker at Beta believed that the in-house identification of potential for improving energy efficiency in operations was more useful than the external kind, because the former is connected to in-house measurements as the reference and background for what can be saved. Nevertheless, the analysis of data revealed that the emergent development efforts to improve energy efficiency in operations that were, initiated by operations employees were shaped in areas about which operations personnel have expertise as well as tacit knowledge.

Table 4. Similarities of induced versus emergent development efforts to improve energy efficiency.

Induced development efforts to improve energy efficiency	Emergent development efforts to improve energy efficiency
Initiated at top management	Initiated by operations employees
Motivated by economic benefits	Motivated by identified improvement opportunities
Large-scale improvements via technological solutions	Small-scale improvements via operations processes
Formal decision-making about investing	Limited formality in decision-making about investing
Rapid results expected	Achievements realised gradually

According to the interviewees, whereas top-down induced development efforts to improve energy efficiency usually respond to immediate demands, emergent practices initiated by operations employees for improving energy efficiency typically take a long time to demonstrate results, which may go entirely unnoticed by top management. However, it seems that operations employees have realised not only that working with stabilising processes can improve energy efficiency in operations but also that working to improve the energy efficiency of operations can support better ways of working. According to the operator at Alpha, working to improve energy efficiency in order to stabilise operations processes can affect the hands-on activities of operators by reducing waste, eliminating rework needed to solve new problems, and even replacing inefficient routines and equipment. The plant-level worker at Beta argued that working to improve energy efficiency has not only made the company profitable but also cultivated a better work environmental by virtue of more stable processes.

According to the operations manager at Alpha, in order to identify the potential for improving energy efficiency, operations personnel have to identify variations in their processes that affect energy utilisation along with the root causes of those variations – for example, divergent work methods due to a lack of standardised processes, personnel performing the same job differently during different shifts, seasonal variations due to differences in temperature, and the inconsistent quality of incoming raw materials. According to the same informant, Alpha has partly improved its energy efficiency with the help of investments from an operations maintenance budget. At the company, emergent development efforts initiated by operations employees for improving energy efficiency by stabilising processes, for example, are allocated resources directly from operations, linking the emergent practices to the right-hand side of Figure 1 and

follow the process as an operations practice. As a consequence, the outcomes of those efforts to promote sustainable development later surface in the company's sustainability performance unbeknown to top management. As the plant-level worker at Beta reported, 'We're done with simple actions [e.g., eco-efficient technologies]. The potential that I see today, to go a step further, is by changing behaviour . . . to get energy as a natural part of the work. . . . Changing behaviour doesn't cost much'. As the production manager at Alpha 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'. In that way, the positive impact of improved energy efficiency from emergent development efforts initiated by operations employees are intertwined with operations performance and incorporated into operations performance objectives, including improving operational processes. In the words of the energy technology manager at Alpha, 'We hide energy waste within our processes'.

To be implemented, emergent development efforts, presented down the centre of Figure 1, initiated by operations employees require the ability of operations personnel to either implement them through available operations resources, thereby linking them to the right-hand side of Figure 1, or scaling them up, thereby linking them to the left-hand side of Figure 1, and securing the organisation's commitment to allocating the required resources to maintain the operation. The interviewees also indicated that, due to limited operations resources, emergent development efforts initiated by operations employees that require sizeable investments have had to secure top management's commitment by competing for resources with every other improvement proposal, thereby linking the emergent practices to the left-hand side of Figure 1. However, the empirical data did not contain any such emergent initiatives for improving energy efficiency, perhaps due to the long payback period of emergent development efforts initiated by operations employees that need large investments. Even so, if those emergent development efforts ultimately become more than observations or one-time activities – that is, if they become realised – then they can enable continual integration in action.

The other iterative loop recognised in the data in relation to induced development efforts has primarily been implemented to conceptualise structures, processes, and control activities but also to share sustainability-related objectives with the organisation. However, by developing expertise and knowledge in operations, additional emergent development efforts, as captured down the centre of Figure 1, were initiated by operations employees. One such induced development effort was sharing information via visualisation tools as a means to create common knowledge. For example, on a site visit at Beta, an A3 document could be observed in each work group that visualised the company's goals, including ones about energy, with an explanation of benefits from the targeted goals, the work group's definition of the company's core values, and the group's contributions to realising the goals. Similarly, at Alpha, improvement boards could be seen in each work group that included A3 documents, fish bone diagrams, and visuals about the daily management needed to meet energy targets. Another way of showing operations employees that improving energy efficiency is important to the company has been permitting energy experts to be present at the plants, which allows energy governance to be recognised by all employees. Even so, differences were observed in the interviewees' understanding of the objectives for improving energy efficiency in operations while such information-sharing channels are in place.

Yet another example is implementing and certifying an energy management system under ISO 50001 that, for instance, is linked to regular auditing. As companies implement such systems and have them certified, emergent practices initiated by operations employees for improving energy efficiency become more of a counterpart to quality improvements in operations in which 'continual improvement' and 'everyone's involvement' are fundamental. Whereas Alpha implemented an energy management system certified by ISO 50001 as a requirement of the PFE programme, Beta and Gamma did the same without requiring legal compliance. The energy technology manager and project manager at Alpha mentioned that implementing the system certified by ISO 50001 due to a regulation has resulted in the continual improvement of energy efficiency in operations. By comparison, the plant-level worker at Beta claimed that Beta was one of Sweden's first companies to implement an energy management system and have it certified. He added that once top management approved the implementation of the system, ambivalence about supporting more energy-efficient operations and hesitation about new production processes or investments in new machinery started to wane, and more emergent development efforts initiated by operations employees for improving energy efficiency gained support without formal decision-making processes.

Other ways in which induced development efforts seemed to have established conditions for continual improvement and everyone's involvement were by integrating the improvement of energy efficiency into lean thinking (e.g., through heart-rate meetings, heart-rate boards, and 5s), by eliminating energy considered to be waste, and by incorporating improved energy efficiency in operations in companies' production system documents, similar to lean-green integration models reported by Abreu, Alves, and Moreira (2017).

According to the energy technology manager and project manager at Alpha, while the ISO certification led to 'continual improvement', lean thinking showcased how improving energy efficiency in operations could be integrated into the organisations' culture and way of thinking.

Documentation is yet another example in the empirical data of knowledge creation through standardised ways of working. Producing and distributing guidelines, action points, and procedures stressing the importance of improving energy efficiency signalled not only top management's intentions but also the conditions that would allow for continual improvement. In general, the findings also show that operations employees perceived well-structured guidelines, action points, and procedures more as tactics to reduce deviation than as exercises of control by top management. Moreover, integrating the improvement of energy efficiency into documents such as operator's checklists not only increased operators' attention to its importance but also created a standardised way of working.

Discussion and conclusion

The results of examining development efforts to improve energy efficiency in operations suggest that actualising improved energy efficiency in operations is not an escalated top-down or bottom-up approach but a continuous participatory process realised by adopting iterative loops. Investigating how such efforts influence and can be influenced by the existing sustainability-oriented corporate-level and operations strategies afforded an understanding of how the efforts can become more than just the realisation of individual ideas. Moreover, the results advocate the approval of development efforts to be allocated resources and made durable by being incorporated into existing practices (Nicolini 2012).

Each sampled company has developed its own in-house terminology about sustainability that includes an objective for energy efficiency, including in operations. Interviewees in top management roles did not differentiate between the concepts of improving energy efficiency, environmental management, or sustainability, and in their interviews, they referred to 'sustainability strategy', which encompasses objectives for improving energy efficiency. The same interviewees were invariably involved in decision-making geared towards improving energy efficiency, primarily concerning large investments in technological solutions and equipment with long payback periods. Although the literature, primarily in the field of sustainable supply chain management, reports pressure from supply chain partners, stakeholders, society, regulators, and particularly customers to adopt sustainability in their practices (Walker et al. 2014), such pressure to improve energy efficiency in operations was not recognised by the interviewees, nor was it considered to be a competitive priority. Although some environmental development efforts are considered to be threats with legal force to induce companies to adopt new business strategies, improving energy efficiency in operations can be an objective pursued to enhance financial output without external pressure. Thus, the induced development efforts to improve energy efficiency originated from a profit-seeking motive among top management that followed a top-down process and was included as the ad hoc responsibility of a centralised support function. As a result of a focus on reducing costs, large, proactive investments to facilitate the improvement of energy efficiency in operations have not been prioritised. Instead, managers tend to favour product and service offerings that promote or are associated with energy efficiency to differentiate themselves from competitors in the market and, in turn, generate more profit. However, corresponding to the paradigm of pollution-prevention strategies and in relation to reducing resource consumption in operations processes that consume large amounts of energy (Koh et al. 2016), improving energy efficiency in operations affects operations decisions at the interorganisational group level in dimensions of operations strategy (i.e., delivery and flexibility) that set the conditions for energy use. Those findings can be summarised in the following proposition:

> **Proposition 1(a)**: Induced development efforts to improve energy efficiency in operations derive directly from sustainability-oriented objectives as an ad hoc responsibility of a centralized support function with the intention to reduce cost and enhance innovation in product development.

By contrast, emergent autonomous efforts to improve energy efficiency in operations initiated by operations employees have often emerged in recognition of an opportunity for improvement and as a means to express their ideas, skills, and/or knowledge. At the operations level, improving energy efficiency is more tangible and clearly differentiated from general sustainability or environmental management. For operations employees, improving energy efficiency is counterpart to operations improvements and the enhanced efficiency of the sociotechnical conditions of the operations in which they work. That dynamic can be explained by operations employees' tacit knowledge in the area of daily work. Therefore, the positive impact on improving energy efficiency from emergent efforts to that end in operations initiated by operations employees is intertwined with the performance of operations. It also relates to the interorganisational group level dimensions of operations strategy (i.e., quality, information and process technology) that

operations employees come into daily contact with. Those findings can be summarised in the following proposition:

> **Proposition 1(b)**: Emergent development efforts to improve energy efficiency in operations are integrated into daily operational improvements, are tangible, are clearly differentiated from sustainability-oriented objectives, and are not derived from any formulated strategy.

The analysis of empirical data confirmed that implementing sustainability-oriented and operations strategies is not as straightforward as presented in the literature (Edh Mirzaei, Fredriksson, and Winroth 2016) and that objectives such as improving energy efficiency in operations can be incorporated into different performance objectives for operations. That shift, observable in the characteristics of development efforts that tend to address different strategic intentions, can be explained by the fact that different organisational levels consider it to be easier to change what they have tacit knowledge about in the area that they perform their daily work than what is distant:

> **Proposition 1(c)**: While moving across organizational levels from top management to operations, improving energy efficiency changes from being incorporated into the dimensions of cost and innovation to being incorporated into intraorganizational group-level dimensions of operations strategy.

Previous research has investigated conflicting schemas and the lack of understanding among operations employees about sustainability-oriented thinking and shown that operations are normally not viewed through the lens of sustainability (Longoni et al. 2019). Likewise, although the need for strategic support from top management has been addressed as a driver for improving energy efficiency (Brunke, Johansson, and Thollander 2014), the lack of a strategic management perspective on improving energy efficiency has also been noted (Rudberg, Waldemarsson, and Lidestam 2013). Therefore, this article argues that the fate of the process of improving energy efficiency in operations is promoted not only as a set of activities limited to the achievement of companies' sustainability-oriented objectives but also as a context for sustainability as practice in which different actors are engaged to contribute to continual improvement. That promotion depends on developing a shared understanding, recruiting and committing actors to acquiring resources and enhancing knowledge and learning. In other words, if emergent development efforts to improve energy efficiency in operations only move between levels within the company or are linked to short-term decisions and actions or the company's mid- to long-term directions within operations or the corporate sustainability-oriented strategy process, labelled 'spatial' and 'temporal' aspects by Ivory and MacKay (2020), then improving energy efficiency in operations should be scaled up as a core strategic direction of the company.

In relation to findings from Williams et al. (2021) identifying three subsets of sustainability work, namely goal-directed, other directed and self-directed, the findings of this study illustrate how these subsets change in the 'work of sustainability agents' from different hierarchal levels in the same company. The findings confirm Williams et al. (2021) suggestions that sustainability work cannot be generalised because its enactment is mediated by the sustainability agents' identity as well as their social-symbolic context. Similarly, this study provided examples in the context of operations such as induced development efforts to improve energy efficiency in operations being more goal-directed facilitated by legitimised oragnisational practices. In contrast, emergent development efforts to improve energy efficiency in operations are more self-directed. The variation in interviewees' underlying reasoning and motivation for initiating development efforts to improve energy efficiency in operations emphasises different types of competencies needed for managing such improvement at strategic and operational levels. Whereas induced efforts to improve energy efficiency in operations derived directly from sustainability-oriented objectives can benefit from the specialisation of competency (Siva, Gremyr, and Halldórsson 2018), emergent development efforts to that end need the integration of competency, in which an operations expert can improve the energy efficiency of operations in their specific tasks. The integration of competency allows broadening the tacit knowledge of operations employee and encourages the initiation and deployment of more development efforts. The literature has identified the existence of an energy manager, although not full-time, as a factor of the success of in-house energy management (Johansson and Thollander 2018), namely by integrating energy planning and initiating energy-saving activities across the organisation (Rudberg, Waldemarsson, and Lidestam 2013). The findings of the study presented in this article confirm a previous finding by Thollander, Palm, and Hedbrant (2019) that the deep knowledge of management and internal employees about operations processes and their related energy consumption give rise to improved energy efficiency. Similarly, Halldórsson et al. (2018) have investigated how established 'lean energy' competence can help to turn sustainable development into organisational renewal. That finding implies that combining the tacit knowledge of employees in their areas of daily work with efforts to improve energy efficiency can create opportunities to influence operations strategy.

> **Proposition 2(a)**: While moving across organizational levels from top management to operations, separation of specialty competencies about sustainability should change to the integration of specialty competencies to

> enable sustainability as practice, namely by shortening the distance between expertise in improving energy efficiency and local operations processes.

Although such expertise is crucial for enforcing the process of improving energy efficiency in operations, it is not enough to bring the organisation a step further towards strategic renewal. Taking that extra step requires creating mandates by having committees or steering groups to establish interactions between the strategic and operations levels for improving energy efficiency close to operations processes. The findings confirm similar results found by McCardle, Rousseau, and Krumwiede (2019) showing that in the exploration of the competitive priorities of operations strategy (e.g., environmental practices), less power distance and more individualistic cultures are more conducive to the task because they are more tolerant of new ideas and innovative behaviour. One example identified in the study presented here is the existence of a fund allocated to improving energy efficiency in operations, which can encourage more emergent practices from operations employees than a parity comparison for funding can. The results of the analysis thus suggest the following proposition:

> **Proposition 2(b)**: A fund dedicated to improving energy efficiency enables sustainability as practice by creating mandates at the operations level to implement action plans as a result of emergent practices.

In light of the analysis of development efforts to improve energy efficiency in operations at three companies, this article suggests that improving energy efficiency in operations is a dynamic process involving interactions between competing logics of actors who are officially accountable for or personally interested in improving energy efficiency in their companies. Moreover, studying the process of improving energy efficiency in operations relative to the existing sustainability-oriented corporate-level strategy and operations strategy at the companies has allowed the creation of a practice-based framework (see Figure 1) for describing and analysing the ways in which development efforts to improve energy efficiency in operations interacts with existing sustainability-oriented operations and strategies. As such, the framework can help to actualise the objective of improving energy efficiency in operations at the different organisational levels within companies. Therefore, it is proposed by engaging 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. The theoretical contributions of this article to the current body of knowledge are twofold. First, the article contributes to knowledge about operations strategy and sustainable operations management by providing evidence that sustainability as practice can be achieved by improving energy efficiency in operations. In introducing the practice-based framework derived from the findings, this article proposes a new way for approaching the process of improving energy efficiency in operations with a multidimensional approach. As such, the framework responds to calls emphasising a shift from sustainability as performance (Silva and Figueiredo 2017) towards the perspective that sustainability practices as a bundle of practices are resulted from a combination of activities in daily operations (Silva and Figueiredo 2020). Second, the article has not only focused on how daily activities occur and what personnel do in relation to those activities but also sought to enable an understanding of real-life events from the viewpoint of a range of practitioners who are integral actors in the process of improving energy efficiency in operations. In that light, the study has opened up the 'formulate-then-implement' view on the top-down approach in the research, and the article thereby offers insights that actualising the objective of improving energy efficiency in operations is not an escalated top-down or bottom-up approach but a continuous participatory process involving the adoption of iterative loops. This article has thus proposed propositions for enabling the improvement of energy efficiency in operations.

The article also highlights the practical implications for companies and managers who adopt objectives for improving energy efficiency in their operations. In producing the framework, the study has facilitated a description of the process of improving energy efficiency in operations and provided guidelines on 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 emphasise that improving energy efficiency in operations needs to be treated as an iterative process. It is not just the linear sequence of the induced development efforts, followed a top-down process and included as the ad hoc responsibility of a centralised support function. Instead the different sets of activities and the practitioners who carry them out are central to this iterative process. Moreover, by clarifying the various underlying reasons for initiating development efforts, the research suggests that managers should consider changing their approach in goal- setting and communicating their objectives for improving energy efficiency in order to create a shared understanding, namely through transparent information-sharing via efficient communication channels (e.g., daily meetings, presentations, general meetings, and internal and external networks). By doing so, managers can not only enable the actualisation of improved energy efficiency in operations but also enforce interaction and empower iterative loops in the process.

Notwithstanding those contributions, the study had some limitations. For one, it did not constitute comprehensive research on mapping operations strategies.

Nevertheless, it did attempt to identify examples of induced development efforts from top management and emergent development efforts initiated by operations employees in multiple companies in order to portray the process of operations strategy in relation to improving energy efficiency in those companies. Even so, the findings may be biased towards the identified efforts identified and examined in the cases, which calls for more comprehensive longitudinal studies on other activities. For another, the propositions remain to be empirically tested, because the findings are limited to the nature of the interviews and based on interviewees' perceptions. While the interviewees were the actors in the companies most knowledgeable about improving energy efficiency and the study sought to include respondents from different organisational levels, future research could gather and analyse more data from different levels within such companies – for example, by conducting surveys. Moreover, while the study has answered the call for cross-level research that links individual behaviour and internal processes with sustainability as an organisational-level phenomenon (Williams et al. 2021), alternative theoretical lenses, such as complex adaptive systems lens (e.g. Touboulic, Matthews, and Marques 2018), can be further used for multilevel analysis to map the evolution of improving energy efficiency in operations as a sustainability-oriented strategy in a supply network. The findings have also observed differences in the interviewees' understanding of the objectives for improving energy efficiency in operations while information-sharing channels are in place in the companies. That difference indicates that either the means of communication and information-sharing channels or the underlying reason for individuals not to acknowledge the information needs to be further examined.

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No potential conflict of interest was reported by the author(s).

Notes on contributor

Naghmeh Taghavi is a Ph.D. candidate in service management and logistics at Chalmers University of Technology, Sweden. She will be defending her Ph.D research in June 2022. Her research relates sustainable development of operations. She holds a master's degree in Quality and Operations Management from Chalmers University of Technology, Sweden. She is currently working as a senior scientist at AstraZeneca Early Product Development and Manufacturing in Gothenburg, Sweden.

ORCID

Naghmeh Taghavi http://orcid.org/0000-0002-3928-6048

References

Abdul-Rashid, S. H. Y., N. Sakundarini, R. A. Raja Ghazilla, R. Thurasamy. 2017. "The Impact of Sustainable Manufacturing Practices on Sustainability Performance." *International Journal of Operations & Production Management* 37 (2): 182–204. doi:10.1108/IJOPM-04-2015-0223.

Abreu, M. F., A. C. Alves, F. Moreira. 2017. "Lean-Green Models for Eco-efficient and Sustainable Production". *Energy* 137: 846–853. doi:10.1016/j.energy.2017.04.016.

Accenture Strategy & United Nations Globa l Compact. 2019. "CEO Study on Sustainability 2019." https://www.accenture.com/_acnmedia/pdf-109/accenture-ungc-ceo-study.pdf#zoom=50

Adamides, E. D. 2015. "Linking Operations Strategy to the Corporate Strategy Process: A Practice Perspective." *Business Process Management Journal* 21 (2): 267–287. doi:10.1108/BPMJ-07-2013-0107.

Albino, V., A. Balice, R. M. Dangelico. 2009. "Environmental Strategies and Green Product Development: An Overview on Sustainability-driven Companies." *Business Strategy and the Environment* 18 (2): 83–96. doi:10.1002/bse.638.

Anderson, S. T., and R. G. Newell. 2004. "Information Programs for Technology Adoption: The Case of Energy-efficiency Audits." *Resource and Energy Economics* 26 (1): 27–50. doi:10.1016/j.reseneeco.2003.07.001.

Angell, L. C., and R. D. Klassen. 1999. "Integrating Environmental Issues into the Mainstream: An Agenda for Research in Operations Management." *Journal of Operations Management* 17 (5): 575–598. doi:10.1016/S0272-6963(99)00006-6.

Avella, L., D. Vazquez-Bustelo, E. Fernandez. 2011. "Cumulative Manufacturing Capabilities: An Extended Model and New Empirical Evidence." *International Journal of Production Research* 49 (3): 707–729. doi:10.1080/00207540903460224.

Bansal, P., and K. Roth. 2000. "Why Companies Go Green: A Model of Ecological Responsiveness." *Academy of Management Journal* 43: 717–736.

Barratt, M., T. Y. Choi, M. Li. 2011. "Qualitative Case Studies in Operations Management: Trends, Research Outcomes, and Future Research Implications." *Journal of Operations Management* 29 (4): 329–342. doi:10.1016/j.jom.2010.06.002.

Brandi, U., and M. L. Thomassen. 2020. "Sustainable Organizational Learning and Corporate Entrepreneurship: A Conceptual Model of Sustainability Practices in Organizations." *Journal of Workplace Learning* 33 (3): 212–228.

Brunke, J. C., M. Johansson, P. Thollander, 2014. "Empirical Investigation of Barriers and Drivers to the Adoption of Energy Conservation Measures, Energy Management Practices and Energy Services in the Swedish Iron and Steel Industry". *Journal of Cleaner Production* 84: 509–525. doi:10.1016/j.jclepro.2014.04.078.

Bryman, A., and E. Bell. 2015. *Business Research Methods*. 4th ed. Glasgow: Bell & Bain.

Corbett, J., J. Webster, T. A. Jenkin. 2018. "Unmasking Corporate Sustainability at the Project Level: Exploring the Influence of Institutional Logics and Individual Agency." *Journal of Business Ethics* 147 (2): 261–286. doi:10.1007/s10551-015-2945-1.

De Burgos Jiménez, J., and J. J. C. Lorente. 2001. "Environmental Performance as an Operation Objective." *International Journal of Operations & Production Management* 21 (12): 1553–1572. doi:10.1108/01443570110410900.

Directive 2012/27/EU on energy efficiency. "The European Parliament and the Council of the European Union Amending 877 Directives 2009/125/EC and 2010/30/EU and Repealing Directives 2004/8/EC and 2006/32/EC." Accessed 15 April 2021. https://eur-878lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:en:PDF

Edh Mirzaei, N., A. Fredriksson, M. Winroth. 2016. "Strategic Consensus on Manufacturing Strategy Content: Including the Operators' Perceptions." *International Journal of Operations & Production Management* 36 (4): 429–466. doi:10.1108/IJOPM-07-2014-0309.

Edmondson, A. C., and S. E. McManus. 2007. "Methodological Fit in Management Field Research." *Academy of Management Review* 32 (4): 1246–1264. doi:10.5465/amr.2007.26586086.

Egels-Zandén, N., and M. Rosén. 2015. "Sustainable Strategy Formation at a Swedish Industrial Company: Bridging the Strategy-as-practice and Sustainability Gap." *Journal of Cleaner Production* 96: 139–147. doi:10.1016/j.jclepro.2014.01.072.

Eisenhardt, K. M. 1989. "Building Theories from Case Study Research." *Academy of Management Review* 14 (4): 532–550. doi:10.2307/258557.

Eisenhardt, K. M., and M. E. Graebner. 2007. "Theory Building from Cases: Opportunities and Challenges." *Academy of Management Journal* 50 (1): 25–32. doi:10.5465/amj.2007.24160888.

Elkington, J. 2018. "25 Years Ago I Coined the Phrase "Triple Bottom Line." Here's Why It's Time to Rethink It." *Harvard Business Review* 25: 2–5.

Ellram, L., and W. L. Tate. 2015. "Redefining Supply Management' S Contribution in Services Sourcing." *Journal of Purchasing and Supply Management* 21 (1): 64–78. doi:10.1016/j.pursup.2014.10.001.

Engert, S., R. Rauter, R. J. Baumgartner. 2016. "Exploring the Integration of Corporate Sustainability into Strategic Management: A Literature Review". *Journal of Cleaner Production* 112: 2833–2850. doi:10.1016/j.jclepro.2015.08.031.

Figueiredo, M. D., de Castro, N. M., Silva, M.E. 2020. "A Practice-based Learning Approach toward Sustainable Consumption in the Workplace." *Journal of Workplace Learning* 33 (3): 197–211.

Flick, U. 2018. *An Introduction to Qualitative Research*. Thousand Oaks, CA: Sage.

Fritz, M. M. C., and M. E. Silva. 2018. "Exploring Supply Chain Sustainability Research in Latin America." *International Journal of Physical Distribution & Logistics Management* 48 (8): 818–841. doi:10.1108/IJPDLM-01-2017-0023.

Froschauer, U., and M. Lueger. 2009. "Expert Interviews in Interpretive Organizational Research." In *Interviewing Experts*, 217–234. London: Palgrave Macmillan.

Garetti, M., and M. Taisch. 2012. "Sustainable Manufacturing: Trends and Research Challenges." *Production Planning & Control* 23 (2–3): 83–104. doi:10.1080/09537287.2011.591619.

Gunasekaran, A., and A. Spalanzani. 2012. "Sustainability of Manufacturing and Services: Investigations for Research and Applications." *International Journal of Production Economics* 140 (1): 35–47. doi:10.1016/j.ijpe.2011.05.011.

Gupta, M., and K. Sharma. 1996. "Environmental Operations Management: An Opportunity for Improvement." *Production and Inventory Management Journal* 37: 40–46.

Halldórsson, Á., I. Gremyr, A. Winter, N. Taghavi 2018. "Lean Energy: Turning Sustainable Development into Organizational Renewal." *Sustainability* 10 (12): 4464. doi:10.3390/su10124464.

Hayes, R. H., and S. C. Wheelwright. 1984. *Restoring Our Competitive Edge: Competing through Manufacturing*. Vol. 8. New York: Wiley.

Hong, P., S. Jagani, J. Kim, S. H. Youn, 2019. "Managing Sustainability Orientation: An Empirical Investigation of Manufacturing Firms". *International Journal of Production Economics* 211: 71–81. doi:10.1016/j.ijpe.2019.01.035.

Ivory, S. B., and R. B. MacKay. 2020. "Scaling Sustainability from the Organizational Periphery to the Strategic Core: Towards a Practice-based Framework of What Practitioners "Do"." *Business Strategy and the Environment* 29 (5): 2058–2077. doi:10.1002/bse.2487.

Jarzabkowski, P., G. W. Dowell, L. Berchicci, 2021. "Strategy and Organization Scholarship through A Radical Sustainability Lens: A Call for 5.0." *Strategic Organization* 19 (3): 449–455. DOI:10.1177/14761270211033093.

Jarzabkowski, P., Spee, A. P., Smets, M. 2013. "Material Artifacts: Practices for Doing Strategy with 'Stuff'." *European Management Journal* 31 (1): 41–54. DOI:10.1016/j.emj.2012.09.001.

Johansson, M. T., and P. Thollander. 2018. "A Review of Barriers to and Driving Forces for Improved Energy Efficiency in Swedish industry–Recommendations for Successful In-house Energy Management." *Renewable and Sustainable Energy Reviews* 82: 618–628. doi:10.1016/j.rser.2017.09.052.

Kiesnere, A. L., and R. J. Baumgartner. 2019. "Sustainability Management Emergence and Integration on Different Management Levels in Smaller Large-sized Companies in Austria." *Corporate Social Responsibility and Environmental Management* 26: 1607–1626.

Kim, Y. H., F. J. Sting, C. H. Loch, 2014. "Top–down, Bottom–up, or Both? toward an Integrative Perspective on Operations Strategy Formation." *Journal of Operations Management* 32 (7–8): 462–474. doi:10.1016/j.jom.2014.09.005.

Kiridena, S., M. Hasan, R. Kerr, 2009. "Exploring Deeper Structures in Manufacturing Strategy Formation Processes: A Qualitative Inquiry." *International Journal of Operations & Production Management* 29 (4): 86–417. doi:10.1108/01443570910945837.

Klettner, A., T. Clarke, M. Boersma. 2014. "The Governance of Corporate Sustainability: Empirical Insights into the Development, Leadership and Implementation of Responsible Business Strategy." *Journal of Business Ethics* 122 (1): 145–165. doi:10.1007/s10551-013-1750-y.

Koh, S. C. L., J. Morris, S. M. Ebrahimi. 2016. "Integrated Resource Efficiency: Measurement and Management." *International Journal of Operations & Production Management* 36 (11): 1576–1600. doi:10.1108/IJOPM-05-2015-0266.

Ligonie, M. 2021. "Sharing Sustainability through Sustainability Control Activities. A Practice-based Analysis." *Management Accounting Research* 50: 100726. doi:10.1016/j.mar.2020.100726.

Linneberg, M. S., M. T. Madsen, J. A. Nielsen. 2019. "Micro-level Translation of Corporate Sustainability: When Strategy Meets Practice in the Danish Hospitality Sector". *Journal of Cleaner Production* 240: 118–159. doi:10.1016/j.jclepro.2019.118159.

Longoni,A., M. Pagell, A. Shevchenko. 2019. "Human Capital Routines and Sustainability Trade-offs: The Influence of Conflicting Schemas for Operations and Safety

Managers." *International Journal of Operations & Production Management* 29 5): 690– 713. doi:10.1108/IJOPM-05-2018-0247.

Lopes de Sousa Jabbour, A. B., D. Vazquez-Brust, C. J. Chiappetta Jabbour. 2020. "The Interplay between Stakeholders, Resources and Capabilities in Climate Change Strategy: Converting Barriers into Cooperation." *Business Strategy and the Environment* 29 (3): 1362–1386. doi:10.1002/bse.2438.

Luederitz, C., G. Caniglia, B. Colbert. 2021. "How Do Small Business Pursue Sustainability? the Role of Collective Agency for Integrating Planned and Emergent Strategy Making." *Business Strategy and the Environment* 30 (7): 3376–3393. doi:10.1002/bse.2808.

May, G., B. Stahl, M. Taisch. 2017. "Energy Management in Manufacturing: From Literature Review to a Conceptual Framework". *Journal of Cleaner Production* 167: 1464–1489. doi:10.1016/j.jclepro.2016.10.191.

McCardle, J. G., M. B. Rousseau, D. Krumwiede. 2019. "The Effects of Strategic Alignment and Competitive Priorities on Operational Performance: The Role of Cultural Context." *Operations Management Research* 12 (1–2): 4–18. doi:10.1007/s12063-019-00139-7.

Miles, M. B., Huberman, A. M., Saldaña, J. 2020. *Qualitative Data Analysis: A Methods Sourcebook*. Los Angeles, CA, USA: Sage.

Naor, M., E. S. Bernardes, C. T. Druehl. 2015. "Overcoming Barriers to Adoption of Environmentally-friendly Innovations through Design and Strategy: Learning from the Failure of an Electric Vehicle Infrastructure Firm." *International Journal of Operations & Production Management* 35 (1): 26–59. doi:10.1108/IJOPM-06-2012-0220.

Neugebauer, F., F. Figge, T. Hahn. 2016. "Planned or Emergent Strategy Making? Exploring the Formation of Corporate Sustainability Strategies." *Business Strategy and the Environment* 25 (5): 323–336. doi:10.1002/bse.1875.

Nicolini, D. 2012. *Practice Theory, Work, and Organization: An Introduction*. Oxford: OUP.

Paul, A., J. W. B. Lang, R. J. Baumgartner. 2017. "A Multilevel Approach for Assessing Business Strategies on Climate Change". *Journal of Cleaner Production* 160: 50–70. doi:10.1016/j.jclepro.2017.04.030.

Pratt, M. G. 2008. "Fitting Oval Pegs into Round Holes: Tensions in Evaluating and Publishing Qualitative Research in Top-tier." *North American Journals, Organizational Research Methods* 11 (3): 481–509. doi:10.1177/1094428107303349.

Roy, V., and S. Singh. 2017. "Mapping the Business Focus in Sustainable Production and Consumption Literature: Review and Research Framework." *Journal of Cleaner Production* 150: 224–236. doi:10.1016/j.jclepro.2017.03.040.

Rudberg, M., M. Waldemarsson, H. Lidestam. 2013. "Strategic Perspectives on Energy Management: A Case Study in the Process Industry". *Applied Energy* 104: 487–496. doi:10.1016/j.apenergy.2012.11.027.

Rusinko, C. 2007. "Green Manufacturing: An Evaluation of Environmentally Sustainable Manufacturing Practices and Their Impact on Competitive Outcomes." *IEEE Transactions on Engineering Management* 54 (3): 445–454. doi:10.1109/TEM.2007.900806.

Samson, D., and M. Kalchschmidt. 2019. "Looking Forward in Operations Management Research." *Operations Management Research* 12 (1–2): 1–3. doi:10.1007/s12063-019-00138-8.

Sandberg, J., and G. Dall'Alba. 2009. "Returning to Practice Anew: A Life-world Perspective." *Organization Studies* 30 (12): 1349–1368. doi:10.1177/0170840609349872.

Sandberg, J., and H. Tsoukas. 2015. "Practice Theory: What It Is, Its Philosophical Base, and What It Offers Organization Studies." In *The Routledge Companion to Philosophy in Organization Studies*, 216–230. New York: Routledge.

Schatzki, T. R. 2012. "A Primer on Practices: Theory and Research." In *Practice-based Education*, 13–26. Leiden, The Netherland: Brill Sense.

Schulze, M., H. Nehler, M. Ottosson. 2016. "Energy Management in Industry–a Systematic Review of Previous Findings and an Integrative Conceptual Framework". *Journal of Cleaner Production* 112: 3692–3708. doi:10.1016/j.jclepro.2015.06.060.

Seuring, S., S. Gold, and R. Wilding. 2012. "Conducting Content-analysis Based Literature Reviews in Supply Chain Management." *Supply Chain Management: An International Journal* 17 (5): 544–555. doi:10.1108/13598541211258609.

Sharma, S. 2000. "Managerial Interpretations and Organizational Context as Predictors of Corporate Choice of Environmental Strategy." *Academy of Management Journal* 43: 681–697.

Siggelkow, N., and D. A. Levinthal. 2003. "Temporarily Divide to Conquer: Centralized, Decentralized, and Reintegrated Organizational Approaches to Exploration and Adaptation." *Organization Science* 14 (6): 650–669. doi:10.1287/orsc.14.6.650.24840.

Silva, M. E., and M. D. Figueiredo. 2017. "Sustainability as Practice: Reflections on the Creation of an Institutional Logic." *Sustainability* 9 (10): 1839. doi:10.3390/su9101839.

Silva, M. E., and M. D. Figueiredo. 2020. "Practicing Sustainability for Responsible Business in Supply Chains". *Journal of Cleaner* 251: 119621. Production 251. doi:10.1016/j.jclepro.2019.119621.

Siva, V., I. Gremyr, Á. Halldórsson. 2018. "Organizing Sustainability Competencies through Quality Management: Integration or Specialization." *Sustainability* 10 (5): 1326. doi:10.3390/su10051326.

Skinner, W. 1969. "Manufacturing-missing Link in Corporate Strategy." *Harvard Business Review* (May-June): 136–145.

Slack, N., and M. Lewis. 2011. *Operations Strategy*. 3rd ed. Harlow, UK: Pearson Education.

Szasz, L., and K. Demeter. 2014. "How Do Companies Lose Orders? A Multi-country Study of Internal Inconsistency in Operations Strategies." *Operations Management Research* 7 (3–4): 99–116. doi:10.1007/s12063-014-0091-z.

Thollander, P., M. Danestig, P. Rohdin. 2007. "Energy Policies for Increased Industrial Energy Efficiency: Evaluation of a Local Energy Programme for Manufacturing SMEs." *Energy Policy* 35 (11): 5774–5783. doi:10.1016/j.enpol.2007.06.013.

Thollander, P., J. Palm, J. Hedbrant. 2019. "Energy Efficiency as a Wicked Problem." *Sustainability* 11 (6): 1569. doi:10.3390/su11061569.

Touboulic, A., L. Matthews, L. Marques. 2018. "On the Road to Carbon Reduction in a Food Supply Network: A Complex Adaptive Systems Perspective." *Supply Chain Management: An International Journal* 23 (4): 313–335. doi:10.1108/SCM-06-2017-0214.

Touboulic, A., H. Walker, P. Maria Jesus Saenz, and D. Xenophon Koufteros. 2015. "Theories in Sustainable Supply Chain Management: A Structured Literature Review." *International Journal of Physical Distribution & Logistics Management* 45 (1/2): 1–44. doi:10.1108/IJPDLM-05-2013-0106.

Walker, H., P. S. Seuring, P. J. Sarkis. 2014. "Sustainable Operations Management: Recent Trends and Future Directions." *International Journal of Operations & Production Management* 34 (5). doi:10.1108/IJOPM-12-2013-0557.

Wesselink,R., V. Blok, S. van Leur. 2015. "Individual Competencies for Managers Engaged in Corporate Sustainable Management Practices". *Journal of Cleaner Production* 106: 497–506. doi:10.1016/j.jclepro.2014.10.093.

Wickert, C., C. Post, J. P. Doh. 2021. "Management Research that Makes a Difference: Broadening the Meaning of Impact." *Journal of Management Studies* 58 (2): 297–320. doi:10.1111/joms.12666.

Williams,T., M. Edwards, T. Angus-Leppan. 2021. "Making Sense of Sustainability Work: A Narrative Approach." *Australian Journal of Management* 46 (4): 740–760. doi:10.1177/0312896220978447.

Williams, A., and G. Whiteman. 2021. A Call for Deep Engagement for Impact: Addressing the Planetary Emergency." *Strategic Organization* 19 (3): 526–537.

Yacob, P., L. S. Wong, S. C. Khor. 2019. "An Empirical Investigation of Green Initiatives and Environmental Sustainability for Manufacturing SMEs." *Journal of Manufacturing Technology Management* 30 (1): 2–25. doi:10.1108/JMTM-08-2017-0153.

Yin, R. K. 2009. *Case Study Research: Design and Methods*. Thousand oak: SAGE publications.

Appendix 1

Study protocol

Research background

Sharpening the focus on the sustainability of operations processes provides opportunities for companies to work on the sustainable development of operations and to analyse the root cause of sustainability in terms of energy efficiency. Recent research has identified a gap between visions for sustainability and actions taken for sustainable development—that is, to design and execute processes that lead to sustainable outcomes). Companies struggle to translate their visions into day-to-day actions despite having a formal strategy and commitment to sustainability. One way to implement sustainability is to develop a paradigm for sustainability based on previously implemented paradigms in the company.

Research focus

The study seeks to investigate distinct steps in the process of improving energy efficiency and how companies take those steps in order to provide a systematic approach to achieving energy efficiency.

Energyeffektivisiering som en process

Key questions

What do companies do at each of those stages?

What pathways lead to increased energy efficiency?

What is the role of training and education for professionals in developing such a process and achieving results?

Research activities

Case studies will be conducted to investigate companies that have achieved energy efficiency by working with lean improvement processes.

What we need from you

We need to gather data from interviews as well as from internal company documents and presentations. Interviews will primarily be conducted with people working with energy efficiency and improvement processes.

Rules for data collection

- Each interview will last 2 hours at most.
- The researcher should initiate each interview by telling the interviewee what the research is about, its purpose, and that their answers will be treated confidentially.
- If possible, then the interview should be audio-recorded.
- Notes should be taken and sent to the interviewee for validation.

Appendix 2

Interview guide

Introductory questions, *to be directed to each interviewee individually to understand the interviewee's role in improving energy efficiency*

Questions about general sustainability

- How do you define *sustainability* at your company?
- Do you consider sustainability to be a competitive priority for your company?
- Is sustainability part of your company's corporate and/or business strategy? If so, then how is it formulated?
- Is sustainability part of your company's manufacturing strategy? If so, then how is it formulated?
- What different aspects of sustainability does your company include?
- Does your company have any strategies for dealing with sustainability?
- How does sustainability affect decisions at the operation level at your company?
- How does sustainability affect everyday activities at the operation level at your company?
- Do you measure sustainability in any way for your company?
- How are sustainability measures reported at your company?

Questions about energy efficiency in operations

- What motivates your company to invest in improved energy efficiency?
- Does your company have a vision for energy efficiency improvement?
- Do you consider energy efficiency to be a competitive priority for your company?
- Is improving energy efficiency part of your company's formal sustainability strategy? If so, then how is it formulated?
- How are your company's goals for energy efficiency set?
- How are the goals translated at the upper and lower levels within your company?
- Would increasing employees' knowledge and developing their competence cultivate a more bottom-up approach? If so, then how?
- How are projects for improving energy efficiency initiated at your company?
- How are projects for improving energy efficiency at your company evaluated? Are they evaluated differently from other projects?
- Would increasing employees' knowledge and developing their competence cultivate a more inside-out approach? If so, then how?
- What is the time horizon for investments and returns in improving energy efficiency?
- How are projects for improving energy efficiency funded?
- To what extent is improving energy efficiency integrated into other improvement processes at your company?

- What are the primary challenges in and/or barriers to implementing projects for improving energy efficiency? How are they addressed at your company?
- Are cross-functional teams used to implement projects for improving energy efficiency at your company?
- Are production and/or operations personnel involved in implementing projects for improving energy efficiency?
- What are the drivers of projects for improving energy efficiency at your company? How does your company motivate employees to be interested in the goals and strategies related to improving energy efficiency?
- How can employees at your company become more involved and interested in pursuing improved energy efficiency?
- How would increasing employees' knowledge and competence improve the implementation of projects for improving energy efficiency? How can knowledge of corporate strategy goals for improving energy efficiency affect the implementation of projects for improving energy efficiency?
- Do you measure and report energy use at the product level?
- Do you measure and report energy use at the factory level?
- To whom are energy-related issues reported at your company?
- How are energy-related issues reported at your company?
- Is energy measured and reported in the same way across different units at your company?
- Are employees at your company trained to measure, report, and use measured items? How would training employees improve measurement and reporting processes at your company?
- Do you benchmark internally or externally?