Towards Collaborative Green Business Process Management as a Conceptual Framework

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Abstract: Organizational strategies for saving energy are currently largely defined by three main courses of action: From a process organization perspective, efforts are being made to optimize processes and invest into more energy efficient infrastructure; from a behavioral perspective, one-time interventions such as energy campaigns or feedback mechanisms are common means to reduce environmental impact. However, both approaches face limitations concerning the scope of intervention. Researching organizational needs in the wild, we conducted action-based research regarding energy optimization practices. We discovered a lack of integrated approaches as regards fostering sustainability in organizations and deriving strategies for bridging the gap between strategic planning and everyday work in order to manage sustainability strategies more effectively and efficiently. We conclude by laying out a research agenda, which we seek to address in course of the ongoing research project in order to gain more sophisticated understanding of how to conduct collaborative green business process management in the wild.

1. Introduction

Energy is increasingly gaining importance as a critical factor to many businesses' success. Traditionally, due to its low costs and also out of the sheer inability to account for energy consumption costs of single processes or products, energy costs have always been perceived as overhead costs. There was neither the urgent need nor any suitable tools for making energy consumption costs accountable. However, with increasing energy prices, businesses are seeking for the tools to change this situation and optimize resource consumption systematically.

Organizations' typical countermeasures are closely connected to the advent of ubiquitous computing technologies and the rise of smart, networked organizations. In providing affordable technological means for tracking and making energy consumption accountable, digital measurement is key to introducing energy monitoring into controlling. Traditional approaches for the strategic optimization of organizations, such as Business Process Management (BPM) [22], were quick to adopt the new parameter into so-called GreenBPM approaches [5,13,16,17].

Classic BPM is typically characterized by a top-down approach and is often driven by external specialists. Therefore, criticism towards such conduct addresses the approaches' inherent structure, as measures are in danger of failing practicability for routines at operative level. In order to better address local workers as sources of energy consumption, one popular suggestion is to foster more sustainable work practices. Their effectiveness, however, is largely limited by organizationally defined processes. As a result, neither strategy makes use of the full potential of rendering an organization sustainable in terms of energy consumption (Fig. 1). It is, therefore, an open research question as to how far there is potential to integrate both methods into a collaborative green business process management approach. Successful integration of local workers' expertise is expected not only to better motivate people involved in processes to alter their behavior with respect to energy consumption. It is also expected to uncover additional potentials to save energy in making use of workers' specific process knowledge. However, the suitable tools to inform stakeholders within a collaborative workshop on green business process management are unknown. Motivated by an ongoing case study, in this paper we outline possible strategies and tools for raising collective awareness and supporting the direct involvement of all stakeholders in the analysis and rearrangement of organizational work by introducing **Collaborative GreenBPM**. We

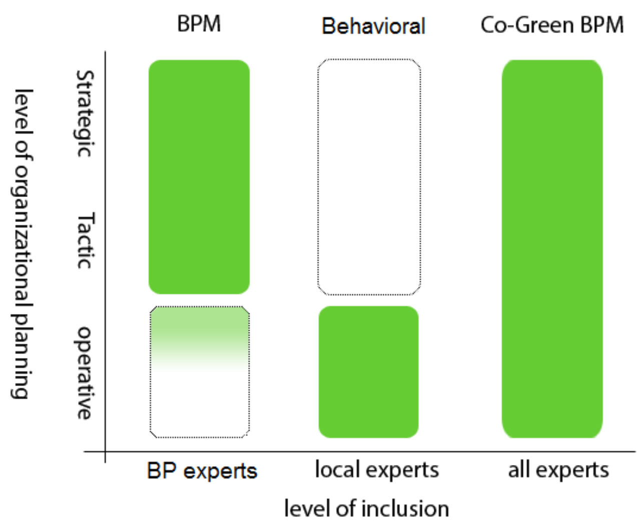

Fig. 1: Comparing the two dominant approaches increasing organizational sustainability and introducing Co-GreenBPM.

therefore show potentials of extending existing models which already take into account environmental data for business process management with a collaborative approach. Referring to an ongoing case study, we outline prototypical tools and methods of moving from GreenBPM to **Collaborative GreenBPM** and outline a research agenda for supporting participants' views on energy consumption data when conducting collaborative workshops for business process management based on environmental data.

2. Sustainability in BPM and organizational development

2.1. Energy feedback for behavioral change

In the course of the oil crisis in the 1970s, research of environmental psychology started to take an interest in the influence of behavior on energy consumption and investigated consumption feedback as a means of encouraging energy conservation [4]. At the same time, a body of theoretical approaches emerged within environmental research, seeking to understand individual's (un-) sustainable behaviors. Early and most common approaches adopted rational choice theory [19], arguing that energy-relevant behavior is conceptualized as an act of informed decision-making by consumers. Over time, other theories (like Stern's Value Belief Norm Theory [37]) emerged, considering e.g. subjective norms, beliefs and the influence of social surrounding. Both concepts of norms and rational behavior provide theoretical ground for persuasion and feedback campaigns, which nowadays are the most widespread methods of trying to implement changes in behavioral energy consumption [8,11].

In recent years, several design concepts and energy feedback systems inspired by these theories have emerged in the domestic context [1]. In addition to the differentiation between the theoretical foundations, approaches mainly differ on the levels of data gathering, data processing and data visualization. Due to the developments in smart metering technology, it has become possible to capture real-time consumption data disaggregated at device- or room-level to gain detailed understanding of the consumption of specific devices [12]. Instead of visualizing raw consumption data, more and more data is processed and intelligently analyzed with smart algorithms to support the user with detailed feedback and treatment suggestions (e.g. automatic evaluation of consumption) [40]. The visualization of data and the feedback types employed vary widely, ranging from approaches using goal-setting and gamification to motivate the user to reach a specific goal [20] through conditioning feedback mechanisms that reward or punish users if the consumption is not sustainable [23] to interactive and context-aware feedback that links consumption data to additional data to make energy data more meaningful to the user [6].

As most studies focus on private households, there are only few experiences and guidelines available in organizational settings, with most of them relying on monetary incentive schemes. Evaluative studies suggest, however, that other factors such as design concepts of feedback may be of more relevance [14,18]. Following this, several best practices and guidelines for campaigns, largely in the context of public administration and companies alike have been created [25,35]. These typically focus on classic materials such as posters, flyers, information brochures and letters from superior authorities. They also offer some advice on how to use email and web-sites, but suggestions for using smart technologies are usually not addressed in such toolboxes.

More recent research tries to make use of such existing ubiquitous sensing technologies in developing feedback solutions for organizations [2,24]. First, general design guidelines and wireframe sketches were developed by Foster et al. [10] using focus group sessions. Based on a literature review about techniques of intervention appropriate for the workplace, Yun et al. [41] implemented a first functional prototype of an energy-dashboard.

Looking at studies investigating and evaluating eco-feedback in organizations, there are fewer examples showing mixed results. According to Carrico and Riemer [8], even monthly feedback with a motivating message can provoke energy savings in a case study with university workers. Also in the context of a university, Murtagh et al. [26]'s study tested eco-feedback applications on employees' desktops, finding significant reductions of consumption. However, due to manifold work- and context-dependent restrictions, many studies notice a complex nexus of dependencies between feedback, organizational constraints and behavior, resulting in numerous reasons not to switch off.

Another problem which was identified is the long-term impact of measures, typically appearing as a one-time intervention. Until now, this phenomenon has only been addressed by very few studies. As one of the first to observe this, Schwartz et al. [36] used smart metering technology in a research institute, evoking significant positive short-term effects, with conservation fading successively over time. This finding is backed by a more recent study by Jakobi et al. [21], who investigated office energy consumption and the possibility to provide tailored feedback as a one-time intervention based on design guidelines from energy feedback for households. Jakobi et al. also point out how processes and formal organizational restrictions limit the effectiveness of feedback. Piccolo et al. [30] took a closer look at this, equipping an office environment with a debating tool, smart monitors and a haptic feedback tree in order to raise awareness and provide a collaborative discussion platform. On analyzing discussion input, it became obvious how technical, formal and informal constraints exist within and around the group, shaping and limiting behavioral change.

In summary, while some feedback mechanisms from research in domestic contexts can successfully be adapted to organizational eco-feedback solutions, there are open challenges: Firstly, feedback systems effective in the long run are needed to embed more sustainable behavior into organizational routines. This in turn could reduce the costs of one-time interventions, at the same time supporting sustaining effects and learning about energy efficiency. Secondly, feedback fails to overcome formal organizational hurdles, thus leaving behind strategic inefficiencies. It is an open research question, how far combining the benefits of behavioral energy feedback for workers with common change management methods thus might hold the potential to increase the added value of measuring energy consumption in organizations when allowing behavioral change to further affect organizational process management.

2.2. BPM for organizational sustainability

The optimization of organizational practices often is managed through business process management approaches. Literature contains very diverse approaches in context of business process management methods. These approaches are mostly organized in lifecycles that are repeated iteratively, to achieve a continuous improvement process (CIP).

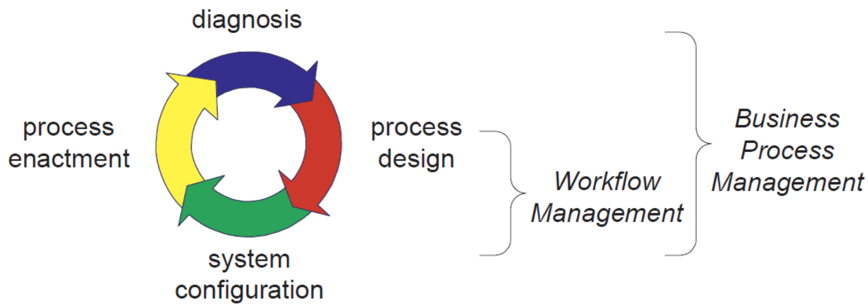

Fig. 2: BPM lifecycle by van der Aalst et al. [7]

One of the most prominent approaches is the lifecycle by van der Aalst [7] which iterates through four phases (c.f. Fig. 2). In the process design phase, business processes are identified and designed/redesigned. The configuration phase includes configuration and selection of the system and implementation of first-phase designs. In the enactment phase, the configured systems are used to execute and monitor the operational business processes. Finally, during the diagnosis and evaluation phase, monitored information is analyzed to identify problems and to detect potential room for improvements. While this approach clearly focuses on the execution and monitoring of processes supported by a workflow engine, there are other approaches that place stronger emphasis on the phases of process analysis and process design.

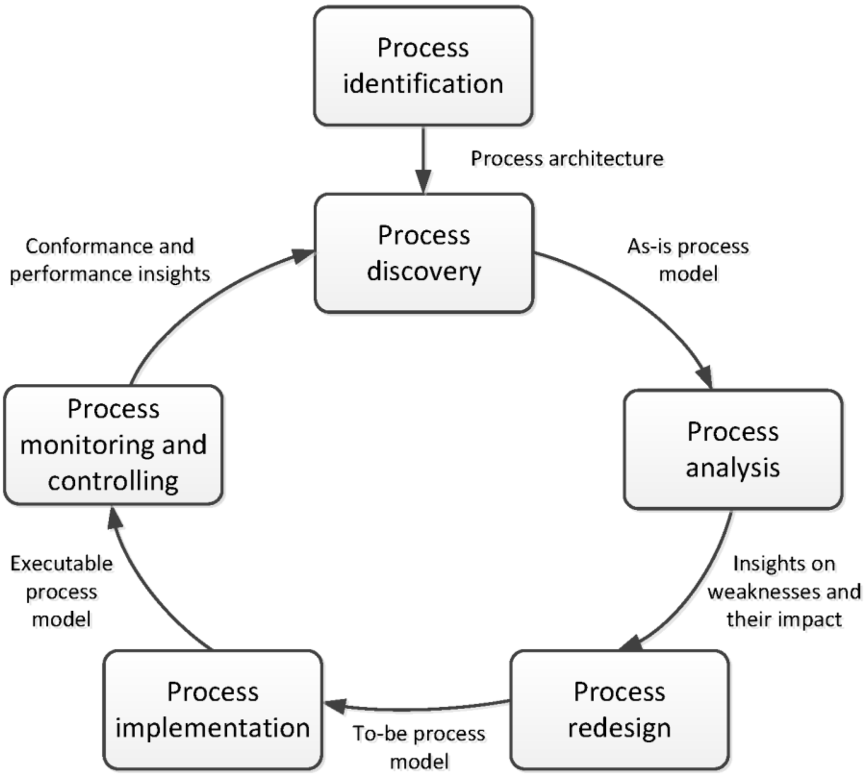

Fig. 3: BPM lifecycle by Dumas et al. [9]

One of these lifecycles is the one recently published by Dumas et al. 2013 [9]. In contrast to the aforementioned lifecycle by van der Aalst et al. there is a clear distinction between phases in which processes are visualized and analyzed (c.f. Fig. 3). However, before analyzing a process, the lifecycle starts with a phase termed "process identification". The main goal of this phase is to identify the start and end of the process in question as well as the factors potentially influencing it. This phase also aims to identify relevant stakeholders which are then used as a source of information for the process in the next phase (c.f. process discovery in Fig. 3), ultimately leading to a visualization of the process within a process model that describes the current state of the process (AS-IS-model). This model is then used to analyze the process in question, to identify problems and flaws. Afterwards, the process is re-designed in order to tackle the identified flaws before it is implemented. During implementation, it is monitored and the lifecycle is run again if necessary.

Both the aforementioned lifecycles – as well as others – are based on the Deming cycle (Shewhart cycle) of plan, do, check and act [39]. Approaches within GreenBPM commonly refer to this model as well. Therefore, in case of a holistic infrastructure for collecting and distributing environmental context data from processes, GreenBPM can adopt and adapt to existing BPM tools, instead of reinventing the wheel.
This is reflected by the GreenBPM model of vom Brocke et al. [5] (c.f. Fig. 4), which expands the dimensions of the BPM model by Becker and Kugeler [3]. The model includes six phases (description of processes, workflow definition, workflow instance execution, monitoring of workflow instance execution, workflow reporting and entire process reporting) evaluated by dimensions of cost, quality, flexibility and time. Vom Brocke et al. add "sustainability" as a dimension of decision making, arguing for the consideration of sustainability objectives in workflows. Deriving a GreenBPM approach from van der Aalst [7], Nowak et al. [28] demonstrate how integrating environmental data into BPM has effects on both general conduct (inclusion of further stakeholders) and design of specific phases (including new key figures). Therefore, sustainability as an issue influences the whole BPM process; yet this does not necessarily imply adding another stream of data, but sometimes just processing existing data in a different way.

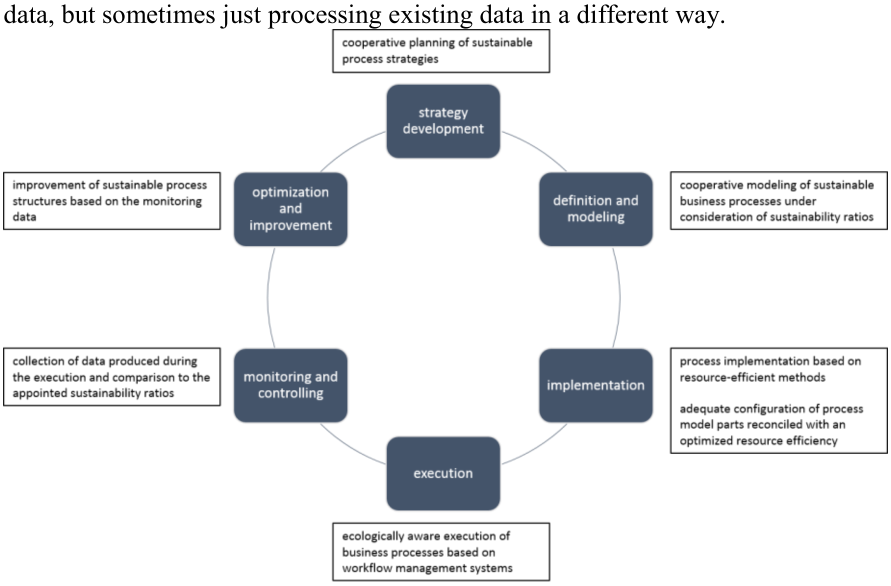

Fig. 4: GreenBPM model by vom Brocke et al. [5]

One major downside of all of the aforementioned lifecycles is that they are usually management-driven as a result of strategic planning. This means that they are mostly driven by a top-down approach in which stakeholders are only partially involved, if at all. This effect is reinforced by the fact that corresponding initiatives are often conducted by external consultants analyzing existing processes and (re-

)designing them with respect to strategic goals. To do so, these consultants may gather information about the processes in question as well as their surroundings using a number of sources. These sources include, but are not limited to, analyzing existing process-documentation, running interviews with process stakeholders or analyzing the data output of software systems. Based upon the knowledge gathered, processes are then typically visualized using graphical modeling notations. These models then serve as a basis for process analyses and are subsequently altered by aforementioned consultants, aiming at attaining strategic goals set by management. It may be necessary to run multiple cycles until a sufficient stage for the model is reached. This model is then also used as a means to inform organizational change and thus to implement the process. During the analysis and design phase, individual workers only passively serve as a source of information about the process in question. However, during the organizational implementation phase afterwards, during which all the designed and developed processes will actually be brought to life, the individual workers are the ones who have to carry out the processes in the way they were designed [22]. Various strategies are used to ensure that people apply new process functions effectively and efficiently. These include: people changing management strategies to overcome the not-invented-here syndrome; set up training strategies to overcome knowledge deficits; and management and controlling strategies to verify whether the actual process is in line with the process designed.

Approaches like the ones described above can be considered common practice within organizations. However, this conduct limits the influence of people directly involved in or affected by the processes at stake to the provision of data. Thus they are not allowed to directly participate in design, which potentially limits people's motivation to adapt to the newly designed processes. Furthermore, by gathering data from single sources and putting it together afterwards, knowledge about the process is only presented from a single perspective, thus leaving out important information. This may result in inefficient processes, if they are seen to be designed against routines and informal workflows made use of by local experts.

In order to address the aforementioned limitations, different approaches have been created in recent years, which can be subsumed as collaborative modelling [27,29,34]. At the center of these approaches are workshop concepts, in which stakeholders - together with consultants - jointly develop models of processes, analyze them and discuss possible changes. These approaches allow for stakeholders to directly participate in process design, thus potentially increasing their motivation to adapt to process modifications afterwards and limiting possible misguided designs. Furthermore, these approaches also allow people to exchange perspectives within workshops, discuss alternatives and come up with a more sophisticated solution on which all stakeholders can agree. So far, however, they lack a discussion of how to appropriately support workers as well as management and external business process managers to take environmental data, such as energy consumption data, into account.

3. Collaboration in green process management

In this chapter we describe the first impressions we gained from an ongoing case study, in which we are investigating and accompanying the implementation of a holistic energy management system. During our interviews with several stakeholders, ranging from operative to strategic management, the need for tailored feedback according to individual roles and specific process knowledge as well as ways to make energy accountable become apparent. We then outline the challenges and benefits of Collaborative GreenBPM and present a preliminary set of tools for supporting collaborative process analysis and modeling.

3.1. Understanding needs in practice

In an ongoing case study within a metal working business, we are exploring possible support for the organizations' style of tracking, evaluating and using energy consumption data for more sustainable processes. While the former are themselves highly complex tasks and out of the scope of this contribution, we here focus on different workers' needs in terms of energy consumption data in order to gain the highest possible added value from the data available.

The company is operational in the area of fastening technology. It employs more than 2300 people in 30 subsidiaries worldwide, and thus can be characterized as largely decentralized. In contrast, the company has a centralized energy management department, which is part of a shared service center and is responsible for managing all subsidiaries in this matter.

Based on an Action Research Methodology [38], we conducted 19 interviews with different stakeholders within the companies. These included workers at operative level, employees explicitly concerned with existing energy management and parts of the companies' management.

Our status quo analysis was aimed at understanding general organizational energy-management activities, as well as individual and role-based preconditions regarding the existing infrastructure, in addition to goals, needs and possible benefits for the internal energy management. The interviews lasted between 30 minutes and 1.5 hours and were recorded on tape for later transcriptions and analysis.

As a result of our research and in close cooperation with the company, we developed an integrated energy management concept that consisted of the major areas hardware, software and processes. The key of the concept includes a measuring sensor system which allows the energy consumption of e.g. the machinery to be monitored. This is already partially realized in practice (e.g. one subsidiary was equipped with sensor technology) Data is stored in a central real-time database system to allow the precise evaluation of the energy consumed in the production process. We additionally plan to roll out our concept to other sites and partners

both from the retail industry and from financial institutes to make the approach more robust.
Throughout the process of accompanying the organization on their way to making choices regarding hardware, software and infrastructure, we also gained insights on the data preferred to better understand energy consumption from each individual's perspective. For example, an energy manager told us quite explicitly:

> "Well you have to understand that my information need is quite different from the need of my CEO. Whereas I need a more specific view on the cause-effect relationship, he needs a more aggregated view."

This depicts a representative statement regarding our general impression of individual and role-dependent needs of energy consumption feedback. Furthermore, during our interviews we were repeatedly confronted with workers' ideas of how to make use of energy feedback data, or how to improve work procedures for more sustainability.

3.2. Envisioning Co-GreenBPM

Taking the aforementioned empirical findings and existing approaches for process improvement into account, we envision Co-GreenBPM as being an approach that ties together individual energy feedback with mechanisms of collaborative modeling. This approach should make use of existing business process management tools, which have proven effective to change organizational structures.

Based on the identified gap regarding potentials of a joint approach integrating both process management and behavioral approaches for optimizing process sustainability, we envision a Co-GreenBPM approach. Our concept of Co-GreenBPM stands in the tradition of collaborative approaches as laid out above. It aims towards a more holistic approach that allows for stakeholders to actively trigger and participate in all phases of the BPM lifecycle. Referring back to the aforementioned lifecycle by vom Brocke et al. [5], we thus do not aim to alter the lifecycle as a whole. Rather our aim is to strengthen the participation of stakeholders throughout the lifecycle (c.f. Fig. 4). This in turn allows us to tap into the full potential of energy saving by making use of local expertise while at the same time fostering acceptance of new processes. We therefore propose to add means of collaboration such as collaborative modeling during process analysis and re-design to the all phases of the lifecycle. We also propose to allow process stakeholders to actively intervene in GreenBPM, thus aiming towards a more bottom-up and people-centered strategy that affects all phases of the lifecycle. Finally, we propose energy feedback to be linked to process models as those models can be seen as the central artifact for process analysis and (re-)design. Linking process steps to energy data using interfaces such as the ones described in the following section might provide a hint for tying abstract representations such as process models to real world data. This in turn might help process stakeholders who are not trained in using models to tie actual energy consumption to abstract representations of process steps in process models.

In order to increase such tools' efficiency and acceptance, however, we aim to add the workers' perspective and local expertise to guide the definition of new workflows by making use of their knowledge on tweaks of everyday working activities. Workshops are at the center of this approach, in which people involved in or affected by processes can discuss "their" respective energy consumption, identify potentials and alter processes with respect to tapping into these potentials. By bringing people together from multiple teams and potentially multiple departments, it is expected that the identification of energy saving potentials that go beyond individual workplace adjustments will be fostered. We furthermore envision Co-GreenBPM as being a bottom-up rather than top-down approach. Using energy feedback systems that allow process stakeholders to view their current and past energy consumption in a manner suitable for them and not only at an individual level but also with respect to the processes they perform, could enable them to identify space for optimization. It should then be possible for them to trigger the aforementioned workshops. Subsequently, the energy feedback allows the impact of the changes that they made to a process to be assessed and may further trigger another round of workshops thus at best resulting in a continuous process of improvement.

However, we additionally do not neglect the potential triggering of Co-GreenBPM by management. Instead, we argue that even if it is a top-down initiative, the worker-level should be involved, thus integrating multiple perspectives and increasing motivation among participants to subsequently actively alter their behavior.
Our concept therefore relies on a bottom-up management approach, which brings changes to the cycles previously used in BPM and considering several issues.

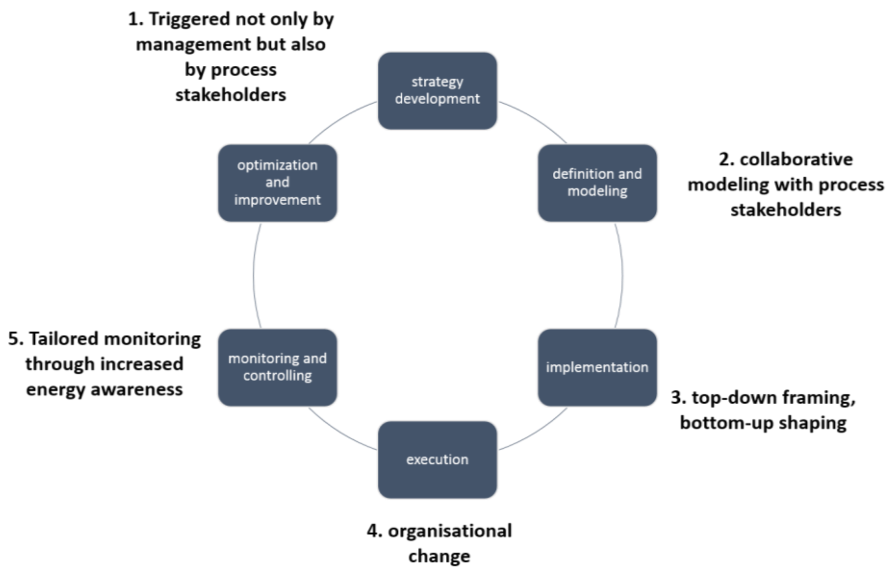

Fig. 5: Co-GreenBPM lifecycle based on classic understanding of vom Brocke [5].

This brings changes to the cycles previously used in BPM with respect to the following issues (c.f. Fig. 5):

1. While BPM initiatives are mostly triggered by management, we aim to allow for process stakeholders and especially process participants to actively start (Green)BPM initiatives. Moreover, if polluting practices are not caused by a lack of motivation, but are due to current process design, workers should be empowered to become aware of this and contribute this knowledge to a continuous improvement process, thus sparking a BPM initiative.
2. In contrast to a top-down change management, in a Co-GreenBPM, next to BPM-specialists, all relevant stakeholders should be asked to participate. Process participants should especially be involved as they are experts of the demands of the situated work practices and opportunities provided by knowledge at operational level. In general, the diversity of the stakeholders makes the process more complex, which has a negative impact on the efficiency of process design phase. Yet including a wide array of knowledge generally has a positive impact with respect to perspectives covered when analyzing a process. To overcome the asymmetries of knowledge among the stakeholders in particular, modelling should take place in collaborative workshops where all participants are valued as experts for their particular domain. Furthermore these workshops provide an environment where abstract visualizations of processes in models can be combined with energy data within those process models, thus creating a possibility for stakeholders of relating models to their individual real world practices.

3. When a process is designed and implemented, the overall circumstances it is conducted in have to be taken into account, e.g. the strategy that the company follows. While this strategy is set by management, it should leave enough room for process participants to shape a process in a form that they can imagine would fit their requirements. Processes stakeholders should thus not only become involved with respect to carrying out a process but also with respect to shaping it, while taking the overall strategy into account.
4. While a lot of BPM initiatives aim towards processes that can later be transformed into a workflow and potentially even carried out by a workflow engine, our approach also aims towards processes that might not be carried out with respect to a predefined workflow. We rather also intend to allow Co-GreenBPM to be useful for e.g. knowledge-intensive processes. This in turn means that execution has to focus on an organizational change project, with stakeholders being strongly involved in order to ensure its success.
5. Traditional eco-feedback systems mainly focus on direct feedback to motivate people to act sustainably in the current situation [8,11]. In the context of Co-GreenBPM eco-feedback, people should additionally be encouraged to reflect on their work practice with regard to green processes (and vice versa). Furthermore, in a green process, environmental data is needed by various stakeholders (e.g. the management, the worker, the controller, etc.). Hence, data visualization needs to be tailored to the individual demands of different stakeholders. Furthermore feedback has to be tied to process steps in a visual way, thus building the bridge between abstract representations of process steps and real life data. Providing individualized views on process and energy consumption feedback and tying that feedback to process steps will enable stakeholders to use their tacit knowledge to reflect how processes and (!) situated work could be designed in more sustainable ways. Such tailored feedback for included stakeholders needs to provide a basis for decision making when designing sustainable processes. Taking into account energy's complex nature [31], this, however, raises the question, which kind of data workers need to reflect on their energy consumption behavior in terms of both their own workplace and the organizations processes.

3.3. Envisioning tools and methods

In order to include the heterogeneous group of stakeholders and their individual expertise, we envision a highly customizable set of tools for understanding and evaluating energy consumption and thus enabling a change process. At a methodological level, our approach is based on the established concept of collaborative modeling [32,33,34]. This concept focuses on a series of workshops in which stakeholders jointly analyze processes they are involved in by visualizing them using process models. During these workshops, they are supported by a facilitator who manages the communication and also translates the contributions by the process stakeholders into elements of a modeling notation [15]. It has also been observed that process stakeholders are capable of analyzing parts of processes they are involved in on their own [27]. Due to this possibility, process analysis may also be extended across the boundaries of workshops and may thus ultimately also occur while the process is being executed. To analyze the sustainability of processes, we extend on these approaches by suggesting appropriate tools of making energy consumption accountable. We are currently developing prototypic solutions in close collaboration with employees of the company and plan to evaluate them in practice to increase our understanding of designing for respective stakeholders.

To address the significantly varying requirements, the first software tool we designed provides the different stakeholders with individually tailored and highly customizable feedback. As a direct consequence of our empirical work, employees should be enabled to create their own, meaningful key performance indicators and visualizations for their area of expertise using this software.

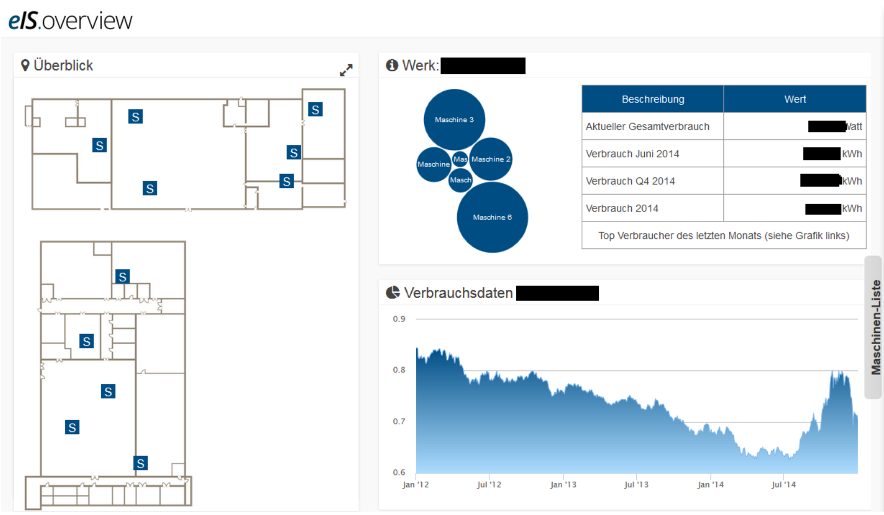

Fig. 6: Prototype of energy awareness board for flexible feedback allowing for individual tailoring

To support communication across hierarchical boundaries, we are implementing a sustainability-reporting tool that supports semi-automatic creation of sustainability reports with a drag-and-drop mechanism. Templates for reporting standards (e.g. GRI v4) are already implemented in the tool, but employees also have the opportunity to create their own templates for custom reporting. It is possible, for example, to create an in-house process-reporting template, which employees can build individually or collaboratively; and they are empowered to customize the reports to fit their individual information need, e.g. by incorporating KPIs that are compiled by the KPI editor. The intention is to support communication across organizational structures and to raise energy awareness for colleagues' or other departments' understanding of energy consumption. To foster general awareness about processes and their energy consumption intensity, we are currently building a tool for digital representation of organizational sites.

This tool allows e.g. executive producers, maintenance, or employees to monitor real time consumption of the plant and its (measured) appliances and workers. Furthermore, we will implement real-time algorithms that allow users to specify ranges of energy consumption, to allow proactive maintenance. Although the tool does not aim specifically to support a green bpm process, it gives the relevant stakeholders the feedback which is both desired and needed to engage in a CoGreenBPM.
In addition to this overview, we prepared an organizational-role-based dashboard for the company to support the need for information even further. By virtue of the role-based construction, each employee automatically receives the energy feedback data of the relevant processes, machines, equipment and environment which are relevant to him. The data is presented in a meaningful form. In addition, the dashboard can be customized by the employees to show more information if necessary. Both the KPI-editor and the dashboard widgets are an integral part of the sustainability-reporting tool, since the KPIs and the widgets can be integrated into the reports.
Within the next few months, our prototypes will be rolled out and evaluated in practice in order to develop them further and to gain a deeper understanding of organizational needs and the potentials and challenges when introducing a CoGreenBPM.

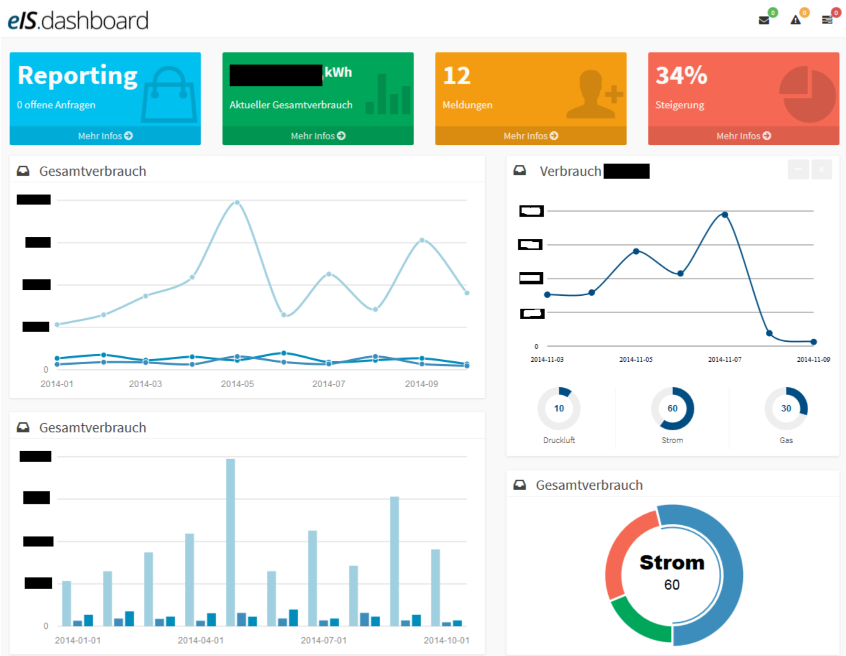

Fig. 7: Tailorable dashboard for understanding and managing energy consumption for different levels of accountability

4. Discussion & Research Agenda

We have addressed the gap between green processes and green practices by combining environmental, psychological and organizational theories. We presented Co-GreenBPM as a conceptual framework to bridge the gap, taking into account work practices as well as strategic process improvement. We further outlined the key challenges of how environmental data should be included into a collaborative GreenBPM in order to enable stakeholders to make sense of data, provide group awareness for energy consumption and actively include them into process management, thus tapping the full sustainability potential in organizations. While we do acknowledge that there is work on collaborative modeling as well as on Green BPM still to be done, we think that the combination of both approaches in Co-GreenBPM the way is novel and extends existing methods in multiple ways:

- CoGreemBPM is not limited to processes that are carried out and controlled by using workflow engines. It rather explicitly aims at any process in which collaboration takes place, thus explicitly taking organizational change into account.
- In contrast to other frameworks Co-Green BPM places emphasis on process stakeholders as triggers, drivers and active participants in process analysis and (re-)design, focusing on reducing energy consumption and can thus be considered a bottom-up approach. While not diminishing the importance of management support (e.g. the provision of a frame for process change), our emphasis clearly lies on active (!) stakeholder involvement. This is expected to not only allow for identifying potentials for saving energy but also to increase the motivation of stakeholders to actively pursue an energy saving approach.
- Co-Green BPM includes continuous awareness and feedback mechanisms which do not only serve as a means to assess the current state of energy consumption but that may also be used to trigger process assessments as mentioned before.
- Technical as well as conceptual combination of process models with energy awareness links abstract representations of processes (models) to real world phenomena thus again strengthening the combination of organizational change and individual behavior.

As Co-GreenBPM does not aim towards reinventing BPM but rather at altering existing approaches in order to tap their full potential, organizations may even build upon established strategies.

Our next step will be to aim towards enriching our theoretical considerations with further empirical work. We will investigate in more detail effective ways of including environmental data to identify green process improvements and set up collaborative modeling workshops accordingly. This covers multiple areas and may serve as a future research agenda:

- Investigating various views, interests and motivations on green processes, including questions such as what kind of environmental data is needed, both every day and at strategic work level. This also includes ways of feeding back such data effectively and efficiently to stakeholders in a collaborative BPM process.
- Identifying ways of combining energy feedback with process models thus connecting process steps in models directly with energy data using interfaces as described before. This explicitly takes into account whether or not the combination of models and energy feedback actually leads to a better understanding of processes and ultimately to better processes with respect to energy consumption.
- Assessing the impact of environmental data on decision-making, process modelling and process adoption. Concerning this, we are currently approaching a variety of organizations including manufacturing, trading sector and office work.
- Assessing the impact of the Co-Green BPM on the motivation of stakeholders for behavioral change. This includes not only the question if stakeholders are willing to participate in organizational change based on energy feedback and a corresponding analysis of processes not only in Co-Green BPM; but also aims to understand factors that lead participants to start Co-Green BPM themselves.

While the approach is firmly grounded in literature and backed up by first empirical findings, it is still limited as it is a conceptual approach that has to undergo a more thorough assessment, thus answering the aforementioned research questions.

We will continue our action research and plan to conduct a first beta version of Co Green BPM within the afore-mentioned organization by bringing together strategic and operative planning and working. We will further foster collaborative work of the stakeholders on making their organization more sustainable, on both levels: everyday behavior, infrastructure and processes in order to tap into the full potential of smart energy measurements in organizations.

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