Kick-starting Green Business Process Management – Suitable Modeling Languages and Key Processes for Green Perfomance Mesaurement

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ABSTRACT

In this paper we examine an initial step towards Green Business Process Management. We give insights from a research project with the goal of monitoring and redesigning business processes in an environmentally sustainable manner. Using literature analysis and three case studies we derive suitable languages and software for business process modeling. In addition, we show business processes that can act as key examples for green process monitoring and redesign. The results show that enterprises can build up on process modeling and energy monitoring to become more environmentally sustainable.

Keywords

BPM, Green IS, Green IT, Sustainable Information Management, Green Business Process Management

INTRODUCTION

During the last decade environmental protection has started to gain reasonable awareness in information systems (IS) research. As a result of the growing global population, increasing demands, limited resources, and the effects of global warming, the information technology (IT) industry is challenged with minimizing its environmental impact and facilitating new and smart solutions to provide more with less (Schmidt, 2011). Building upon these issues, a new IS research discipline has emerged during the last years by additionally taking into account the role of IS to support sustainable business practices: Green IS (Watson, Boudreau and Chen, 2010). Similarly in the research discipline of business process management (BPM) substantial progress was made in terms of process orientation in enterprises. However, in terms of combining the two aspects Green IS and BPM, there is still a certain lack of research. Although there are countless case studies about environmentally sustainable IT projects, almost all of them have chosen a more functional or organizational approach. In particular, most projects deal with aspects of *greening* a department or business functions, like green data centers, green office environments or green logistics. A process oriented approach towards a green business is still missing in research and practice. This article is a research in progress paper from a long term research project and addresses the following issues:

- *Which business process modeling language and software is suitable for monitoring energy efficiency key performance indicators (KPIs) in business processes?*
- *Which business processes can be used as key examples for a green business process management tool?*

For answering these questions we will give insights from a public private partnership project with the goal of developing a business process oriented management cockpit for monitoring and managing the energy efficiency of information technology resources in enterprises. It is structured as follows: In the next section we will discuss the fundamentals of Green IS, process management, and give some insights into our current project. Thereafter we will explain our research concept and explain our methodology. In the following section we will show our findings. The research questions are answered in the last section, along with some implications and ideas for further research.

RELATED RESEARCH

In the following section the fundamentals of process management and the *Green* dimension of sustainability are discussed for the sake of legitimization of the research field. Furthermore, we give some insights into the research project from which this article originates.

Sustainability and Green IS

Not at least because of the growing consumption of natural resources and the increased carbon dioxide emissions, sustainability has been considered as a crucial concept within corporate management (Lubin and Esty, 2010). The predominant understanding of sustainability was shaped by the definition of the Brundtland commission as a "… development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). This definition is broad and somewhat imprecise. This makes it difficult for organizations to apply the concept in the business environment. Sustainability at the business level has emerged as a concept of long-term simultaneous optimization of economic, environmental and social objectives to generate a lasting superior financial performance for the business, known as the "triple-bottom-line" concept (Epstein and Roy, 2001; Elkington, 1997). Its three dimensions are not mutually exclusive and provide a framework for companies to measure and report their performance and organizational success according to these three pillars.

While organizations are still motivated to adopt sustainable business practices (Seidel et al. 2011), the IS research community is encouraged to clarify the role of IS in contributing to these efforts by using its transformative potential (Watson 2010; Melville 2010). The latter has resulted in the term *Green IS*, which is more far-reaching than 'Green IT' and comprises a greater variety of possible initiatives to support sustainable business processes (Watson et al. 2010, Boudreau et al. 2008). In contrast, Green IT is used as a generic term and multifaceted construct for measures and activities which aim at increasing the energy efficiency of IT operations and enhancing the sustainable usage of material resources (Boudreau, 2007). Murugesan (2008) for example, refers Green IT to environmentally sustainable IT and defines it as "the study and practice of using computing resources efficiently". In line with Watson, Boudreau and Chen (2010) we argue that Green IT is too limited because it is restricted to the lifecycle of IT, whereas Green IS (which includes Green IT) encompasses all IS-based initiatives, supporting sustainable business practices.

Business Process Management

Processes have been established as a central element of analysis in the planning, managing, and controlling of tasks in enterprises and government. However, the process view focusing on the transformation of input factors into an output is never an independent view of activities (Hammer and Champy, 1996). Within the holistic approach of Business Process Management (BPM) we focus on business processes, combine different perspectives and their artifacts – for example: a process, its assigned (IT) resources and its integration into the organizational structure – to generate a feasible process performance (Hammer, 2010).

In the last 20 years the IS and BPM research community focused particularly on questions concerning the value addition of IT for the business (Brynjolfsson, 1993; Lucas, 1999; Remenyi et al., 2007; Renkema and Berghou, 1997). On the one hand, IT was identified as a technological enabler of a specific business. On the other hand, IT supports processes, which made it very difficult to measure the direct impact of IT (Wigand et al., 1997). In our new common understanding, Green IT and Green IS support a process change which in turn enables a Green Business design (Seidel et al., 2011). As a result, it is not sufficient to introduce new Green IT and Green IS 'features'. It is also important to adapt the old processes and other connected artifacts, e.g. the organizational structure (Reichwald et al., 1996). An additional management task is to establish sensitivity and acceptance for employees by working with the new developed Green Processes and their related systems (Seidel et al., 2011).

For the management of business processes there are a number of different process models, maturity models, languages and graphical notations. De Bruin et al. (2005) developed a maturity model to evaluate the ability of an organization to perform their process management. This maturity model used the evaluation criteria "strategic alignment", "governance", "methods", "technology", "people" and "culture". One of the most widely used languages which comes with a graphical notation is the Business Process Model Notation (BPMN) to represent processes (OMG, 2009). The parent challenge lies in the integration of different concepts to a holistic approach for Green IT and Green IS which finally supports the management.

The Public Private Partnership Project

This article is based on the insights gained during the initial phases of a long term federal funded project[1] with several partners from both research and business. The project's goal is the development of a business process oriented management

[1] The project has a duration of three years and started in September 2011. It is funded by the German Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie, BMWi). Researchers from two universities are involved. From a business side there is one stock listed globally acting corporation, a German federal department and one SME (small and medium-sized enterprise) involved.

cockpit for monitoring and managing the energy efficiency of IT resources in corporations. Based on a set of Green KPIs and a performance measurement system we aim to improve on the field of operational business intelligence.

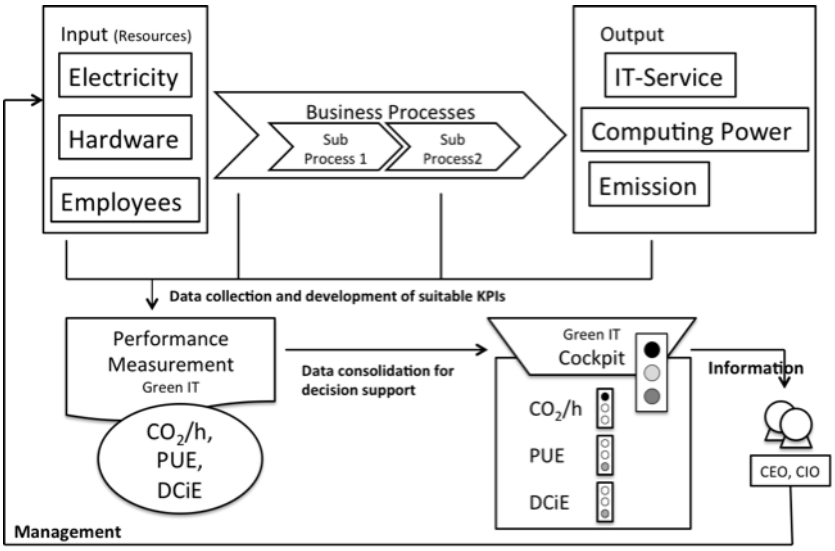

Figure 1: Project Overview

The cockpit software is an integrated and organization-wide reporting portal for the monitoring and controlling of IT energy efficiency in processes and value chains. It will enable organizations and managing personnel to manage the energy efficiency of different departments (such as data centers, office environment, network infrastructure and peripherals such as servers, clients, printers, phones etc.). It will collect data from those location sites and will display them in a business process oriented and easy to understand way e.g. with charts, traffic lights or tachometers (see Figure 1). This is going to help organizations to identify the environmental impact of their business processes and to redesign them to become more environmentally sustainable.

METHODOLOGY

This section gives an overview of our research process. As this is a long term project the process is shown in total and then refocused on the goals that have already been achieved. Initially, there is a comprehensive description of the whole research framework, followed by in-depth reviews of our criteria check lists for modeling languages, software and to be selected business processes of our project partners.

Conceptual Research Framework

The general approach in our project is modeling suitable current business processes and IT resources from our partners. After that the individual sub processes are connected to the IT resources used (work stations, notebooks, servers, communication devices etc.). Simultaneously, EMS (energy monitoring systems) are installed to monitor and aggregate energy consumption of the involved IT resources. For achieving this goal we divided our initial research process into five steps (see Figure 2). Our current research is focused on process modeling and performance measurement. It has not to be confused with the holistic business process management approach described in the former section – it is only part of it. Concerning the *six core elements of BPM*, our current research is located in the process modeling, monitoring and control section of the methods and information technology area (Rosemann, 2010).

After a systematic literature review (step 1) several criteria check lists have been developed for suitable process modeling languages, IT resources modeling languages, modeling software and exemplary business processes (steps 2a – 2c). This will be discussed further in the next subsection. In addition a list of Green KPIs was derived (step 2d), that could possibly be calculated from the energy monitoring system outputs and later be part of the Cockpit software. Examples are the already known PUE (Power Usage Effectiveness), DCiE, DCE (Data Center Infrastructure Efficiency) or DCeP (Data Center energy Productivity). In step 2e a list of EMS vendors was created, including their features, licensing cost and further info.

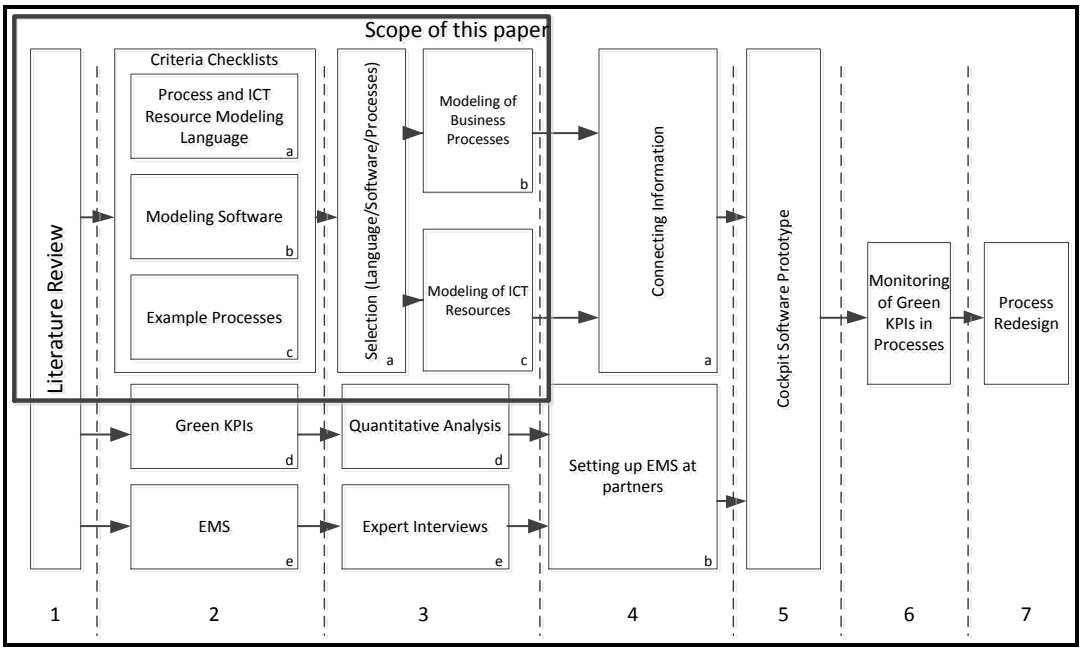

Figure 2: Green BPM Research Concept

In step 3 we selected the appropriate modeling language, software and business processes (step 3a) and started building the business processes and IT resources models (step 3b and c). The findings are discussed in detail in the next section. In addition, we validated our Green KPI list in a cross-sectional study (step 3d) and further investigated in EMS by expert interviews with users and vendors. This outlines our research so far. The next steps will be to connect the information of the processes and resources models, to start collecting KPI data with EMS and to build the Cockpit software prototype. After that, we can finally start monitoring Green KPIs on a business process based level and redesign those processes to become more environmentally sustainable.

Criteria Checklist for Modeling Languages, Software and Business Processes

While we started investigating on a suitable language for process modeling, one for resource modeling and a software tool separately, at second glance this turned out not to be a good approach. There are several dependencies between these three choices. As our project is business process centered, we started over by choosing a process modeling notation which met our requirements. Afterwards we looked for software tools that can handle the selected process modeling language and also suited our other requirements. For modeling the IT resources we would then just use whatever the selected tool is capable of. Concerning the criteria check list for process modeling languages we have chosen to split the criteria in two groups. Group one contains formal aspects of modeling notations that we derived from literature (see Table 1). The second group contains project specific requirements that were formulated during case studies with our project partners. What has been said about the missing link between business process management and Green IS in the beginning of this article can also be applied on process modeling and Green IS. While there is plenty of literature on process modeling in general the research on combining this with sustainability aspects has only just begun (Recker, 2010).

Following Becker et al. (2008), there are six characteristics of proper modeling. These are in particular correctness, relevance, effectiveness, clearness, comparableness and systematic design. From the basic characteristics two dimensions have been derived. The cognitive dimension describes the ability of model users to grasp and understand the notation (Carlsson et al., 2008). It is based on the characteristics clearness, correctness and comparableness. This is important for an effective communication. A good model is one that helps with effective communication among its users. As minimal changes in notation can have severe consequences in terms of comprehension, misunderstanding can lead to serious problems (Carlsson et al. 2008). According to Moody (2006) the cognitive dimension of graphical modeling can be divided into nine sub perspectives. For reduction of complexity we decided to use five of these, especially discriminability, manageable complexity, direct perception, structure, identifiability, visual expressiveness and graphic simplicity. For a deeper review of the single perspectives please refer to the original source (Moody, 2006).

The technical dimension on the other hand describes the capabilities of the modeling language and the number, meaning and limitations of its notation elements. According to List and Korherr (2006), the technical dimension can be divided in a

functional, organizational, behavior-related, informal, and a supporting sub perspective. The functional perspective contains activities and sub processes. The organizational perspective is divided into notation elements which describe who performs which task, especially internal and external participants, organizational units, roles and software. The behavior-related perspective describes control flows and branching, so it contains AND, OR and XOR operators. The informal perspective represents information objects, such as events, data flow, information, and software resources. Finally the supporting perspective contains information on supported software tools, convertibility, diffusion rate and automated execution. For a detailed review on this set of perspectives please refer to the original source (List and Korherr, 2006).

For evaluating different modeling languages with the aforementioned criteria we used a fictional case study based on several standard business processes. We weighted the cognitive and technical dimension equally, as an intuitive graphical reference is as important as its content (Carlsson et al., 2008).

Dimension / Perspective	Item
Cognitive Dimension	
	Discriminability
	Manageable Complexity
	Direct Perception
	Structure
	Identifiability
	Visual Expressiveness
	Graphic Simplicity
Technical Dimension	
Functional Perspective	
	Activity
	Sub Processes
Organizational Perspective	
	Internal
	External
	Organizational Unit
	Role
	Software
Behavior-related Perspective	
	AND
	OR
	XOR
Informal Perspective	
	Event
	Data Flow
	Information Resource
	Software Resource
Supporting Perspective	
	Tool Support
	Convertibility
	Diffusion Rate
	Automated Execution

Table 1: Formal Criteria for Modeling Languages

In addition to the formal criteria on modeling languages, we identified project specific aspects a modeling notation should be capable of. First of all, the meta model of the language should be non-proprietary so we could adapt the language if necessary. Secondly, the language should not be bound to any specific software tool. It should be capable of measuring our Green KPIs. Lastly, if a specific language would have been already thoroughly in use in process models of our project partners we would consider them even if they do not perform so well in the remaining criteria.

Dimension	Item
Project Specific Dimension	
	Adaptable
	Not bound to Software
	Green KPIs
	Already in use

Table 2: Project Specific Criteria for Modeling Languages

Concerning modeling software we defined several project specific criteria. The most important aspect was the ability to model both business processes and IT resources as it would add too much complexity to have two separate software tools for

those tasks. Secondly the tool had to support the chosen business process modeling language. In addition, licensing cost and compatibility was an issue. The tool has to be compatible with the different operating systems of our project partners or at least have standardized and open format import or export functionality in order to use already existing process or IT resource models, preferably XML. Finally a simulation engine would be a nice additional feature.

Dimension	Item
Project Specific Dimension	
	Process and Resources Modeling
	Support of Chosen Modeling Language
	Licensing Cost
	Compatibility
	Import and Export XML
	Simulation Engine

Table 3: Project Specific Criteria for Modeling Software

In order to gather input data for the cockpit software prototype, we had to choose meaningful example business processes from our practice partners. This is an ambivalent issue however. From a researcher's perspective, standard business processes were somehow desirable, as those are transferable to many other businesses. This would ensure a broader impact of our findings. From our partner's perspective, however, their core business processes were the most interesting, as these are critical for their business. The challenge was to find processes that met both party's demands. As our project is aimed at environmental sustainability, IT involvement was another general criterion on the selected processes. In order to be able to monitor the involved IT resources, the processes have to run in-house.

Dimension	Item
Project Specific Dimension	
	Standard Business Process for Broad Impact
	Core Business Process for Meeting Project Partners Demand
	IT Involvement
	In-House

Table 4: Project Specific Criteria on Business Processes

FINDINGS

Business Process Modeling Languages

All findings are based on the criteria lists from the previous section. We started with compiling a list of all modeling languages that seemed to be suitable. This list included BPMN (Business Process Model and Notation), EPC (Evident Driven Process Chain), UML 2.0 Activity Diagram (Unified Modeling Language), IDEF0 (Integrated DEFinition Method) Petri Net and RAD (Role Activity Diagram). After a first audit BPMN, EPC and UML were chosen for an in depth review. All criteria list items could be scored with + (1 point), o (0 points) and – (-1 point). The results were then added up as shown in Table 5.

Dimension / Perspective	Item	EPC	BPMN	UML Activity Diagram
Cognitive Dimension (50%)	**Sum**	**1**	**2**	**0**
	Discriminability	o	o	-
	Manageable Complexity	o	+	o
	Direct Perception	o	o	o
	Structure	-	+	-
	Identifiability	o	o	o
	Visual Expressiveness	+	+	+
	Graphic Simplicity	+	-	-
Technical Dimension (50%)	**Sum**	**-0,8**	**3**	**1,2**
Functional Perspective (20%)	**Sum**	**0**	**2**	**1**
	Activity	o	+	o
	Sub Processes	o	+	+
Organizational Perspective (20%)	**Sum**	**-1**	**2**	**2**
	Internal	-	o	o
	External	o	o	o
	Organizational Unit	o	+	+
	Role	o	+	+
	Software	o	o	o
Behavior-related Perspective (20%)	**Sum**	**0**	**3**	**0**
	AND	o	+	o
	OR	o	+	o
	XOR	o	+	o

Informal Perspective (20%)	Sum	0	4	1
	Event	o	+	o
	Data Flow	o	+	+
	Information Resource	+	+	+
	Software Resource	-	+	-
Supporting Perspective (20%)	**Sum**	**-1**	**4**	**2**
	Tool Support	-	+	o
	Convertibility	-	+	+
	Diffusion Rate	+	+	+
	Automated Execution	o	+	o
Final Score		**0,1**	**2,5**	**0,6**

Table 5: Formal Scoring of Modeling Languages

As can be seen in Table 5 BPMN scored best concerning the formal criteria list. In addition we checked for project specific criteria. It turned out that all three modeling notations are generally adaptable, as they have a free non-proprietary meta model. Likewise all three notations are not bound to any specific software tool. Because of the better integration of system and software roles, BPMN and UML scored better in terms of connecting to KPIs than EPC. BPMN and EPC scored one additional point as they were already quite common at our project partners' enterprises, making learning and understanding for involved employees easier.

Dimension	Item	EPC	BPMN	UML activity Diagram
Project Specific Dimension	**Sum**	**3**	**4**	**3**
	Adaptable	+	+	+
	Not bound to Software	+	+	+
	Green KPIs	o	+	+
	Already in use	+	+	o

Table 6: Project Specific Scoring of Modeling Languages

Summarizing Table 5 and Table 6, BPMN was chosen as a suitable language for our research. It has broader technical capabilities as of its number of symbols than EPC. On the other side it is more focused an easier to understand than the UML Activity Diagram. Finally it was designed specifically for business process modeling.

Modeling Software

Currently there are over 70 vendors of BPMN software solutions (Object Management Group, 2012). This enormous list is hard to evaluate as a whole. For this reason we shortened the list down to five suitable tools and reviewed them according to our criteria list. The results are shown in Table 7. Following these findings, we use ARIS Business Architect. It can display the selected business processes and the involved IT resources in one tool, has XML import and export, and is kind of a business standard.

Dimension	Item	Adonis	ARIS	Bonapart	Eclipse BPMN	jBoss	Prometheus
Project Specific Dimension	**Sum**	**4**	**5**	**4**	**4**	**3**	**2**
	Process and Resources Modeling	+	+	+	+	o	o
	Support of chosen Modeling Language	+	+	+	+	+	+
	Licensing Cost[2]	-	+	-	+	+	o
	Compatibility	+	o	+	+	+	o
	Import and Export XML	+	+	+	+	+	+
	Simulation Engine	+	+	+	-	-	o

Table 7: Project Specific Scoring of Modeling Software

Business Processes

As mentioned in the related research section, we are modeling business processes of three different entities: a globally acting corporation, a German federal department and one SME. The challenge was to find processes which are core to the business partners, but are also transferrable to some extent.

In the globally acting corporation, we chose one core and two supporting processes. The core process is publishing a news article over the internet. It starts with the arrival of a news agency announcement and matching media such as photos or videos. An editor preselects a suitable announcement, does additional research on the matter and writes an initial version of

[2] Scoring for software licenses were based on special educational or individual offers. They do not reflect retail prices.

an article. Afterwards the article is escalated to a senior editor for quality check. The article then comes back to the editor for revision or directly goes to the layout department. After layout, the article is published. This is where the process stops, as we cannot monitor the involved IT on the way to the customer (internet access technology). The process heavily relies on a central CMS, which itself uses various IT resources. The first support process is procurement. An employee announces demand for some goods, a supervisor approves it and the procurement department places an order and does the invoice handling. The second support process is internal IT helpdesk. It is implemented as an IT Infrastructure library (ITIL) process.

In the federal department we also chose one core and two support processes. Here the core process is drug accreditation. A pharmaceutical or chemical company gives samples to the department. They are checked in various subsequent steps and finally approved or rejected. At the moment this process relies on three completely different software systems. Some sub processes have to be done repeatedly on multiple systems. There is high potential for process redesign. The support processes also involve procurement and internal IT helpdesk.

Finally, for the SCE we chose three standard processes: Procurement, invoice handling and hiring of a new employee. The SCE had no significant IT based core processes, so standard processes were the way to go.

CONCLUSION

From the results in the former sections it can be concluded that with certain limitations process and resources modeling in combination with energy monitoring systems can build a solid foundation for working towards Green Business Process Management.

Our initial research question "Which business process modeling language and software is suitable for monitoring energy efficiency key performance indicators in business processes?" can be answered as follows: Based on formal and project specific criteria, BPMN performed best in terms of functionality, adaptivity, and diffusion rate. Concerning modeling software, there are many alternatives with individual up and downsides. ARIS Business Architect proved to be a good fit. It does meet our demands and has proven to be widespread among many enterprises (Lankhorst, 2005). Our second research question was titled: "Which business processes can be used as key examples for a green business process management tool?" For that matter it can be stated that exemplary processes for green monitoring and process redesign should meet some requirements. They should be run as much in-house as possible. As soon as sub processes are performed elsewhere they can hardly be properly monitored. Furthermore, processes should rely on IT in order to gain meaningful data on their environmental impact. With processes from procurement, IT helpdesk, electronic publishing and drug accreditation we met these demands.

Limitations & Implications

There are some limitations in our preliminary findings. First of all, an energy monitoring system was not set up yet. So we cannot see how well our processes and resources modeling turns out right now. As this is work in progress, the focus relies on only few key processes at the moment. In the long run all business processes of enterprises should be monitored and redesigned. Moreover, at this time only IT related energy consumption is monitored. Although IT has a severe impact on environmental sustainability, it goes without saying that its redesign is not sufficient for achieving a green business.

There are several practical implications of our findings. For enterprises we suggest the selection of IT involving exemplary processes for monitoring their energy efficiency. This would have several benefits. One the one hand these processes can be redesigned in an environmentally sustainable way. That would lead to lower energy consumption, energy cost and ultimately a greener business. On the other hand collected data can be used in advertising their services. In addition to publishing environmental footprints for mere products, a footprint of complete business services can be used.

Our research contributes to the body of knowledge, as our approach can be seen as the base of a Green Business Process Management. We showed a starting point for researchers to build up on with their own theories and concepts on Green BPM. Further research is necessary however. We will continue with our concept as shown in Figure 2. By the end of the research project we will have a best practices framework for Green BPM. In addition to that we will conduct several more case studies with other companies in order to validate our concepts. By connecting the results of this paper with our findings on EMS and Green KPIs, our insights will help to advance theory in terms of Green Business Process Management.

REFERENCES

1. Bannister, F., Remenyi, D. (2000) Acts of faith: instinct, value and IT investment decisions. in: *Journal of Information Technology 15 (3)*, 231-241.
2. Becker, J., Kugeler, M., Rosemann, M. (2008) Prozessmanagement, Ein Leitfaden zur Prozessorientierten Organisationsgestaltung, 6th edition, Springer, Berlin.
3. Boudreau, M.-C. , Chen, A. J. and Huber, M. (2007) Green IS: Building Sustainable Business Practices, in Watson, R. T. (eds.) *Information Systems*, Global Text Project, Athens, Georgia, 1-15.
4. Boudreau, M., Watson, R. T. and Chen, A. (2008) From Green IT to Green IS, *Cutter Benchmark Review*, 8, 5, 5-11.
5. Brynjolfsson, E. (1993) The productivity paradox of information technology. in: *Communications of the ACM 36* (12), 67-77.
6. Carlsson, S., Johansson, L.-O., Kjellin, H., Wärja, M. (2008) Graphical modeling techniques and usefulness in the Model Driven Arcitechture: Which are the criteria for a"good" Computer independent model?, in: *The 31st Information Systems Research Seminar in Scandinavia* (IRIS31).
7. de Bruin, T., Rosemann, M., Freeze, R., Kulkarni, U. (2005) Understanding the Main Phases of Developing a Maturity Assessment Model. in: *16th Australasian Conference on Information Systems* (ACIS 2005), University of Technology Sydney, Sydney, 1-10.
8. Deming, W. E. (1986) Out of the Crisis. MIT Center for Advanced Engineering Study.
9. Elkington, J. (1997) Cannibals With Forks: The Triple Bottom Line of the 21st Century, Capstone, Oxford.
10. Epstein M. J. and Roy M. J. 2001. 'Sustainability in Action: Identifying and measuring the key performance drivers'. Long Range Planning Journal, 34: 585-604.
11. Hammer, M., Champy, J. (1996) Business Reengineering – Die Radikalkur für das Unternehmen. 7th edition, Campus. Frankfurt a. M., Germany.
12. Hammer, M. (2010) What is Business Process Management? in: vom Brocke J. and Rosemann (eds.) Handbook on Business Process Management 1: Introduction, Methods and Information Systems, Springer, Berlin, Germany, 3-16.
13. Lankhorst, M. (2005). Enterprise Architecture at Work: Modeling, Communication, and Analysis, Springer, Berlin.
14. List, B., Korherr, B. (2006) An Evaluation of Conceptual Business Process Modelling Languages in: *Proceeding of the 2006 ACM symposium on applied computing (SAC)*, Dijon 2006, 1532-1539.
15. Lubin, D. A. and Esty, D. C. (2010) The Sustainability Imperative - Lessons for Leaders from Previous Game-Changing Megatrends, *Harvard Business Review*, 88, 5, 42-50.
16. Lucas, H. C. (1999) Information technology and the productivity paradox. Oxford Univ. Press, New York et al.
17. Melville, N., (2010) Information Systems Innovation for Environmental Sustainability, MIS Quarterly, 34, 1, 1-21.
18. Moody, D. (2006) What Makes a Good Diagram? Improving the Cognitive Effectiveness of Diagrams in IS Development, *Advances in Information Systems Development*, Budapest 2006, 481-493.
19. Murugesan S. (2008) Harnessing Green IT: Principles and Practices, *IEEE IT Professional*, January-February, IEEE Press, 24-33, New York.
20. OMG. (2009). Formally Released Versions of Business Process Model and Notation (BPMN) Version 1.2.
21. OMG (2012), *http://bpmn.org/#tabs-implementers*, retrieved on 2012-02-12.
22. Recker, J., Rosemann, M., Gohar, E. R. (2010) Measuring the Carbon Footprint of Business Processes in: zur Muehlen, M., Su, J. (eds.) Business Process Management Workshops, BPM 2010 International Workshops and Education Track Hoboken, NJ, USA, September 2010, Revised Selected Papers, Springer, Heidelberg, Germany, 511-520.
23. Reichwald, R., Höfer, C., Weichselbaumer, J. (1996) Erfolg von Reorganisationsprozessen. Schäffer-Poeschel, Stuttgart, Germany.
24. Renkema, T. J. W., Berghou, E. W. (1997) Methodologies for information systems investment evaluation at the proposal stage: a comparative review. in: *Information and Software Technology 39 (1)*, 1-13.
25. Remenyi, D., Money, A. H., Bannister, F. (2007) The Effective Measurement and Management of IT Costs and Benefits. 3rd Edition, Elsevier, Amsterdam.

26. Rosemann, M., vom Brocke, J. (2010) The Six Core Elements of Business Process Management in: vom Brocke J. and Rosemann (eds.) Handbook on Business Process Management 1: Introduction, Methods and Information Systems, Springer, Berlin, Germany, 107-122.
27. Schmidt, N. H. (2011) Environmentally Sustainable Information Management – Theories and Concepts for Sustainability, Green IS and Green IT, Cuvillier, Göttingen.
28. Seidel S., vom Brocke J., and Recker J. (2011) Call for action: Investigating the Role of Business Process Management in Green IS, in *Proceedings of SIGGreen Workshop*, Sprouts: Working Papers on Information Systems 11(4), http://sprouts.aisnet.org/11-4.
29. Watson, R. T., Boudreau, M. C. and Chen, A.J. (2010) Information Systems and Environmentally Sustainable Development: Energy Informatics and New Directions for the IS Community, *MIS Quarterly*, 34, 1, 22-38.
30. Wigand, R. T., Picot, A., Reichwald, R. (1997) Information, Organisation and Management. John Wiley & Sons, Chichester, UK.
31. World Commission on Environment and Development (WCED) (1987) Our Common Future, Oxford University Press, UK and New York.