

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/337488277>

A systematic review of Green Business Process Management

Article in *Business Process Management Journal* · November 2019

DOI: 10.1108/BPMJ-03-2019-0106

CITATIONS

25

READS

2,094

2 authors:



[Dries Couckuyt](#)

Waseda University

10 PUBLICATIONS 112 CITATIONS

SEE PROFILE



[Amy Van Looy](#)

Ghent University

102 PUBLICATIONS 1,430 CITATIONS

SEE PROFILE

A systematic review of Green Business Process Management

Dries Couckuyt

Department of Business Informatics and Operations Management, Faculty of Economics and Business Administration, Ghent University, Tweekerkenstraat 2, 9000 Ghent, Belgium

dries.couckuyt@ugent.be

Amy Van Looy

Department of Business Informatics and Operations Management, Faculty of Economics and Business Administration, Ghent University, Tweekerkenstraat 2, 9000 Ghent, Belgium

amy.vanlooy@ugent.be

Abstract

Purpose – Green Business Process Management (BPM) focuses on the ecological impact of business processes. Although it is an emerging field, different attitudes exist towards the discipline's name, the objectives and the approaches to realize them. By means of a systematic literature review, our study aims at a common understanding of the discipline for successful development.

Design/methodology/approach – The review methodology relies on a hermeneutic framework which integrates the search, analysis and interpretation of literature. The sample is used in a text analysis to find an appropriate definition (RQ1), a bibliometric analysis to give insights in current Green BPM contributions (RQ2), and a content analysis to present differences with conventional BPM (RQ3).

Findings - Green BPM follows a similar development as conventional BPM, namely from a more technical perspective to also including the managerial perspective. More research is required that goes beyond the traditional business process lifecycle.

Originality/value - The research questions generated a comprehensive overview about application domains and research topics, which in turn can deliver benefits for both research and practitioner-related communities. Researchers identify future research avenues, while practitioners find appropriate Green BPM techniques for their domain.

Keywords Green BPM, Green IS, systematic literature review, environmental sustainability, BPM capabilities

1. Introduction

In recent years, the optimization of operations for ecological objectives has gained importance. Business Process Management (BPM), which refers to “*concepts, methods, and techniques that support the design, configuration, enactment, evaluation, and administration of business processes*” (Weske, 2012, p. 5), is a key starting point. BPM's optimization objectives typically refer to cost, quality, time, and flexibility (Reijers & Liman Mansar, 2005). Recently, however, researchers increasingly advocate to extend the scope of conventional BPM (Nowak et al., 2011) with an environmental sustainability dimension, i.e. Green BPM (Seidel et al., 2011).

In general, BPM relies on three major process traditions: the Quality Control tradition, the Business Management tradition, and the Information Systems (IS) tradition. Currently, the tendency is that these three traditions are merging into a more comprehensive BPM approach (Harmon, 2015). However, the research field of Green BPM is currently dominated by Green IS, i.e. the discipline that examines the possibilities of information technology-based systems to cope with environmental problems (SIGGreen, 2015). Therefore, our study targets a comprehensive Green BPM approach which incorporates also other relevant but still under-investigated research areas. Although an emerging field, Green BPM suffers from uncertainty about the current state. For instance, scholars refer to “Green BPM” (Jakobi et al., 2016) as well as “Sustainable BPM” (Ahmed & Sundaram, 2012). Some researchers solely focus on the reduction of carbon emissions in business processes (Ghose et al., 2009), while others aim to reduce all environmentally harmful effects of organisational activities (Seidel et al., 2011). Finally, Green BPM can also be seen as a general management approach (Kuppusamy & Gharleghi, 2015) while other contributions refer to an extension of existing BPM techniques (Nowak et al., 2011) and/or a central role for IS (Opitz et al., 2014b). These different attitudes towards the discipline's name, the objectives and approaches to realize them are not contributing to a durable development of the research field. Instead, the research community should first have a common understanding of the discipline for successful development (Baskerville & Myers, 2002).

Webster and Watson (2002) argue that an effective literature review advances knowledge. “*It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed*” (Webster & Watson, 2002, p. xiii). Our review methodology relies on a hermeneutic framework presented by Boell and Cecez-Kecmanovic (2014). In line with the framework, we developed three research questions:

- RQ1. What is a valid definition for Green BPM?
- RQ2. What is the current state of Green BPM research?
- RQ3. What are the differences between Green BPM and conventional BPM?

For RQ1, a text analysis is conducted on different Green BPM definitions. We present the differences with (1) Sustainable BPM, (2) environmental sustainability contributions related to the underlying BPM traditions (e.g. Green IS), and (3) conventional BPM. For RQ2, a bibliometric analysis is conducted to examine the publication type and geographical distribution of authorship. As a result, we encourage participation of currently missing but relevant research types. Finally, RQ3 deepens the differences with conventional BPM and investigates the current scope of Green BPM by means of a content analysis. This results in future research directions on the body of theory and knowledge.

This research in the Green BPM field has social, business and academic purposes. As the effects of environmental degradation concerns the entire society, industry should take responsibility. Green BPM research will help businesses make environmental considerations since Green BPM methods and techniques can be used by practitioners to environmentally optimize processes. From an academic point of view, we present a classification framework for Green BPM that researchers can use as a research agenda. Simultaneously, it can be used by practitioners as they can check if the techniques are relevant for them to deliver practically useful results.

This article continues with the theoretical background (section 2). Next, the methodology is detailed in section 3. The results are given in section 5 (RQ1), section 6 (RQ2) and section 4 (RQ3). The discussion is presented in section 7, followed by concluding comments (section 8).

2. Theoretical background

2.1. *Foundations of Green BPM*

The concept of sustainability (Brundtland, 1987) introduced environmental considerations into economic sciences. The Triple Bottom Line (Elkington, 1997) distinguished three dimensions of sustainability, i.e. economic, social and environmental. The IS community acknowledges the importance of environmental sustainability and states that the IS profession can provide critical knowledge to tackle the challenge of environmental deterioration (SIGGreen, 2015).

In addition to Green IS, a crucial role for process-centred techniques is acknowledged (Lübbecke et al., 2016; Opitz et al., 2014; Seidel et al., 2011). In recent years, this Green BPM approach gained momentum for practice and research (Gohar & Indulska, 2015; Maciel, 2017; Opitz et al., 2014; Stolze et al., 2012). Both disciplines are related but Green BPM, as opposed to Green IS, has a main focus on process change that goes beyond IT applications. In essence, this difference is due to the three major process traditions underlying BPM (Harmon, 2015). Table 1 gives an overview of the different traditions. For a profound discussion, we refer to Harmon (2015).

Table 1 An overview of the different approaches to business process change, including illustrative examples.

Business Process Management		
Quality Control	Business Management	Information Systems
Taylor's Work Simplification Quality movement: <ul style="list-style-type: none"> • TQM • Six Sigma • Lean • Capability Maturity Models 	Overall firm performance: <ul style="list-style-type: none"> • Porter's Value Chain • Balanced Scorecard 	Process Reengineering Application-based: <ul style="list-style-type: none"> • Process Modelling Tools • Enterprise Resource Planning Applications • Business Rules

Process improvements are often represented by a business process lifecycle involving different consecutive and iterative phases, i.e. originating from the established Plan-Do-Check-Act cycle (Deming, 1986). Initially, BPM focused rather on technical capabilities such as process modelling, deployment and optimization (Dumas et al., 2013). These are mainly extracted from the Quality Control and IS tradition. Afterwards, also management capabilities gained importance (Weske, 2012). Finally, authors started examining organisational capabilities such as culture and structure (McCormack & Johnson, 2001; vom Brocke & Rosemann, 2014). These capability areas also originate from the Business Management tradition and support process improvements.

2.2. Classification frameworks for Green BPM

Being an emerging research field, Green BPM' underpinning is still missing. Intuitively, a well-accepted classification framework in the field of BPM could serve as a starting point for theory development. In our search for a holistic BPM framework, we looked at governance frameworks (e.g. COBIT), performance metrics (e.g. Balanced Scorecard) and measurement models (e.g. maturity models). Particularly, business process maturity models (BPMM) seem to be appropriate candidates because they help organisations in developing BPM strategies and roadmaps to guide their ongoing process efforts. Therefore, as companies have a wide variety of activities, a BPMM should cover all critical success factors in BPM. We make the proposition that these factors can also be used to evaluate the scope of Green BPM. More specifically, the question could be raised whether all critical capabilities for business processes are covered in a Green BPM context. Moreover, it allows a comparison between Green BPM and conventional BPM methods and techniques.

In the last decade, BPM researchers and practitioners have developed a long list of BPMMs with varied focus and depth (Hammer, 2007; McCormack & Johnson, 2001; OMG, 2008; Rosemann & de Bruin, 2005). However, only a limited set of BPMMs has been verified by sufficient empirical research (Tarhan et al., 2016). To evaluate the scope of Green BPM, we rely on the conceptual

framework presented by Van Looy et al. (2014). This meta-framework draws on theories regarding the traditional business process lifecycle and multiple recognized organisation management theories. The comprehensiveness of this framework was validated by mapping 69 BPMMs to the identified capability areas (Van Looy et al., 2014). Being a meta-framework, its completeness and correctness of the presented critical success factors is better guaranteed.

Table 2 presents an overview of the capability areas, combined with the process change traditions, the categories of our evaluation model, and the proposed translation to a Green BPM context. The capabilities for 'process modelling', 'process deployment' and 'process optimisation' are grouped in the first category, called 'business process lifecycle' (BPL) (Deming, 1986; Dumas et al., 2013). These rather technical capability areas are mainly extracted from the IS and Quality Control tradition. The second category consists of the first three capabilities extended with a 'process management' capability area (Weske, 2012), and is referred to as 'business process management' (BPM). This capability area mainly relies on the Quality Control and Business Management tradition. The third category, 'business process orientation' (BPO), adds the remaining capabilities for a 'process-oriented culture' and 'process-oriented structure'. They are mainly based on the Business Management tradition (McCormack & Johnson, 2001). By combining the process traditions and the capability areas, we present an integrated classification framework. We are aware that exceptions exist, e.g. the use of information technology for management.

Table 2 An overview of the main process change traditions, capability areas proposed by Van Looy et al. (2014), evaluation categories in this study and translation to a Green BPM context.

Main traditions		Capability areas	Evaluation categories		Translation to a Green BPM context
Quality Control	Information Systems	(1) Process modelling (2) Process deployment (3) Process optimization	BPL	BPM	This category groups research on making the business process lifecycle environmentally sustainable. It comprises methods and IT for the design, analysis, implementation and enactment, measurement and control, evaluation, and improvement of business processes for environmental objectives.
	Business Management	(4) Process management			BPO
	Business Management	(5) Process-oriented culture (6) Process-oriented structure			This category extends the first two categories with values that favour environmentally sustainable business processes and their translation into attitudes and behaviours. It requires appraisals and rewards that consider green process results and top management commitment. It also comprises specific organisational bodies to coordinate the management of all environmentally sustainable business processes within an organisation.

3. Methodology

Our methodology relies on a hermeneutic framework for reviews (Boell & Cecez-Kecmanovic, 2014) and integrates the search, analysis and interpretation of literature. Figure 1 presents the framework applied to our study.

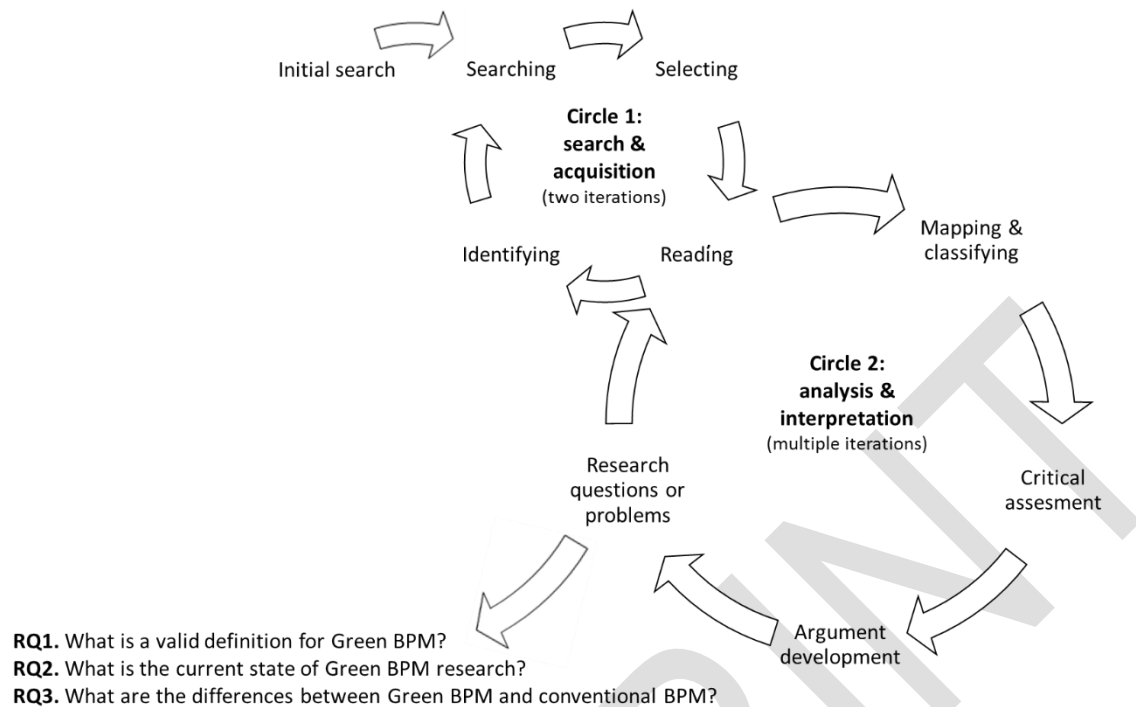


Figure 1 Hermeneutic framework for literature reviews (Boell & Dubravka, 2014) applied to our study

We iteratively ran through circle 1 (i.e. search and acquisition) and circle 2 (i.e. analysis and interpretation). We started with an initial search in several databases, resulting in 20 papers related to Green BPM and different terms related to the Green BPM field. Based on these terms, we developed a search string that was queried in seven leading academic databases. (i.e., Web of Science, ScienceDirect, Emerald Insight, EBSCOhost Research Databases, IEEE Xplore Digital Library, Springer and AISEL). 147 results were generated from the search string that combined the four key terms “Green Business Process Management”, “Green BPM”, “Sustainable Business Process Management” and “Sustainable BPM” with an OR-operator. After removing duplicates, 70 papers were investigated on their relevance. We decided to limit our sample to those with a main focus on Green BPM, i.e. if they could be related to the critical BPM capabilities presented by Van Looy et al. (2014) (Table 2). After investigation of the title, keywords, abstract and introduction, 45 out of 70 articles were selected as relevant. Next, the 45 primary articles were read and additional publications were detected based on citations. This resulted in 164 papers, from which 72 articles remained after removing duplicates.

Next, we re-started our first cycle with a search for those articles identified by citations. 11 additional articles focusing on Green BPM were selected as relevant. We repeated the ‘read’ and ‘identify’ phase, but no new Green BPM articles were found. We concluded that two iterations of the ‘search and acquisition’ circle were sufficient to collect the sample. Our initial review was conducted during January 2018. We then updated the review in January 2019 for any articles that

had appeared in the last year, namely four additional papers. Thus, the final sample for our research consists of 60 articles (shown in Appendix 1). We refer to sampled articles via unique IDs for reasons of conciseness.

Although chronologically described above, both research circles were intertwined since they build on each other in a recursive manner. The role and relevance of literature searches (i.e. circle 1) is part of the broader process of literature understanding (i.e. circle 2). The second circle includes specific phases that facilitate an understanding. Against this background, the need for more concrete research questions (RQ1, RQ2 and RQ3) was developed. From multiple iterations, we identified several interpretations of Green BPM. Therefore, RQ1 aims at a common understanding among researchers. Concerning RQ2, we noticed different ways of dissemination and researchers involved, and intend to encourage participation of currently missing but relevant research types. Similarly, we observed that the comprehensiveness of Green BPM and the differences with conventional BPM varies. Hence, for RQ3, we evaluated the sample against the critical capabilities for business processes of Table 2.

4. Results for RQ1

4.1. *Analysis of explicit and implicit definitions*

With regard to a common understanding of the field, we identified three problems to address the differences between Green BPM and (1) Sustainable BPM, (2) environmental sustainability contributions related to the underlying BPM traditions, and (3) conventional BPM. We screened all 60 papers and found both explicit and implicit definitions. With implicit, we refer to indirectly extracted definitions from an extensive description. In 19 out of 60 articles, we observed explicitly stated definitions (e.g. in a textual paragraph). However, only ten articles presented unique descriptions. The other nine definitions were already proposed in earlier work. Given the limited set of definitions, we manually retrieved the used field names, the objectives and approaches of the discipline (Table 3). Important elements are marked: the name is highlighted in bold, the objectives are underlined, and the approach is in italic.

Table 3 Overview of explicitly stated definitions and their important word groups for text analysis.

Article ID	Definition
[2] p. 611	“ Sustainable BPM is an <i>approach for managing businesses</i> that draws on an integrated and balanced performance of the business's <u>economic, environmental and social aspects</u> , referred to as sustainability dimensions or the Triple Bottom Lines (TBL) of business management.”
[14] p. 103	“ Green BPM describes a novel class of technologies that <i>leverage and extend existing BPM technology</i> to enable process design, execution and monitoring in a manner informed by the <u>carbon footprint</u> of process designs and instances.”
[22] p. 260	“ Green BPM entails <i>managing a manufacturing corporation's supply chain</i> by conforming to <u>green standards and practices</u> . This also involves management of the corporation's upstream supply chain because managing internal green processes can become effective if external parties' practices are also green.”
[30] p. 1049	“ Green BPM aims at the <i>design and optimization of IT-related processes</i> with regard to <u>ecological objectives</u> such as the resource consumption of business processes.”
[38] p. 570	“ Green BPM is not an entirely new way in optimizing organisations' business processes. In fact, <i>existing BPM methodologies and techniques are leveraged, extended, or refined</i> in order to support the new requirements emerging from <u>environmental concerns</u> .”
[39] p. 2	“While conventional BPM focuses on the <i>optimization of cost, quality, time, and flexibility of business processes</i> , Green BPM additionally considers the <u>environmental perspective</u> and the trade-off between them, before, during, or after process execution.”
[42] p. 3812	“From an IS researcher's perspective, Green BPM is the sum of all <i>IS-supported management activities</i> that help to monitor and reduce the <u>environmental impact</u> of business processes in their <i>design, improvement, implementation or operation</i> stages, as well as lead to cultural change within the process life cycle.”
[46] p. 249	“ Sustainable BPM means that we take a process-oriented approach to an organisation's primary way of management and we <i>continuously re-fine, measure, optimize and reengineer existing processes</i> or introduce new ones in our organisations, which cover all the <u>sustainability dimensions (economic, social, environment)</u> ”
[48] p. 5	“ Green BPM concerns the <i>understanding, documenting, modelling, analysing, simulating, executing, and continuously changing of business process</i> with dedicated consideration paid to the <u>environmental consequences</u> of these business processes.”
[49] p. 3	“ Green BPM can be regarded as an <i>intersection of both BPM and Green IS</i> . Only through process change, and the application of process-centred techniques, the transformative power of IS can be fully leveraged in order to create <u>environmentally sustainable</u> organisations and, in turn, an environmentally sustainable society.”

Table 3 shows that we detected two names: “Sustainable” BPM and “Green” BPM. Concerning the objectives, we found authors proposing Elkington's (1997) sustainability dimensions, general environmental concerns or rather specific goals (e.g. a reduction of carbon emissions). Finally, we identified four categories by which the discipline intends to reach its objectives. These categories are related to a comprehensive BPM approach or to the underlying traditions. The approaches are: Quality Control, Business Management, IS or an extension of existing BPM techniques. The classification is presented in Table 4, which also includes aggregated numbers of explicitly and implicitly stated definitions for all 60 articles.

Table 4 Overview text analysis of explicit definitions and aggregated numbers for explicit and implicit definitions

	Discipline name		Approach				Objectives		
	Sustainable BPM	Green BPM	Quality Control	Business Management	Information Systems	Business Process Management	Sustainability concerns	General Environmental concerns	Specific environmental concerns
Explicit definitions (n = 10)									
[2]	1			1			1		
[14]		1				1			1
[22]		1		1				1	
[30]		1			1			1	
[38]		1				1		1	
[39]		1				1		1	
[42]		1			1			1	
[46]	1						1		
[48]		1				1		1	
[49]		1			1			1	
Total	2	8	0	2	3	5	2	7	1
Explicit and implicit definitions (n = 60)									
Total	17	43	2	5	3	50	14	25	21

4.2. “Green” BPM vs. “Sustainable” BPM

Two explicit definitions used the term “Sustainable” BPM [2],[46]. They referred to the three sustainability dimensions (Elkington, 1997) as the discipline's objectives. In total, 17 articles used this term. However, three of them actually discussed environmental objectives [10],[12],[13] so the term “Green” BPM was more appropriate here. Moreover, four other articles acknowledge Green BPM, next to Sustainable BPM [5],[13],[50],[53]. This means that 10 out of 60 articles propose Sustainable BPM in line with Elkington's TBL (1997). The other 50 articles acknowledge Green BPM as associated with environmental considerations. For the remainder of this study, we do not exclude the articles on Sustainable BPM as they are encompassing Green BPM.

4.3. *Green BPM vs. underlying BPM traditions*

Two explicit definitions interpreted Green or Sustainable BPM as a Business Management approach. [2] discussed “an approach for managing business” while [22] examined “supply chain management”. Three definitions mentioned an inevitable role for IS in Green BPM [30],[42],[49]. Five explicit definitions described Green BPM as an extension of BPM methods and techniques. The three major process traditions underlying BPM (Harmon, 2015) are important. For instance, two articles strongly rely on the Quality Control tradition by proposing a capability maturity model for corporate sustainability [7] and ICT sustainability [10]. The same holds for the Business Management tradition: [59] presented performance measurement systems for sustainable companies. Other articles discussed sustainable business transformation [2], supply chains [22] or project management [47],[51]. With regard to the IS tradition, the score only reflects the inevitable role for IS claims [30],[42],[49]. The vast majority of Green BPM literature in our sample adopted IT, e.g. [3],[4],[6],[10],[52],[54]. However, this was always to support process-oriented techniques.

With 50 out of 60 articles, we found more evidence of Green BPM as an interdisciplinary approach. This is explicitly stated by some authors. For instance, [3] aimed at the development of green business processes “*based on expertise from web service technologies, data deduplication, optimization, performance evaluation and model identification*” (p. 183). [11] developed a sustainability framework “*illustrating the integration of human, supply chain, and IT resources to develop sustainability capabilities*” (p. 63). According to [55], sustainable processes can be achieved “*by challenging the following areas: process design and operations, the link to strategy, and flows, roles involved, relevant rules, and compliance aspects as well as process automation, measurements, and reporting*” (p. 493). These descriptions clearly combine the process traditions. Other authors started from a comprehensive BPM framework reflecting aspects from the three traditions. In [38], a holistic Green BPM approach is presented. First, a conventional business process lifecycle relying on the Quality Control and IS tradition is introduced. Secondly, the value chain of Porter, a concept from the Business Management tradition, was used to identify Green BPM business requirements. Similarly, in [41], various capabilities were discussed that organisations should have in order to actually take advantage of Green BPM. Their ‘Green BPM readiness’ capabilities are: ‘attitude’, ‘strategy’, ‘governance’, ‘modelling’, ‘optimizing’, and ‘monitoring’. Again, these six capability areas rely on a combination of the three traditions.

4.4. *Green BPM vs. conventional BPM*

The analysis also showed that Green BPM addresses topics which are not addressed by conventional BPM. Concerning the objectives of Green BPM, one explicit definition [14] was rather

specific (i.e. reduction of carbon footprint). The seven other explicit definitions had more general objectives (i.e. reducing the environmental harmful effects of business processes). In sum, 25 articles stated general environmental objectives while 21 articles were more specific (e.g. reduction of carbon emissions [1],[14],[17],[18],[19],[43],[44],[58],[59] or energy consumption [4],[5],[6],[13],[21],[30],[31],[35],[37],[45],[52],[56]). These results are not contradictory but can be interpreted as a higher or lower level of specialization. These objectives are opposed to BPM's conventional dimensions of cost, quality, time, and flexibility (Reijers & Liman Mansar, 2005). The question could also be raised if Green BPM methods and techniques differ from conventional ones (see section 6, RQ3).

5. Results for RQ2

For analysing the ways of dissemination and the researchers involved, Figure 2 starts with an overview of the types of scholarly dissemination.

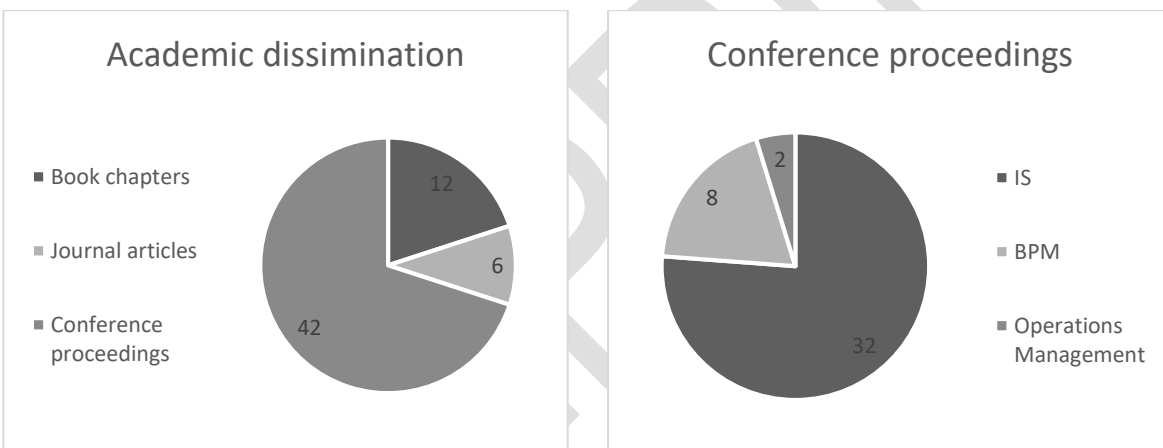


Figure 2 Overview types of scholarly dissemination

Twelve contributions were issued as a book chapter. Nine of them were published in a book on Green BPM by vom Brocke, Seidel and Recker (2012). Although this book has 13 chapters, we only considered nine as a direct Green BPM contribution. Four chapters rather seemed to have a main focus on Green IS without discussing process-centred techniques and were thus excluded. Journal publications were limited and four out of six contributions concerned IS journals [2],[11],[14],[23]. Finally, 42 out of 60 articles were conference proceedings. The International Conference on Business Process Management (BPM) is leading with eight papers [9],[24],[28],[29],[33],[34],[43],[52]. Two papers were presented on conferences in the field of operations management [12],[13] and 32 out of 42 papers were part of IS-related conferences.

We based the assessment of geographical origins on the institutional affiliation of the first author to examine how strong the topic of environmental sustainability in BPM is driven from specific countries. Table 5 shows the countries and number of publications.

Table 5 Overview countries and number of publications

Argentina	1	China	1	Malaysia	1	Sri Lanka	1
Australia	10	Germany	25	New Zealand	1	Switzerland	2
Austria	1	Ireland	1	Norway	1	Netherlands	1
Belgium	2	Italy	2	Slovenia	1	United Kingdom	2
Brazil	1	Liechtenstein	3	Spain	1	United States	2

The data showed that research groups in Germany and Australia are leading Green BPM research, with respectively 25 and 10 publications so far. Liechtenstein is following with three articles. However, it should be noted that the research group at the University of Liechtenstein (Seidel, S. & vom Brocke J.) and the research group at the Queensland University of Technology, Australia (Recker, J.) have co-edited the book on Green BPM (vom Brocke et al., 2012). In general, with 41 out of 60 articles, European research groups are leading Green BPM research.

6. Results for RQ3

6.1. *The classification framework*

The classification framework presented in section 2.2 has two purposes. First, it evaluates the scope of Green BPM. Secondly, it allows a comparison between Green BPM and conventional BPM methods and techniques. The sample was analysed to identify BPM-related capability areas and mapped on three possible categories: (1) business process lifecycle (BPL), (2) business process management (BPM) and (3) business process orientation (BPO). Since several articles could be mapped more appropriately, the scheme was extended with three additional categories, i.e. 'practical', 'focus', and 'review'. Our final classification framework is presented in Figure 3.

Two articles were classified as 'practical' outside the capabilities categories because they investigated Green BPM in organisations. It concerns [25] with a content analysis of 78 case studies and [26] which investigated the current state of Green BPM in German companies with an online-survey. We also identified eight 'review' articles.

- [50] made an interesting contribution to Green BPM modelling and is discussed in the BPL category (section 6.2).

- Four other articles presented a literature review [15],[32],[42],[53]. As they consider a comprehensive Green BPM approach, the six capability areas were discussed.
- Finally, three other review articles discussed the field of research as such. More specifically, two launched a call for action to immerse deeper into the role of business processes for environmentally sustainable organisations [8],[49]. Another article concerns an introductory chapter for a Green BPM book to position the domain [48]. As these contributions are introductory, they are classified outside the capabilities categories.

The third additional category of ‘focus’ bundles articles concentrating on a particular management concept. These are discussed in the BPM category (section 6.3).

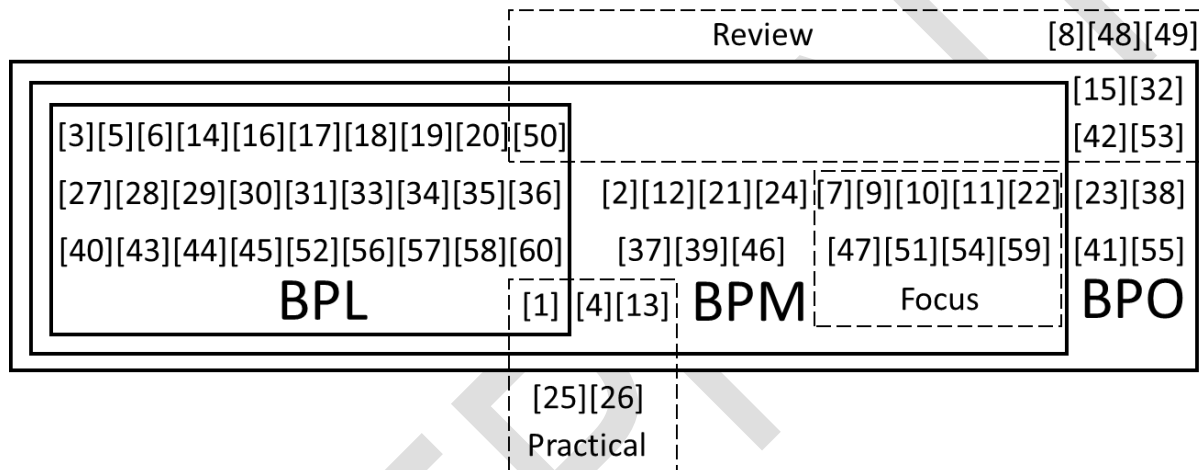


Figure 3 Overview classification of articles (N=60).

6.2. Business process lifecycle

Figure 3 shows that 29 out of 60 articles were mapped on the BPL category. These articles focused solely on the modelling, deployment and optimization of environmentally sustainable business processes. Each paper discussed elements of all three capability areas. However, some articles had a main focus or interesting contribution on a particular capability area. Therefore, the results are discussed from this perspective. Table 6 gives an overview of the covered topics.

Table 6 Topics covered for each capability area of the BPL category.

Capability area	Topics covered
Modelling	<ul style="list-style-type: none"> • Three main modelling approaches: <ul style="list-style-type: none"> ○ Extending notations [3],[14],[17],[18],[43],[44],[45],[56],[57]; ○ Adding notations [1],[16],[19],[20],[31]; ○ Adding patterns [27] [29],[30],[36]; • Conceptual modelling approach using XML-nets [5]; • Modelling guidelines [28]; • Suitable existing modelling languages and software [40]; • Review on modelling techniques [50];
Deployment	<ul style="list-style-type: none"> • Measuring and controlling emissions [1],[14],[58] or energy [6],[35],[52]; • Innovative implementation and enactment approaches [34],[60];
Optimization	<ul style="list-style-type: none"> • Benchmarking of alternative process designs [6],[14]; • Semi-automatic tools for process re-design [16],[17],[18],[19],[31]; • Optimization of inter-operating processes [6],[14],[58]; • Environmental optimization together with traditional dimensions [58]

Concerning the articles which explicitly focused on ‘process modelling’, we identified three approaches. Most authors extended existing modelling frameworks by adding emissions (e.g. [14],[17],[18],[43],[44],[57]) or energy (e.g. [3],[45],[56]) accumulation annotations across process designs. With these new elements (e.g. graphics, icons, indicators), the relationship was modelled between resources and activities to inform the business process with its emission or energy impact. Other articles reused and adapted existing BPM modelling notations from BPMN, UML or EPC to represent environmental aspects in business process modelling [1],[16],[19],[20],[31]. These two approaches were confirmed by [33], and are illustrated in Figure 4. Finally, a third approach relies on adding patterns to apply existing knowledge for enhancing process models. Ecological business process patterns are then presented to examine environmental impact [27],[29],[30],[36]. The three approaches are confirmed by [50], which provides a review of Green BPM modelling.


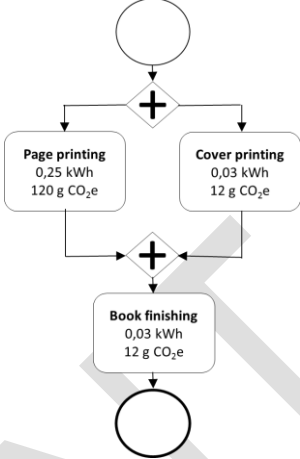

Extending notations		Adapting notations
Construct	Notation	
Fuel consuming activity		
Paper consuming activity		
Example from [44]		Example based on [16]

Figure 4 Examples of extending and adapting modelling notations

Three other papers do not discuss a detailed modelling approach as such. [5] presented a more conceptual approach to support sustainability-aware BPM using XML-Nets. In [28], a set of guidelines for ecology-aware process design was proposed. We believe these principles can be applied to the three approaches identified above. Finally, [40] used a literature analysis and three case studies to derive suitable languages and software.

Articles explicitly focusing on deployment used formulas and standards of environmental authorities to calculate emissions in business processes [1],[14],[58]. Similarly, articles investigating energy consumption presented suitable metrics to monitor the energy efficiency of processes [6],[35],[52]. For the implementation and enactment of ecological processes, two articles offer an innovative approach [34], [60]. In [34], a BPMS-Game tool was presented which combines the concepts of gamification, sustainability and business processes to support games promoting sustainability in BPM. On the other hand, [60] provided an approach that allows executable process models to be integrated with Geographical Information Systems. They illustrated feasibility by means of an exemplary process with ecological concerns.

Except for the two above-mentioned innovative approaches, the optimization of business processes for environmental objectives seemed to rely on conventional BPM. Once process modelling and deployment is enriched with an environmental dimension as described above, optimization is done by, for instance, benchmarking of alternative process designs that are extracted from continuous monitoring and data analysis [6],[14]. Some authors offered semi-automatic tools for this process re-design [16],[17],[18],[19],[31]. Finally, we found articles that did

not merely focused on the optimization of single processes, but on inter-operating processes [6],[14],[58].

6.3. Business process management

As shown in Figure 3, 18 out of 60 articles were mapped on the BPM category. Within this category, nine articles extended the business process lifecycle with a management dimension to achieve (environmentally) sustainable business processes. For instance, [2] presented a sustainable business transformation cycle with five steps: ‘monitor and control’, ‘discover and learn’, ‘strategize’, ‘design’, ‘transform’. Some authors relied on existing lifecycles to achieve sustainable business processes. For instance, [24] used the work of Weske (2012) and [21] adapted the lifecycle of Dumas et al. (2013). Finally, [46] relied on the BPM capability areas framework of de Bruin and Rosemann (2007) to integrate environmental sustainability topics. In [37] and [39], Green Business Process Reengineering (gBPR) was described as an architecture and methodology consisting of four layers, i.e. ‘strategy’, ‘sensing and monitoring’, ‘analysis and management’, and ‘adaptation’. We also observed two more practical contributions [4], [13]. [4] presented the transformation to a green telecommunications company consisting of four stages: ‘strategy’, ‘design’, ‘realization’ and ‘operational’. [13] described a study in a biomass power generation company using a BPM framework for sustainable business processes [12]. Nine other articles in the BPM category solely focused on a particular management concept without discussing capability areas of the BPL category. Table 7 gives a summary of interesting management concepts identified in the light of environmental objectives.

Table 7 Overview of management concepts in light of environmental objectives.

Identified management concepts for environmental objectives
<ul style="list-style-type: none"> • KEIs as an extension of KPIs linked to an environmental strategy [9],[37],[39],[54],[59]; • Maturity models to improve capabilities to meet sustainability objectives [7],[10]; • Sustainability frameworks for organizations or a single business process [9],[11]; • Roles and responsibilities [21],[39]; • External relationships [21],[22],[39],[54]; • Sustainability in project management [47],[51].

We noticed the concept of Key Ecological Indicators (KEIs) to plan and define the environmental performance of organisations [9],[37],[39],[54],[59]. KEIs can be seen as a Green BPM extension of traditional Key Performance Indicators (KPIs). Environmental performance management in organisations was also recognized in [7] by presenting an environmental capability maturity model to determine the process performance. Similarly, [10] used a maturity model for Sustainable ICT (SICT). We also found company-wide frameworks. For instance, [11] used the resource-based view as theoretical foundation for a company’s sustainability capabilities integrating human, supply

chain and IT resources. [9] introduced a preliminary classification framework summarizing sustainability models and indicators, both for entire organisations or single business processes. Roles and responsibilities also appeared to gain importance. According to [39], top management should be involved with strategy and define KEIs. The operational staff should be involved with sensing and monitoring, the business analyst with analysis and management, and the business architect with adaptation. Moreover, external relationships were recognized to be important as the optimization of energy consumption should go beyond the company. These internal roles and external relationships were further stressed by [21]. Successful Green BPM requires the participation of stakeholders in all process lifecycle phases. The influence of green supplier selection, green supplier monitoring and green supplier collaboration towards Green BPM was examined in [22]. To enhance the exchange of sustainability indicators, [54] presented a common platform where providers and consumers of environmental data can connect. Finally, [47] and [51] explored the application of sustainability to project management. Both works argued that companies integrate ideas of sustainability in their marketing, corporate communications, and in their annual reports. Many of these actions are organised in projects. Therefore, project management should address an environmental sustainability agenda.

6.4. Business process orientation

The BPO category contained four articles focusing on general environmental objectives and discussing all six capability areas. Subsequently, we elaborate on specific elements detected for the capability areas 'culture' and 'structure'. Table 8 gives a summary of the topics.

Table 8 Topics covered for the capability areas 'culture' and 'structure'.

Capability area	Topics covered
Culture	<ul style="list-style-type: none"> • Green behaviours of employees [23],[38],[41],[55]; • Training programs for employees [23]; • Green attitudes of companies [41],[55];
Structure	<ul style="list-style-type: none"> • Environmental aware governance bodies [38]; • New governance bodies or actors [41],[55].

For the 'culture' capability area, [38] mentioned the attitudes and behaviours of employees as important. Internal guidelines advise employees in their daily resource usage and lead to a rethinking of established usage patterns. [23] proposed training programs for pedagogical and professional development. By gaining essential skills and knowledge, participants will continue carrying out green business processes. Employees' behaviour was extended with a company's attitude by [41] and [55]. In [41], it was stated that the attitude of a company and its employees towards ecological sustainability is a basic factor for implementing long-term Green BPM. [55]

paid considerable attention to company values. The first and second step in their seven-step plan towards sustainability-oriented processes were dedicated to culture and values in particular.

Also elements of the capability area 'structure' were detected. In [38], the value chain of Porter was used to identify new business requirements relevant to Green BPM. The primary and support activities were all discussed for sustainability. It was stated that specific governance bodies responsible for these primary and support activities, should reflect on and optimize processes for environmental objectives. [55] established a sustainability board and defined sustainability owners to ensure sustainability governance. In [41], it was mentioned that a Chief Ecological Officer, responsible for the green strategy, should be implemented within the organisational structure.

7. Discussion

7.1. Discussion for RQ1

A vast majority of authors agree on the term "Green" BPM (instead of "Sustainable" BPM) by relying on other process change traditions in order to reduce the environmentally harmful effects of business processes. We distinguish Green BPM from conventional BPM in two manners. First, the environmental objectives are opposed to BPM's conventional dimensions of cost, quality, time, and flexibility (Reijers & Liman Mansar, 2005). Secondly, as presented in section 6 (RQ3), Green BPM provides methods and techniques different from the conventional ones. To offer a common understanding among participants, we now propose the following definition:

"Green BPM extends the optimization of cost, quality, time, and flexibility of business processes with an environmental sustainability dimension. This means that Green BPM concerns the modelling, deployment, optimization and management of business processes with dedicated consideration paid to their environmental consequences. In order to facilitate successful Green BPM, organisational capability areas (i.e. culture, structure) should also be considered as important."

Currently, Green BPM research mainly focuses on the capability areas for process 'modelling', 'deployment', 'optimization' and 'management'. Since we also found literature on the capability areas of 'culture' and 'structure', it is important to include them in a comprehensive definition. We noted diverse attitudes towards the Green BPM methods and techniques, which can be attributed to the underlying BPM traditions. Research participants from one tradition often ignore or depreciate other approaches. On the other hand, this diffusion serves as evidence for Green BPM as an interdisciplinary approach. We identified frameworks, concepts and techniques from different process change traditions, offering opportunities for further research. As Green IS researchers already had a significant influence, participants from the Quality Control and Business

Management tradition can also have a more relevant contribution in the development of Green BPM (see RQ3).

7.2. *Discussion for RQ2*

Our sampled Green BPM articles were disseminated through scholarly conferences (42), journals (6) and book chapters (12). Noteworthy is the high number of conference proceedings and the low number of journal publications. This can be explained by shorter publication cycles for most conferences and the relatively recent uptake of Green BPM research. Alternatively, it might be an indication that Green BPM research remains a (side-)project of some researchers. Nonetheless, we evoke to concentrate on Green BPM as a discipline and to deliver high-quality journal publications. Moreover, we uncovered that only eight out of 42 papers were presented on BPM-related conferences. Giving more attention to Green BPM on BPM platforms where process-centred techniques are central, will further enhance the development of the field.

In general, European research groups are leading Green BPM research. To further establish Green BPM worldwide, also non-European research groups are encouraged to participate more strongly. We specially reach out to research groups from North America because they already have a strong tradition in process change.

7.3. *Discussion for RQ3*

While evaluating the Green BPM literature against the critical capability areas of Van Looy et al. (2014) (Table 2), we revealed that Green BPM follows a similar evolution as the BPM discipline. In early BPM research, the main focus was on the traditional business process lifecycle (de Bruin, 2007). Especially the 'modelling' capability area is already well-documented. Three approaches (i.e. extending modelling notations, adapting modelling notations, and adding patterns) have been extensively discussed. For the 'deployment' capability area, the study uncovered some innovative implementation and enactment approaches (e.g. gamification [34] and geographical information systems [60]). Much attention has been paid to frameworks, consisting of formulas and standards, to measure and control emissions or energy in business processes. The optimization of business processes for environmental objectives still relies on conventional BPM methods and techniques. Consequently, process modelling and deployment has been enriched with an environmental dimension. Green process optimization can be done, for instance, by benchmarking of alternative process designs.

As not all capability areas are properly covered, avenues exist for further research and in particular for the managerial, cultural and structural areas of Green BPM. For 'management', aspects concerning strategy and KEIs, roles and external relationships have been discussed. However, a list of other management topics is missing, such as employee skills, training and change

management. Concerning the 'culture' capability area, ecological values and behaviours of employees are only briefly discussed. Also topics on appraisals and rewards, or top management commitment should be investigated in more detail from the perspective of Green BPM. This also holds for the capability area of 'structure': we specifically call for future research on green governance bodies or actors. Finally, as we only found three practical contributions related to BPL [1] or BPM [4],[13], we recommend research on concrete applications for all capability areas.

8. Conclusion

This study has presented a systematic literature review of the Green BPM field. We have offered a comprehensive definition for the discipline (RQ1), and a research agenda by focusing on the current state (RQ2) and the methods and techniques (RQ3).

The comprehensive definition for Green BPM (RQ1) facilitates a common understanding to let the Green BPM discipline further mature, given the international importance of a green economy and the interdisciplinary character of sustainable objectives.

Regarding the current state (RQ2), this work has provided evidence that Green BPM needs more attention on BPM communication channels to bridge the relevance gap with rigorous research. This work call for more research on Green BPM, and especially from an international perspective. For instance, more non-European research groups should get involved.

Finally, RQ3 completes the research agenda by differentiating highly covered Green BPM capability areas from emerging areas. Based on the identified gaps, possible research avenues have been presented.

In sum, despite some typical SLR research limitations (e.g. sampling strategy), the research questions have generated a comprehensive overview about Green BPM application domains and research topics.

References

- Ahmed, M. D., & Sundaram, D. (2012). Sustainability modelling and reporting: From roadmap to implementation. *Decision Support Systems*, 53(3), 611–624. <http://doi.org/10.1016/j.dss.2012.02.004>
- Baskerville, R. L., & Myers, M. D. (2002). Informations Systems as a Reference Discipline. *MIS Quarterly*, 26(1), 1–14. <http://doi.org/10.2307/4132338>
- Boell, S. K., & Cecez-Kecmanovic, D. (2014). A Hermeneutic Approach for Conducting Literature Reviews and Literature Searches. *Communications of the Association for Information Systems*, 34(12), 257–286.
- Brundtland, G. H. (1987). *Our Common Future. Report of the World Commission on Environment and Development*. Retrieved from <http://www.un-documents.net/wced-ocf.htm>
- de Bruin, T. (2007). Insights into the Evolution of BPM in Organisations. In *18th Australasian Conference on Information Systems* (pp. 1–12). Toowoomba. Retrieved from <http://aisel.aisnet.org/acis2007>
- de Bruin, T., & Rosemann, M. (2007). Using the Delphi Technique to Identify BPM Capability Areas. *ACIS Proceedings*, 642–653.
- Deming, W. E. (1986). *Out of the Crisis*. Cambridge: Massachusetts Institute of Technology, Center for Advanced Engineering Study.
- Dumas, M., La Rosa, M., Mendling, J., & Reijers, H. A. (2013). *Fundamentals of Business Process Management*. Berlin, Heidelberg: Springer Berlin Heidelberg. <http://doi.org/10.1007/978-3-642-33143-5>
- Elkington, J. (1997). *Cannibals with Forks: the Triple Bottom Line of Sustainable Development*. Oxford: Capstone Publishing.
- Ghose, A., Hoesch-Klohe, K., Hinsche, L., & Le, L.-S. (2009). Green Business Process Management : a Research Agenda. *Australasian Journal of Information Systems*, 16(2), 103–117. <http://doi.org/10.3127/ajis.v16i2.597>
- Gohar, S. R., & Indulska, M. (2015). Business Process Management: Saving the Planet? In *Australasian Conference on Information Systems* (pp. 1–14). Adelaide.
- Hammer, M. (2007). The Process Audit. *Harvard Business Review*, 85(4), 111–123.
- Harmon, P. (2015). The Scope and Evolution of Business Process Management. In J. vom Brocke & M. Rosemann (Eds.), *Handbook on Business Process Management 1: Introduction, Methods, and Information Systems* (pp. 37–80). Berlin, Heidelberg: Springer Berlin Heidelberg. <http://doi.org/10.1007/978-3-642-45100-3>
- Jakobi, T., Castelli, N., Nolte, A., Schönau, N., & Stevens, G. (2016). Towards collaborative green

- business process management as a conceptual framework. In J. M. Gomez, M. Sonnenschein, U. Vogel, A. Winter, B. Rapp, & N. Giesen (Eds.), *Advances and New Trends in Environmental and Energy Informatics* (pp. 275–293). Springer International Publishing. <http://doi.org/10.1007/978-3-319-23455-7>
- Kuppusamy, M., & Gharleggi, B. (2015). “Green Business Process Management” in Manufacturing Firms: Examining the Role of Upstream and Downstream Suppliers. *International Journal of Applied Business and Economic Research*, 13(1), 259–271.
- Lübbecke, P., Fettke, P., & Loos, P. (2016). Sustainability Patterns for the Improvement of IT-related Business Processes with Regard to Ecological Goals. In *Business Process Management Workshops. International Workshop on Sustainability-Aware Business Process Management*. Rio de Janeiro: Springer.
- Maciel, J. C. (2017). The Core Capabilities of Green Business Process Management – A Literature Review. In J. M. Leimeister & W. Brenner (Eds.), *International Conference on Wirtschaftsinformatik* (pp. 1526–1537). St. Gallen. Retrieved from <http://www.wi2017.ch/de/proceedings>
- McCormack, K., & Johnson, W. C. (2001). *Business Process Orientation : Gaining the E-Business Competitive Advantage*. Florida: St. Lucie Press.
- Nowak, A., Leymann, F., & Schumm, D. (2011). The Differences and Commonalities between Green and Conventional Business Process Management. In *International Conference on Dependable, Autonomic and Secure Computing* (pp. 569–576). Sydney. <http://doi.org/10.1109/DASC.2011.105>
- OMG. (2008). Business Process Maturity Model, version 1.0. Retrieved December 22, 2016, from <http://www.omg.org/>
- Opitz, N., Krüp, H., & Kolbe, L. M. (2014). Green Business Process Management - A Definition and Research Framework. In *Hawaii International Conference on System Sciences* (pp. 3808–3817). Waikoloa. <http://doi.org/10.1109/HICSS.2014.473>
- Reijers, H. A., & Liman Mansar, S. (2005). Best Practices in Business Process Redesign: an Overview and Qualitative Evaluation of Successful Redesign Heuristics. *Omega*, 33(4), 283–306. <http://doi.org/10.1016/j.omega.2004.04.012>
- Rosemann, M., & de Bruin, T. (2005). Towards a Business Process Mangement Maturity Model. *ECIS 2005 Proceedings of the Thirteenth European Conference on Information Systems*, (May), 26–28. <http://doi.org/10.1109/EUROMICRO.2007.35>
- Seidel, S., vom Brocke, J., & Recker, J. (2011). Call for Action: Investigating the Role of Business Process Management in Green IS. In *SIG Green Workshop* (pp. 1–6). Retrieved from

<http://sprouts.aisnet.org/11-4>

- SIGGreen. (2015). An Introduction to Green Information Systems (Green IS). Retrieved December 27, 2016, from <https://siggreen.wikispaces.com/file/view/An+Introduction+to+Green+IS2-Final18-2-15.pdf>
- Stolze, C., Semmler, G., & Thomas, O. (2012). Sustainability in Business Process Management Research - a Literature Review. In *Americas Conference on Information Systems* (pp. 1–10). Seattle.
- Tarhan, A., Turetken, O., & Reijers, H. A. (2016). Business Process Maturity Models: a Systematic Literature Review. *Information and Software Technology*, 75, 122–134. <http://doi.org/10.1016/j.infsof.2016.01.010>
- Van Looy, A., De Backer, M., & Poels, G. (2014). A Conceptual Framework and Classification of Capability Areas for Business Process Maturity. *Enterprise Information Systems*, 8(2), 188–224. <http://doi.org/10.1080/17517575.2012.688222>
- vom Brocke, J., & Rosemann, M. (2014). *Handbook on Business Process Management 1 & 2*. (J. vom Brocke & M. Rosemann, Eds.) (2nd ed.). Berlin: Springer.
- vom Brocke, J., Seidel, S., & Recker, J. (2012). *Green Business Process management: Towards the Sustainable Enterprise*. (J. vom Brocke, S. Seidel, & J. Recker, Eds.) (1st ed.). Springer Berlin Heidelberg.
- Webster, J., & Watson, R. T. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quarterly*, 26(2), xiii–xxiii. <http://doi.org/10.1.1.104.6570>
- Weske, M. (2012). *Business Process Management: Concepts, Languages, Architectures* (2nd ed.). Berlin: Springer.

Appendix 1: list of sampled papers

ID	Reference
[1]	Ahlers, D., Krogstie, J., Driscoll, P., Lundli, H., Loveland, S., Rothballer, C., & Wyckmans, A. (2016). Supporting Municipal Greenhouse Gas (GHG) Emission Inventories Using Business Process Modeling: A Case Study of Trondheim Municipality. In <i>Business Process Management Workshops. International Workshop on Sustainability-Aware Business Process Management</i> (pp. 1–10). Rio de Janeiro: Springer.
[2]	Ahmed, M. D., & Sundaram, D. (2012). Sustainability modelling and reporting: From roadmap to implementation. <i>Decision Support Systems</i> , 53(3), 611–624. http://doi.org/10.1016/j.dss.2012.02.004
[3]	Ardagna, D., Cappiello, C., Lovera, M., Pernici, B., & Tanelli, M. (2008). Active Energy-Aware Management of Business-Process Based Applications. In P. Mähönen, K. Pohl, & T. Priol (Eds.), <i>European Conference on a Service-Based Internet. Towards a Service-Based Internet</i> (pp. 183–184). Springer Berlin Heidelberg.
[4]	Balachandran, R. (2011). Business Processes Management for a Green Telecommunications Company. In <i>Green Technologies: Concepts, Methodologies, Tools and Applications</i> (pp. 1391–1407). Information Resources Management Association. http://doi.org/10.4018/978-1-60960-472-1.ch603
[5]	Betz, S. (2014). Sustainability Aware Process Management using XML-Nets. In <i>EnvirolInfo Conference</i> (pp. 1–8). Oldenburg.
[6]	Cappiello, C., Plebani, P., & Vitali, M. (2013). Energy-Aware Process Design Optimization. In <i>International Conference on Cloud and Green Computing. Workshop on European Actions Towards Eco-Friendly Data Centers</i> (pp. 451–458). Karlsruhe: Institute of Electrical and Electronics Engineers (IEEE). http://doi.org/10.1109/CGC.2013.77
[7]	Cleven, A., Winter, R., & Wortmann, F. (2012). Managing Process Performance to Enable Corporate Sustainability: A Capability Maturity Model. In J. vom Brocke, S. Seidel, & J. Recker (Eds.), <i>Green Business Process Management: Towards the Sustainable Enterprise</i> (pp. 111–129). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-27488-6_7
[8]	Couckuyt, D. (2018). An Overview of Challenges and Research Avenues for Green BPM. In C. Debruyne, H. Panetto, G. Weichhart, P. Bollen, I. Ciuciu, M.-E. Vidal, & R. Meersman (Eds.), <i>On the Move to Meaningful Internet Systems. OTM 2017 Workshops</i> (Vol. 10697, pp. 270–279). Springer, Cham. http://doi.org/10.1007/978-3-319-73805-5
[9]	Couckuyt, D., Van Looy, A., & De Backer, M. (2018). Sustainability Performance Measurement. In E. Teniente & M. Weidlich (Eds.), <i>International Conference on Business Process Management. BPM Workshops</i> (Vol. 308, pp. 520–524). Springer, Cham. http://doi.org/10.1007/978-3-319-74030-0
[10]	Curry, E., & Donnellan, B. (2012). Understanding the Maturity of Sustainable ICT. In J. vom Brocke, S. Seidel, & J. Recker (Eds.), <i>Green Business Process Management: Towards the Sustainable Enterprise</i> (pp. 203–216). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-27488-6_12

[11]	Dao, V., Langella, I., & Carbo, J. (2011). From Green to Sustainability: Information Technology and an Integrated Sustainability Framework. <i>Journal of Strategic Information Systems</i> , 20(1), 63–79. http://doi.org/10.1016/j.jsis.2011.01.002
[12]	Gallotta, B., Garza-Reyes, J. A., Anosike, A., Lim, M. K., & Roberts, I. (2017). A Conceptual Framework for the Implementation of Sustainability Business Processes. In <i>Production and Operations Management Society</i> (pp. 1–10). Orlando.
[13]	Gallotta, B., Kolelas, V., Garza-Reyes, J. A., Anosike, A., & Kumar, V. (2017). Using BPM to Improve Sustainability in Biomass Generation. In <i>International Symposium on Industrial Engineering and Operations Management</i> (pp. 203–214). Bristol.
[14]	Ghose, A., Hoesch-Klohe, K., Hinsche, L., & Le, L.-S. (2009). Green Business Process Management: a Research Agenda. <i>Australasian Journal of Information Systems</i> , 16(2), 103–117. http://doi.org/10.3127/ajis.v16i2.597
[15]	Gohar, S. R., & Indulska, M. (2015). Business Process Management: Saving the Planet? In <i>Australasian Conference on Information Systems</i> (pp. 1–14). Adelaide.
[16]	Gräuler, M., & Teuteberg, F. (2013). Experimental Evaluation of a Process Benchmarking Tool in a Green Business Process Management Context. In <i>Wirtschaftsinformatik Proceedings 2013</i> (pp. 1083–1097). Retrieved from http://aisel.aisnet.org/wi2013/68/
[17]	Hoesch-Klohe, K., & Ghose, A. (2010a). Business Process Improvement in Abnoba. In E. M. Maximilien, G. Rossi, S.-T. Yuan, H. Ludwig, & M. Fantinato (Eds.), <i>International Conference on Service Oriented Computing. International Workshop on Services, Energy, and Ecosystem</i> (pp. 193–202). San Francisco: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-19394-1_21
[18]	Hoesch-Klohe, K., & Ghose, A. (2010b). Carbon-Aware Business Process Design in Abnoba. In P. P. Maglio, M. Weske, J. Yang, & M. Fantinato (Eds.), <i>International Conference on Service Oriented Computing</i> (pp. 551–556). San Francisco: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-17358-5_38
[19]	Hoesch-Klohe, K., Ghose, A., & Lê, L.-S. (2010). Towards green business process management. In <i>International Conference on Services Computing</i> (pp. 386–393). Miami: Institute of Electrical and Electronics Engineers (IEEE). http://doi.org/10.1109/SCC.2010.21
[20]	Houy, C., Reiter, M., Fettke, P., Loos, P., Hoesch-Klohe, K., & Ghose, A. (2012). Advancing Business Process Technology for Humanity: Opportunities and Challenges of Green BPM for Sustainable Business Activities. In J. vom Brocke, S. Seidel, & J. Recker (Eds.), <i>Green Business Process Management: Towards the Sustainable Enterprise</i> (pp. 75–92). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-27488-6_5
[21]	Jakobi, T., Castelli, N., Nolte, A., Schönau, N., & Stevens, G. (2016). Towards collaborative green business process management as a conceptual framework. In J. M. Gomez, M. Sonnenschein, U. Vogel, A. Winter, B. Rapp, & N. Giesen (Eds.), <i>Advances and New Trends in Environmental and Energy Informatics</i> (pp. 275–293). Springer International Publishing. http://doi.org/10.1007/978-3-319-23455-7
[22]	Kuppusamy, M., & Gharleghi, B. (2015). “Green Business Process Management” in Manufacturing Firms: Examining the Role of Upstream and Downstream Suppliers. <i>International Journal of Applied Business and Economic Research</i> , 13(1), 259–271.

[23]	Lan, Y.-C. (2011). Reengineering a Green Business. <i>International Journal of Green Computing</i> , 2(1), 1–11. http://doi.org/10.4018/jgc.2011010101
[24]	Larsch, S., Betz, S., Duboc, L., Magdaleno, A. M., & Bomfim, C. (2016). Integrating Sustainability Aspects in Business Process Management. In <i>Business Process Management Workshops. International Workshop on Sustainability-Aware Business Process Management</i> . Rio de Janeiro: Springer.
[25]	Levina, O. (2015). Exploring the Role of Business Process Management in Sustainability Initiatives. In <i>Mediterranean Conference on Information Systems</i> (pp. 1–7). Samos. Retrieved from http://aisel.aisnet.org/mcis2015/35
[26]	Loepp, F., & Betz, S. (2015). Sustainability Practices in Companies: Strategies Business Process Management ICT. In <i>SIG Green Workshop</i> (pp. 1–10).
[27]	Lübbecke, P., Goswami, A., & Fettke, P. (2018). A Method for Ecological Process Optimization Based on Compliance Checking. In <i>International Conference on Business Informatics</i> (Vol. 1, pp. 119–128). Vienna: IEEE. http://doi.org/10.1109/CBI.2018.00022
[28]	Lübbecke, P., Fettke, P., & Loos, P. (2018). Towards Guidelines of Modeling for Ecology-Aware Process Design. In E. Teniente & M. Weidlich (Eds.), <i>International Conference on Business Process Management. BPM Workshops</i> (Vol. 308, pp. 510–519). Springer, Cham. http://doi.org/10.1007/978-3-319-74030-0
[29]	Lübbecke, P., Fettke, P., & Loos, P. (2016). Sustainability Patterns for the Improvement of IT-related Business Processes with Regard to Ecological Goals. In <i>Business Process Management Workshops. International Workshop on Sustainability-Aware Business Process Management</i> . Rio de Janeiro: Springer.
[30]	Lübbecke, P., Fettke, P., & Loos, P. (2016). Towards Ecological Workflow Patterns as an Instrument to Optimize Business Processes with Respect to Ecological Goals. In <i>Hawaii International Conference on System Sciences</i> (pp. 1049–1058). Koloa: Institute of Electrical and Electronics Engineers (IEEE). http://doi.org/10.1109/HICSS.2016.134
[31]	Lübbecke, P., Reiter, M., Fettke, P., & Loos, P. (2015). Simulation-based decision support for the reduction of the energy consumption of complex business processes. In <i>Hawaii International Conference on System Sciences</i> (pp. 866–875). Kauai. http://doi.org/10.1109/HICSS.2015.109
[32]	Maciel, J. C. (2017). The Core Capabilities of Green Business Process Management – A Literature Review. In J. M. Leimeister & W. Brenner (Eds.), <i>International Conference on Wirtschaftsinformatik</i> (pp. 1526–1537). St. Gallen. Retrieved from http://www.wi2017.ch/de/proceedings
[33]	Magdaleno, A. M., Duboc, L., & Betz, S. (2016). How to Incorporate Sustainability into Business Process Management Lifecycle? In <i>Business Process Management Workshops. International Workshop on Sustainability-Aware Business Process Management</i> . Rio de Janeiro: Springer.
[34]	Mancebo, J., Garcia, F., Pedreira, O., & Moraga, M. A. (2017). BPMS-Game: Tool for Business Process Gamification. In J. Carmona, G. Engels, & A. Kumar (Eds.), <i>International Conference on Business Process Management. BPM Forum</i> (Vol. 297, pp. 127–140). Springer International Publishing. http://doi.org/10.1007/978-3-319-65015-9

[35]	Nowak, A., Binz, T., Leymann, F., & Urbach, N. (2013). Determining Power Consumption of Business Processes and their Activities to Enable Green Business Process Reengineering. In <i>International Enterprise Distributed Object Computing Conference</i> (pp. 259–266). http://doi.org/10.1109/EDOC.2013.36
[36]	Nowak, A., & Leymann, F. (2013). Green Business Process Patterns – Part II. In <i>International Conference on Service-Oriented Computing and Applications</i> (pp. 168–173). Koloa: Institute of Electrical and Electronics Engineers (IEEE).
[37]	Nowak, A., Leymann, F., & Mietzner, R. (2010). Towards Green Business Process Reengineering. In E. M. Maximilien, G. Rossi, S.-T. Yuan, H. Ludwig, & M. Fantinato (Eds.), <i>International Conference on Service-Oriented Computing. International Workshop on Services, Energy, and Ecosystem</i> (pp. 187–194). San Francisco: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-19394-1_20
[38]	Nowak, A., Leymann, F., & Schumm, D. (2011). The differences and commonalities between green and conventional business process management. In <i>International Conference on Dependable, Autonomic and Secure Computing</i> (pp. 569–576). Sydney. http://doi.org/10.1109/DASC.2011.105
[39]	Nowak, A., Leymann, F., Schumm, D., & Wetzstein, B. (2011). An architecture and methodology for a four-phased approach to green business process reengineering. In <i>International Conference on ICT as Key Technology for the Fight against Global Warming</i> (pp. 150–164). Toulouse. http://doi.org/10.1007/978-3-642-23447-7_14
[40]	Opitz, N., Ereik, K., Langkau, T., Kolbe, L., & Zarnekow, R. (2012). Kick-starting Green Business Process Management–Suitable Modeling Languages and Key Processes for Green Performance Measurement. In <i>Americas Conference on Information Systems</i> (pp. 1–10). Seattle.
[41]	Opitz, N., Krüp, H., & Kolbe, L. M. (2014a). Environmentally Sustainable Business Process Management–Developing a Green BPM Readiness Model. In <i>Pacific Asia Conference on Information Systems</i> (pp. 1–12). Chengdu. Retrieved from http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1379&context=pacis2014%5Cnh http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6759075
[42]	Opitz, N., Krüp, H., & Kolbe, L. M. (2014b). Green business process management - A definition and research framework. In <i>Hawaii International Conference on System Sciences</i> (pp. 3808–3817). Waikoloa. http://doi.org/10.1109/HICSS.2014.473
[43]	Recker, J., Rosemann, M., & Gohar, E. R. (2010). Measuring the Carbon Footprint of Business Processes. In M. zur Muehlen & J. Su (Eds.), <i>Business Process Management Workshops. International Workshop on Business Process Management and Sustainability</i> (pp. 511–520). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-20511-8
[44]	Recker, J., Rosemann, M., Hjalmarsson, A., & Lind, M. (2012). Modeling and Analyzing the Carbon Footprint of Business Processes. In J. vom Brocke, S. Seidel, & J. Recker (Eds.), <i>Green Business Process Management: Towards the Sustainable Enterprise</i> (pp. 93–109). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-27488-6_6

[45]	Reiter, M., Fettke, P., & Loos, P. (2014). Towards Green Business Process Management: Concept and Implementation of an Artifact to Reduce the Energy Consumption of Business Processes. In <i>Hawaii International Conference on System Sciences</i> (pp. 885–894). Waikoloa: Institute of Electrical and Electronics Engineers (IEEE). http://doi.org/10.1109/HICSS.2014.117
[46]	Rozman, T., Draghici, A., & Riel, A. (2015). Achieving Sustainable Development by Integrating It into the Business Process Management System. In V. R. O'Connor, M. Umay Akkaya, K. Kemaneci, M. Yilmaz, A. Poth, & R. Messnarz (Eds.), <i>European Conference on Systems, Software and Services Process Improvement</i> (pp. 247–259). Ankara: Springer International Publishing. http://doi.org/10.1007/978-3-319-24647-5_20
[47]	Sánchez, M. A. (2015). Integrating Sustainability Issues into Project Management. <i>Journal of Cleaner Production</i> , 96, 319–330. http://doi.org/10.1016/j.jclepro.2013.12.087
[48]	Seidel, S., Recker, J., & vom Brocke, J. (2012). Green Business Process Management. In J. vom Brocke, S. Seidel, & J. Recker (Eds.), <i>Green Business Process Management: Towards the Sustainable Enterprise</i> (pp. 3–13). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-27488-6_1
[49]	Seidel, S., vom Brocke, J., & Recker, J. (2011). Call for action : investigating the role of business process management in green IS. In <i>SIG Green Workshop</i> (pp. 1–6). Retrieved from http://sprouts.aisnet.org/11-4
[50]	Schoormann, T., Behrens, D., & Knackstedt, R. (2017). Sustainability in Business Process Models: A Taxonomy-Driven Approach to Synthesize Knowledge and Structure the Field. In <i>International Conference on Information Systems</i> (pp. 1–13).
[51]	Silvius, G. (2012). Change the Game: Sustainability in Projects and Project Management. In J. vom Brocke, S. Seidel, & J. Recker (Eds.), <i>Green Business Process Management: Towards the Sustainable Enterprise</i> (pp. 161–177). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-27488-
[52]	Skarlat, O., Hoenisch, P., & Dustdar, S. (2015). On Energy Efficiency of BPM Enactment in the Cloud. In M. Reichert & H. A. Reijers (Eds.), <i>Business Process Management Workshops. International Workshop on Process Engineering</i> (pp. 489–500). Innsbruck: Springer International Publishing. http://doi.org/10.1007/978-3-540-78238-4
[53]	Stolze, C., Semmler, G., & Thomas, O. (2012). Sustainability in Business Process Management Research - a Literature Review. In <i>Americas Conference on Information Systems</i> (pp. 1–10). Seattle.
[54]	Thies, H., Dada, A., & Stanoevska-Slabeva, K. (2012). The Potential of a Network-Centric Solution for Sustainability in Business Processes. In J. vom Brocke, S. Seidel, & J. Recker (Eds.), <i>Green Business Process Management: Towards the</i>
[55]	von Rosing, G., Coloma, D., & von Scheel, H. (2015). Sustainability Oriented Process Modeling. In M. von Rosing, H. von Scheel, & A.-W. Scheer (Eds.), <i>The Complete Business Process Handbook</i> (1st ed., pp. 493–510). Sciencedirect. http://doi.org/10.1016/B978-0-12-799959-3.00024-0

