

# Recommendations from Analyzing the State-of-the-Art of Business Process Management Research\*

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**Abstract:** Business Process Management (BPM) as a research field integrates different perspectives from the disciplines computer science, management science and information systems research. Its evolution has been shaped by the corresponding conferences series, the International Conference on Business Process Management (BPM conference). As much as in other academic discipline, there is an ongoing debate that discusses the identity, the quality and maturity of the BPM field. In this paper, we review and summarize the major findings a larger study that will be published in the *Business & Information Systems Engineering* journal in 2016. In the study, we investigate the identity and progress of the BPM conference research community through an analysis of the BPM conference proceedings. Based on our findings from this analysis, we formulate recommendations to further develop the conference community in terms of methodological advance, quality, impact and progression.

## 1 Introduction

Over the last two decades, there has been a growing interest in Business Process Management (BPM), allegedly due to its potential to assist organizations in increasing productivity, achieving operational excellence or saving costs [vdA13]. Research in this field, which originated from work in computer science, management science and information systems [vDATHW03], has contributed a plethora of models, methods and tools that support the different phases of managing business processes. Many scholars argue that BPM has become a mature discipline [vdA13], with its relevance acknowledged by practitioners and its scholarly impact respected by academics. Other scholars challenge the BPM discipline, questioning whether the “research use cases” it pursues are comprehensive, original and rigorous enough [vdA13, Rec14].

BPM research outcomes are disseminated in a variety of forums. BPM research has been published in the top, general-level journals of various fields, including information

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systems [KTG97, DB95], computer science [ODVDA<sup>+</sup>09, EHLB95], or management science [BT03, Pen03]. There is also a journal focusing exclusively on BPM research, the Business Process Management Journal. Finally, over recent years, many of the premium conferences in the research fields (e.g., ICIS, ECIS, and others) feature dedicated tracks on Business Process Management. In addition, the BPM discipline organizes its own annual conference series, The International Conference on BPM, which commenced in 2003.

The study described in [RM16] examines specifically the role of the BPM conference series in the development of the discipline. In this way, it complements prior BPM-related literature studies that approached the field from different other angles [SI10, HFL10, VBR10a, VBR10b, vBS11, NP11, vdA12, vdA13]. Our aim was to provide empirical insights into the use cases of BPM research as evident in the papers published in the BPM conference proceedings between 2003 and 2014. The focus was on the BPM conference series, because it is regarded as a leading forum for many researchers, practitioners, developers and users in the field of BPM and considered as challenging to get a paper accepted. It is specifically interesting to focus on the BPM conference, because a recent analysis [vdA13] indicated that papers at the BPM conference are somewhat reductionistic in scope, often pursuing either popular problems (such as process modeling languages) or “exotic or even non-existing problems” [vdA13, p.29]. The danger is therefore that the BPM community - as represented in the BPM conference - is not addressing persistent or important concerns and rather follows what others have dubbed research fads.

In completing this work, our ambition was to add to ongoing discussions about the state and progress of BPM research, by developing an understanding of current practices in publishing BPM papers specifically at the BPM conference, and setting the basis for future research practices at this particular conference and hopefully also beyond. In this paper, we discuss a subset of the original study with a focus on three retrospective research questions:

1. Which topics are covered at the BPM conference?
2. Which type of research is presented and is there evidence of increasing maturity over time?
3. Which BPM conference papers made an impact on the development of the field?

With these questions, we aim to establish a ground for formulating recommendations that should be considered in the future of BPM research, at the BPM conference and beyond.

We proceed as follows. Section 2 presents findings to which extent the BPM lifecycle is covered. Section 3 discusses to which extent certain research components are utilized in BPM research. Section 4 shows which BPM papers had an impact in terms of citations. Section 5 presents recommendations for future BPM research.

## **2 Coverage of the BPM Lifecycle by BPM Conference Papers**

Business Process Management is often described as a lifecycle in order to clarify how different BPM-related tasks fit together. Various similar lifecycle models have been pro-

posed [MdMKIDdPLC14]. Figure 1 shows a version with six phases [DRMR13]. It also visualizes the coverage of BPM conference papers of each of the phases with a pink dot. The first phase of process identification is concerned with setting up the BPM initiative and establishing its infrastructure and mission. The major outcome of this phase is a process architecture. This architecture identifies the major processes of the company, describes their relationships, and criteria for prioritizing them.

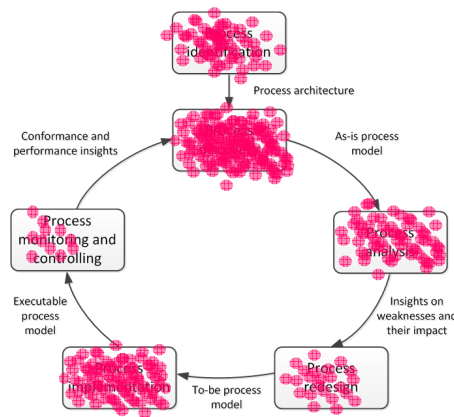


Figure 1: The BPM Lifecycle and Plotted Conference Papers

Entering the cycle shifts the focus from the overall portfolio of processes towards a singular process. The process discovery phase is concerned with the precise description of a business process in its current state. The result is a so-called As-Is process model. Process analysis applies analytical techniques in order to determine weaknesses of the As-Is process and their impact. Process redesign addresses these weaknesses and comes up with a reworked blueprint of the process. The result is a so-called To-Be process model. This model is then considered for process implementation, which can involve information system implementation and measures to facilitate organizational change. Once the redesigned process is up and running, the process monitoring and controlling phase continuously collects and analyzes execution data for performance and conformance to regulations. Such insight, as much as changes in the business environment and the goals of the company, can trigger a new iteration of the BPM lifecycle. In practice, the phases are hardly executed in a purely sequential way. Also, the circle is not always closed, e.g. when a company decides only to document its processes without considering redesign. Still, the BPM lifecycle is a useful analytical scheme for separating different concerns of BPM.

An important observation in [RM16] is that the phases of the BPM lifecycle are covered to different extents in research papers of the BPM conference. Figure 1 shows that most research of the BPM conference is dedicated to questions that are associated with the process discovery and the process implementation phase. Typical matters that are studied in these two pockets are models and modeling languages together with techniques for verification, formal analysis and process mining. The least covered phases are topics associated with monitoring and with redesign.

### 3 Research Components

The maturity of the research contributions are arguably linked to the quality of methodological aspects as report in BPM conference papers. Therefore, we examined whether papers explicitly discuss components of research designs such as variables and hypotheses (for empirical research), or artifact and theory (for engineering and design papers).

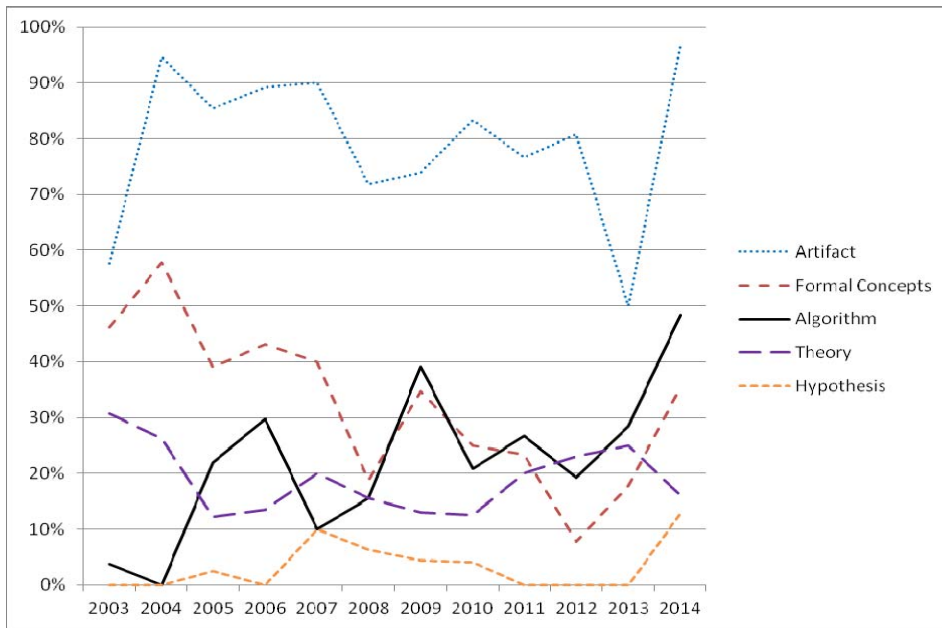


Figure 2: Research Components in Different Years of the Conference [RM16]

Figure 2 shows the relative share of BPM conference papers that explicitly discuss such research components over time. We make two main observations from this data. First, the maturity in terms of methodological rigor appears to be a two-sided coin. On the one hand, we interpret the data as indicating that engineering papers that report on artifacts and formal concepts are traditionally well-represented at the BPM conference. This can also be seen by the high percentage of papers explicitly discussing engineering artifacts and formal concepts over time. On the other hand, from the viewpoint of empirical and theoretical work, however, we note that there are only a handful of BPM conference papers explicitly developing hypotheses (12 out of 347 in total), and very few stating independent or dependent variables. From Figure 2 we note that the share of papers with explicit discussion of theory or hypotheses is also not notably increasing over time. This is a concern, because one would expect that with increasing maturity of research that is presented at a conference, studies would increasingly evaluate and falsify theoretical predictions rather than explore empirical evidence without a priori expectations. This also indicates concerns about the possibility of retrodution as a means of scientific appraisal.

## 4 Citation Impact

Aside from methodological maturity, we were also interested in identifying which BPM conference papers had an impact on the community. We discuss the impact of a contribution from the perspective of citations that a paper attracts. While it is possible that flawed papers stimulate a lot of corrective comments, it is generally believed that the number of citations capture the inspirational capacity and intellectual impact of a paper [MY07]. Of course, we are mindful that citations are only one measure of academic impact [SA10] and, importantly, do not necessarily reflect practical impact [RV08]. Table 1 summarizes citations statistics of BPM conference papers per year collected via Google Scholar as of 28 May 2015.

<i>Year</i>	<i>Citation statistics</i>			<i># of papers with citations</i>		
	<i>Mean</i>	<i>Std. Dev.</i>	<i>Max</i>	<i>&lt; 10</i>	<i>&gt;= 10 &lt; 100</i>	<i>&gt; 100</i>
2003	80.92	238.12	1239	4	20	2
2004	43.21	55.86	196	8	9	2
2005	49.49	82.91	388	11	25	5
2006	55.08	63.56	295	7	22	7
2007	78.80	87.25	327	5	17	8
2008	44.25	47.48	187	9	17	6
2009	42.26	45.86	213	2	20	1
2010	24.04	18.93	80	6	18	0
2011	21.87	21.52	94	11	19	0
2012	14.62	11.78	47	14	12	0
2013	9.64	6.30	26	16	12	0
2014	0.87	1.12	4	31	0	0
<i>Total</i>	<i>39.35</i>	<i>84.40</i>	<i>1239</i>	<i>124</i>	<i>191</i>	<i>31</i>

Table 1: The Citation Impact of Papers in Different Years of the Conference [RM16]

Overall, we note that BPM conference papers attracts fairly high numbers of citations, with papers published before 2010 on average being cited between 42 and 80 times. As expected, we also note a time lag of uptake for papers since 2010. Prior to 2010, in every year at least one paper rose to a status of a well-cited paper with at least 100 citations.

In the section above we observed an imbalance in terms of the number of contributions by a specific type of research component. In [RM16], it is shown that papers that are based on formal science are cited as frequently as scientific studies such as experiments or surveys. To us, this suggests that despite the divide in maturity of using formal versus empirical methods, scientific empirical research seems to be very promising and apparently inspiring to large parts of the research community.

## 5 Recommendations

Table 2 summarizes the findings reported in [RM16]. On the basis of these findings, below we discuss directions for progressing the field in three categories: formal science, behavioural science and design science.

<i>Research Question</i>	<i>Findings based on Observations</i>
Is there evidence in the publication profile of the BPM conference that BPM research is maturing over time?	The conference series has so far attracted an imbalanced portfolio of contributions, largely related to process documentation in the past and increasingly on process identification and implementation. Maturity in the sense of comprehensive coverage of BPM lifecycle phenomena is not evident, and especially contributions to process improvement remain absent.
Which evidence is needed or presented at the BPM conference to sufficiently justify research in the different types of research conduct?	Maturity in the sense of methodological rigor is strong in some type of inquiry – notably formal sciences and engineering research. There is a noted absence of methodologically strong empirical and theoretical research. The conference proceedings are remarkably different from other empirical sciences in its composition of research methods.
Which BPM conference papers are arguably impacting the development of the discipline?	Many BPM conference papers create significant impact. Overall, the spreading of citations is similar to other research communities and follows a power law distribution. Scientific studies and formal analysis papers have high citation averages. In recent years, formal science papers demonstrate most impact.

Table 2: Summary of Research Findings [RM16]

### Progressing BPM as Formal Science:

The results of our analysis suggest that BPM as a formal science is well-represented in the BPM conference series and that it is well-understood by its key contributors. This is, for instance, reflected in the extensive reference to formal Petri net concepts, algebraic definitions and utilization of formal logics in many papers.

We identify three opportunities for further development. First, the methodological expertise of the BPM community can be beneficial and inspiring for neighboring fields. For example, processes are equally important for political sciences or social sciences. Techniques developed in the BPM community such as process mining could advance research in these fields. Second, guidelines and criteria for conducting and reporting research can be further harmonized, for instance on which types of tests and evaluations should be required to demonstrate the quality of a new algorithm. Third, there are opportunities for more intensively mixing formal science with other types of science. Examples of such mixed-method studies are [WM12, RFME11, RF12], but in absolute terms such contributions still remain scarce [Rec14].

### Progressing BPM as Behavioural Science:

BPM as a behavioural science is concerned with human and organizational behaviours in the context of managing business processes. Such aspects are important for studying,

among others, how process knowledge can be effectively documented, which redesign suggestions provide better efficiency, or how processes can be effectively monitored. The results of our study identifies the need to further strengthen BPM as a behavioural science. Methodological guidelines is available in neighboring fields.

The software engineering community has turned to empirical research methods already in the 1980s, most strongly inspired by works of Victor Basili [BW84]. There has been a growing uptake of experimental research and corresponding methodological guidelines as, for example, summarized in the book by Wohlin et al. [WRH<sup>+</sup>12]. Behavioural research on BPM can benefit from adopting such guidelines from software engineering research.

Likewise, the field of information systems research offers rich methodological insights into how survey research can be conducted [SBG04]. Some adoptions can be found in the area of BPM recently [RR10, SvBR14], but are still scarce. We believe that an increasing uptake of these guidelines would be fertile for the conference and the field.

Research that pursues theory-building to capture socio-technical phenomena in the field of business process management is also still scarce. Here, again, the field of information systems research can be a source of inspiration where inductive research methods such as the grounded theory method [SC98] or case study methods [Eis89] are both mature and well-established.

Both empirical software engineering and information systems research further emphasize the need of systematically reviewing literature. Articles in both information systems [WW02] and software engineering [BKB<sup>+</sup>07] give detailed guidelines for transparent reporting. Literature reviews can be varied [Row14, PTJK15]; but we believe that especially those types of literature reviews are required in BPM that assist the development of novel theory about processes and their management [Riv14].

Finally, there seems to be a certain affinity of BPM conference papers of the behavioral science-type with process discovery and redesign as both are organizationally situated tasks conducted by humans. Yet, we posit that organizational performance as related to process monitoring and implementation can also benefit from this perspective.

### **Progressing BPM as Design Science:**

BPM as a design science can be considered a third line of inquiry. It perceives BPM as an engineering discipline with the research objective of designing artifacts that provide superior utility in the context of managing business processes. It requires the capability of a researchers to design algorithms and systems, but it also requires empirical research methods [HMPR04] for artefact design and evaluation. To further develop such research, we offer four suggestions.

First, there appears to be a need for taxonomies to structure the field and the relevant artifacts. This would start with a definition of types of processes [Rec14, p.11] but could expand to a typology of improvement approaches, management techniques or BPM systems. Second, many of the techniques that are discussed in the context of BPM are implicitly tailored to support the process analyst and the control flow perspective. Research to differentiate process roles, tasks and perspectives can help to identify white spots. Third,

there is a need to study BPM-related phenomena within the complex environments in which they occur. Research methods such as case study research [RH09, KM99] and action research [BWH98] appears to be instrumental for capturing this complexity.

Finally, we observe that a good share of BPM conference papers designs algorithms that are meant to provide efficient and effective solutions for BPM-related problems. The engineering of such algorithms requires the explicit definition of hypotheses on which kind of benefits the algorithm is meant to provide [San09], which we rarely found to be explicit in papers. This is related to the need to establish a research contribution, which in design science typically equates with a superior utility. This superior utility (e.g. better runtime performance, better precision and recall, comparable results with weaker assumptions) has to be made more explicit in terms of evaluation hypotheses. Also, in order to advance the design science papers at the BPM conference, it is desirable to make benchmark data publicly available (such as was done with the BPI challenges 2012, 2013 and 2014 or the process matching contest 2013). Finally, the progress of the field benefits from the public availability of prototypical implementations of algorithms (such as within ProM) as it stimulates comparison and incremental improvement.

## 6 Conclusion

In this paper, we reviewed our analysis in [RM16] that BPM research as published in the BPM conference proceedings between 2003 and 2014. Our review of this study focused on the retrospective analysis of research approach, methodological maturity and impact of BPM papers, and we generated a set of varied recommendations for progressing research published at the BPM conference. More details of the study including analyses and recommendations are published in [RM16].

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