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Review

Business Process Management and Digital Innovations: A Systematic Literature Review

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Abstract: Emerging technologies have capabilities to reshape business process management (BPM) from its traditional version to a more explorative variant. However, to exploit the full benefits of new IT, it is essential to reveal BPM's research potential and to detect recent trends in practice. Therefore, this work presents a systematic literature review (SLR) with 231 recent academic articles (from 2014 until May 2019) that integrate BPM with digital innovations (DI). We position those articles against seven future BPM-DI trends that were inductively derived from an expert panel. By complementing the expected trends in practice with a state-of-the-art literature review, we are able to derive covered and uncovered themes in order to help bridge a rigor-relevance gap. The major technological impacts within the BPM field seem to focus on value creation, customer engagement and managing human-centric and knowledge-intensive business processes. Finally, our findings are categorized into specific calls for research and for action to let scholars and organizations better prepare for future digital needs.

Keywords: business process management; business process innovation; digital innovation; emerging technologies; Industry 4.0

1. Introduction

Today's technologies are triggering a fourth industrial revolution and generate new ways of doing business. With the rapid boom of new technologies (e.g., blockchains, Internet of Things (IoT) or artificial intelligence), organizations are struggling to take maximum advantage of new IT [1]. In response, business operations, structures and processes need to learn how to adapt and implement a new version of business process management (BPM), called ambidexterity. Ambidextrous BPM is a mixture of two aspects: (1) exploiting the benefits of existing technologies (i.e., exploitative BPM), while simultaneously (2) exploring the benefits of new IT (i.e., explorative BPM) [2].

On the one hand, emerging technologies enable disruptive digital innovations (i.e., DI or innovations with new technologies) which are rudimentary prerequisites of sustainable business processes (i.e., an organization's long-term way of working). While product/service innovations are a potential feature for organizations to lead in the market, digital process innovations help in terms of reducing time delays and resource sharing [3]. Consequently, digital innovations are transforming both the client needs and the infrastructural requirements. New technologies, such as blockchains, IoT, process mining, robotic process automation, artificial intelligence, virtual reality and 4D printing, have the potential to disruptively change business processes.

On the other hand, regarding BPM, it is generally accepted that each business process follows a lifecycle approach from a process identification phase over implementation to a process monitoring and control phase [4]. Prominent studies also dealt with the BPM maturity model [5], the BPM core elements [6] and BPM context factors [7]. More recently, scholars started focusing on new topics like

green BPM, the human aspects of BPM, social BPM and ambidextrous BPM [8]. Recently, Ref. [9] suggested how two streams of BPM and digital innovations can be combined and highlighted benefits of common methodologies. In another study, Ref. [10] discussed seven paradoxes related to BPM and its alignment with IT by emphasizing smart devices and digital transformation. The changing dynamics of high-speed internet and digital technologies are thus also entering the BPM discipline, albeit at a somewhat slower pace.

Sustainable development through change in business operations depends on open innovation in business processes [11]. In response, to let the BPM discipline better prepare for a digital knowledge economy, Ref. [12] conducted an expert panel with practitioners' opinions on future BPM trends with respect to emerging technologies and digital innovations. While their study revealed seven BPM-DI trends based on empirical data only, our purpose is to supplement these inductive trends with a theory base to verify the extent to which the current body of knowledge addresses each trend, and to better cope with the current gap between what is practically relevant or needed and the availability of already rigorous knowledge [13]. The present study in particular aims at exposing the uncovered aspects of BPM research in combination with emerging digital technologies from the past few years and recent trends. The ultimate benefit is to discover promising but still under-investigated benefits of digital innovations relevant to specific circumstances in BPM. Hence, to offer well-motivated advice and a relevant research agenda that combines BPM with digital innovation, our research question is as follows.

> RQ. *What are (un)covered aspects in the literature (state-of-art) of digital innovations for transforming business process management?*

Based on a Systematic Literature Review (SLR), this study points towards the yet uncovered aspects of BPM in this era of digital innovations to help practitioners in their current endeavors. For the purpose of our SLR, we used five renowned databases with peer-reviewed management information system (MIS) articles. To comprehensively cover our research subject, the results will differentiate between IS-related and management-related studies that simultaneously combine the topics of BPM and DI. With the resulting research, we launch a firm call for more BPM-DI research to bridge a rigor-relevance gap [13].

In the remainder, Section 2 presents the research background against which our literature review is conducted. We describe the SLR method in Section 3, before presenting the results (Section 4). Section 5 discusses promising research avenues and practical guidelines, while Section 6 concludes with the limitations of our study.

2. Research Background

We first describe the notions of BPM and DI separately, and continue with explaining the BPM-DI trends underlying our study.

2.1. Business Process Management (BPM)

BPM is recognized as a set of methods and techniques to discover a business process, to develop designs for that process, monitor it by measuring data, as well as by optimizing and automating the process with human, technological and financial resources [14]. Similarly, past researchers have visualized this set in a BPM lifecycle with subsequent phases to address a business process, namely iterations that begin with process identification and process discovery, then process analysis and redesign, leading towards implementation and finally monitoring and control [4].

This entire BPM lifecycle requires innovation in each phase to obtain faster workflows [15]. Such innovations should also closely adhere to organizational goals, namely both explorative and exploitative goals to comply to the needs of ambidexterity in a digital knowledge economy. With enhanced flexibility features, ambidextrous BPM is more dynamic and extends traditional BPM with a more balanced view between incremental and innovative process changes. Moreover,

knowledge transformation within business processes transform the discipline into more dynamic BPM. For instance, knowledge sharing from seniors to newcomers among process teams is crucial for BPM success [16]. Binci et al. [17] also revealed four project-based factors including (1) task specialization, (2) knowledge transfer, (3) conversion of knowledge and (3) ambiguity and change management, that help in ambidexterity adoption.

According to [18], BPM is dynamically changing to facilitate a broad level of organizational performance in various perspectives. For example, faster innovations in business processes increase productivity and raise company revenue. Since business process modeling and related objects are seen as prominent BPM sub-areas, which are now reshaping abruptly [8], prior studies have mostly contributed to these domains while other BPM sub-areas such as ambidextrous BPM have been largely ignored in the BPM discipline from an innovation perspective [2].

More specifically, prior studies revealed that some BPM core elements (i.e., strategic alignment, people, culture and governance) play a vital role for successfully implementing a business process [6]. For instance, an organizational structure needs to support the organization's BPM adoption on different hierarchical levels (e.g., the Board, managers and assembly line workers) [19]. Similarly, an organization's external environment (e.g., stakeholders, customers and competitors) can influence the BPM characteristics when a new technology emerges in the market. Consequently, vom Brocke et al. [7] summarized these contextual factors into four groups, namely goal-related, process-related, organization-related and environment-related BPM context factors. Recurrence is also observed in studies regarding BPM maturity models and their advice to reach a higher BPM adoption [5]. Nonetheless, such studies on BPM maturity models, the BPM core elements and BPM context factors primarily follow a rather traditional (exploitative) perspective, instead of discussing the particularities of disruptive innovations and BPM exploration.

2.2. Digital Innovation (DI)

Digital innovations apply new technologies to resolve existing business problems and practices in order to achieve new business models, products, services and/or processes [20]. Emerging technologies impact on the execution of tasks in a business process, enable the coordination among work teams and affect the entire BPM lifecycle, albeit more influential at the re-design phase [21]. Examples of digital (process) innovations are easy and fast integrations of IT systems and operations, secure payments solutions and automatic price updates [22]. Or smart devices can be used to upsurge process improvement for an organization to go faster and within budget. Interoperability between the BPM lifecycle phases and (new) IT is important to achieve substantial benefits from information and data [23]. Hence, digital innovations affect both the organizations' strategic and operational levels.

2.3. Digital Innovation Trends in BPM

As shown in the previous sections, BPM in the digital economy is transforming and creating new opportunities for improving business processes [24]. For example, new IT can automate several manual tasks with internet-based and intelligent devices [25]. An extensive use of social technologies encourages push and pull factors in marketing, leading to increased sales volumes and customer interactions [26]. Or emerging technologies also help during process analysis, namely for tracking and monitoring in a fast and efficient manner. Although digital innovation transforms BPM with the help of emerging technologies, more research is needed to fully grasp those opportunities. Hence, Van Looy and Poels [12] collected the opinions of 19 BPM practitioners on how they see the future of BPM evolve based on emerging technologies, and categorized them into the following seven BPM-DI trends:

(1) Ever changing customer experience
(2) Stronger strategic link between BPM and digital innovation
(3) Faster innovations, process changes, way of working
(4) Increasing need for business-IT alignment

(5) New CxO role to bring BPM and DI to the Board
(6) BPM becomes more appealing (e.g., process modeling and monitoring)
(7) Less resistance to BPM and digital innovation

We have adopted these BPM-DI trends to categorize our literature review in order to find ways to bridge the rigor-relevance gap [13], which refers to the differences between practical experience from industry and academic theories or literature. Bridging this gap is important, as research and real-time practical experience are interdependent to obtain rigorous insights that are relevant for society. Subsequently, we explain each BPM-DI trend by highlighting relevant studies on different industries and perspectives before systematically mapping the state-of-art for deriving calls to research and practical guidelines.

2.3.1. BPM-DI Trend 1: Ever Changing Customer Experience

The first BPM-DI trend implies that digital technologies continuously change the experience of end customers, and this possibly with an increased speed. With enriched data management and big data analytics, organizations can use data for incorporating customer-centric offerings [27]. Market responsiveness and creating value propositions about customer requirements are the basics of developing a new and exceptional customer experience [28]. When organizations have a massive amount of data, applying big data analytics can help identify and differentiate between customer profiles based on a faster retrieval of information than before. Ultimately, providing a customization facility can improve customer relationships, stimulate customer engagement and determine/predict consumer behaviors [29]

Data mining, machine learning and artificial intelligence continue to improve customer interactions. While data mining refers to discovering patterns in large datasets using real-time customer data [30], machine learning refers to the scientific study of algorithms and models that information systems apply to perform tasks without human instructions but with machines behaving intelligently like human beings [31]. Artificial intelligence also uses big data to derive decisions and for making predictions. One example that many organizations are already using is a Customer Relationship Management (CRM) system for storing and sharing real-time information of customers [32]. In short, with these mechanisms, the experience of customers can drastically change due to the interventions of new technologies, and this will only increase in the near future.

2.3.2. BPM-DI Trend 2: Stronger Strategic Link between BPM and Digital Innovation

The current technological revolution is responsible for a paradigm shift towards ambidextrous BPM [33]. While many organizations already apply traditional (exploitative) BPM methods and techniques, the explorative variant can help promote a culture of collaboration (e.g., by social media) and entrepreneurship to explore new ways of doing business (e.g., Uber) [3]. BPM's success is concealed in the strategic adoption of IT, and thus also in new IT. Not only should process goals be aligned with organizational goals, but an alignment between business and IT is also essential for BPM. Nowadays, BPM needs to especially create value out of employees and customers, called value-driven BPM [3]. Nevertheless, there is a dire need for obtaining a balance between exploitative and explorative business processes to achieve organizational performance [34]. For instance, this trend includes big data management strategies that describe how big data can be linked with digital innovation and BPM [35]. In an ambidextrous environment, the role of big data for creating a balance between exploitation and exploration is less discussed in the literature. Whenever a new technology arrives in the market, organizations make an effort to adopt and attain a relative competitive advantage. IT enables organizations to get the maximum benefits from (un)structured data. Hence, changing an organization's strategies towards digital technology can be a successful path.

2.3.3. BPM-DI Trend 3: Faster Innovations, Process Changes and Way of Working

Business processes can become faster by applying agile principles [36]. Regarding the traditional (exploitative) BPM approach, Six Sigma and lean manufacturing have been used since many years for ensuring continuous process improvements [37]. Similarly, Total Quality Management (TQM) is applied to increase business process quality and relevant ISO standards (e.g., the ISO 9000 series) are related to several products/services and organizations [38]. Nonetheless, for exploration reasons, BPM requires a combination of standardization in today's high-speed internet environment with an increased awareness of the DI potentials. Therefore, learning new technologies is crucial to improve business processes [39]. Process goals are only achievable with teamwork. BPM managers and practitioners must be trained in time management, so they can inject teamwork in their teams. Similarly, project management skills are highly important to manage each BPM lifecycle phase [40]. In addition, BPM maturity models can play a vital role in the adoption of digital technologies. For instance, Ref. [41] contributed to a comprehensive maturity model involving strategic alignment, culture, people, governance, method and IT elements, and they revealed how these core elements can contribute to BPM success (albeit with a stronger focus on exploitation).

Nonetheless, digital technologies open gateways for innovation by sharing information externally (i.e., outside the organization). Innovation in business processes is positively associated with an information exchange towards an organization's environment [42]. The ease of use and perceived usefulness of these technologies also contribute to a positive integration with business processes [43]. Agile business process development is possible in different ways. One way is to divide the innovation project into sub-tasks and to integrate them with the help of digital technologies. An alternative way is using BPM knowledge with user-friendly BPM systems or suites (BPMS) [44]. Knowledge transformation in BPM enables faster communication, a deeper understanding and an abrupt execution of tasks. Therefore, tacit knowledge should be converted into explicit knowledge in BPM scenarios. Thus, BPM is reshaping in such a way that it becomes more agile and faster in critical situations.

2.3.4. BPM-DI Trend 4: Increasing Need for Business-IT Alignment

Venkatraman, Henderson and Oldach [45] already revealed that IT capabilities should be exploited for competitive success and continuous strategic alignment. The related notion of business-IT alignment refers to the required integration between a business strategy and an organization's IT strategy, as well as between a business and its IT structures [46]. This alignment type remains a major concern to be assessed by IT departments. Many prior studies examined the nature of business-IT alignment, such as its measures and outcomes. Alternative studies discussed the ongoing nature or sustainability of business-IT alignment [47].

Nonetheless, business-IT alignment remains to be a prerequisite for successful BPM in the twenty-first century, for which the IT architecture constitutes an important pillar. Alignment between an organization's process architecture and its entire enterprise architecture is mandatory to guarantee a smooth execution of tasks [48]. Business-IT alignment is strengthened by collaboration in each BPM lifecycle phase, and helps achieve a faster processing time, better customer experience, realizing technological transformations, achieving IT agility and increased collaboration [49]. Consequently, the overall profitability of organizations can increase as well. Moreover, business-IT alignment supports strategies for customer involvement and allows us to step forward towards digitized solutions (e.g., robotics).

2.3.5. BPM-DI Trend 5: New CxO Role to Bring BPM and DI to the Board

The importance of top management support and especially executive support has been widely known [50]. Top managers should actively participate, give relevant directions and take technology adoption decisions for achieving organizational goals and increasing business (process) performance [51]. One of the roles of top managers is to estimate and explain user IT adoption

behaviors (e.g., how users react towards new technologies) [52]. Besides the ease of use and perceived usefulness [43], the adoption of a new technology is affected by its financial perspective [53]. Without a practical IT budget, technological infrastructures cannot be built. Such investment decisions are typically the responsibility of top management. The chief executive officer (CEO) in particular is a key person in taking these decisions while, in some organizations, the chief information officers (CIO) and chief financial officers (CFO) have this authority [19]. Moreover, consensus among all top managers is required for devising the BPM and IT strategies of an organization. Since conflicting interests may hinder technology transformations [12], a new CxO role dedicated to digital process innovation can bring solace. In any case, the CEO remains accountable for describing the organization's portfolio of business processes, recruiting the process owners/managers and creating a BPM-promoting culture [54]. Therefore, all management functions related to the planning, implementation, monitoring and controlling of business processes (i.e., which are performed by process owners/mangers) should be under the supervision of the Board and the CEO in particular.

2.3.6. BPM-DI Trend 6: BPM Becomes More Appealing (e.g., In Process Modeling and Monitoring)

While the traditional (exploitative) BPM approach has been criticized for being bureaucratic, emerging technologies give a possibility to the BPM field to reposition itself and become more appealing in terms of practicing new ways of process modeling and monitoring. More appealing things are happening on the BPM exploration domain, such as journey mapping through a comic book style [55], which strongly contrasts with the traditional process languages (e.g., process diagrams in BPMN and UML) [56]. Real-time app monitoring tools are useful for monitoring an IT infrastructure [57]. Also, network monitoring tools are increasingly used. Furthermore, explorative tools have been designed for more demand-driven, case-driven and value-driven BPM [58]. Knowledge management tools are introduced to derive knowledge-intensive processes that perform in unexpected conditions. Similarly, knowledge-intensive BPM works in unstructured environments by using knowledge to promote employee involvement in process improvements [44]. Other examples are intelligent neonatal monitoring systems using multi-sensors for intelligent monitoring [59].

The above-mentioned explorative BPM examples also turn out to be successful. For instance, studies showed that a business intelligence implementation in BPM escalates the performance of corporate performance management [60]. Knowledge management in BPM also turned out to ensure the quality of data and information [61]. Alternatively, reducing carbon footprints across the BPM lifecycle phases are vital steps towards green BPM [62]. Nonetheless, while digital process innovations help advance process analytics and trigger a new generation of process modeling and of organizational capabilities by emerging technologies, [63] argued that such recent technologies will decrease human interventions in BPM.

2.3.7. BPM-DI Trend 7: Less Resistance to BPM and Digital Innovation

The final BPM-DI trend predicts a reduced degree of resistance against process change by promoting an adaptation culture in digital technologies and a learning organization. So far, change management models like Lewin's change management model and the McKinsey 7-S model have been applied in BPM [64]. Demonstrated techniques for managing process changes are culture mapping, force field analysis, metrics and flow charts. New curricula in IT and BPM confirm that change management remains beneficial in removing the hindering factors in BPM and learning. For instance, a future BPM curriculum should include teaching BPM practices, teaching BPM as a problem-solving domain and teaching about the technology-driven benefits of BPM. A paradigm shift from exploitative BPM to explorative BPM is seen as a must to be considered in future BPM curricula [65].

Learning about BPM also depends upon the effective utilization of available data, namely how effectively organizations use the information of employees and customers [39]. Subjective elements such as job satisfaction, performance and job engagement can be determined by data with the help of technologies in a BPM environment. Evaluation criteria and measuring standards can be made

available to unexperienced employees for reasons of learning. Employee participation in strategic process decisions is inevitable for organizations to avoid an integration cost later on. Experienced-based learning considers experience as the main method of learning for BPM tools and techniques. A learning cycle can be used to transform tacit knowledge into work patterns [66].

In addition to the impact of digital innovations on BPM, other factors such as social culture and work culture also have a promising role in reshaping BPM [67]. For instance, an educated society with an open culture is less resistant to change, and therefore more open to disruptive process changes. Similarly, digital innovations also affect social culture. In other words, the BPM field is not only reshaped by technological factors but also cultural changes which reinforce the former.

In sum, all expected BPM-DI trends from Section 2.3 can already be observed in the literature, at least to some extent and with different dimensions. Based on these trends, we now intend to find a comprehensive set of related studies to analyze the degree to which each trend is currently addressed and which issues are still concealed.

3. Methodology

Given that BPM functions are reshaping with digital innovations, we used the systematic literature review (SLR) methodology of [68] to identify the extent to which (IS-related and management-related) research avenues of BPM remain underdeveloped in today's research. Firstly, a comprehensive protocol was developed to streamline the SLR. This protocol is essential to minimize the chances of biased results in research. It concretizes our research design by highlighting the followed approach and conditions to ensure quality measures [69]. The protocol also specifies the research question, the sources of search (i.e., academic databases), search terms (i.e., key words) and the inclusion and exclusion criteria for screening the observed studies. After scanning, these studies were classified into IS-related studies, management-related studies and literature research. As a starting point, the search terms or keywords related to the information technology domain were selected to include recent technologies, paradigms and approaches. Afterwards, nodes were developed in Nvivo *12* and then converted into themes. Finally, the research agendas were identified along these themes and linked to the seven BPM trends of Van Looy and Poels [12] to allow for a more structured overview of the SLR findings, as explained in Section 2. Van Looy and Poels [12] initially conducted an expert panel study with 19 West-European practitioners (i.e., BPM and DI managers and consultants), and formulated and linked the trends to IS-related and management-related emerging strategies. Those authors, however, called for a more conceptual approach to supplement their future trends with literature to better position the gaps between "*what we know*" from the knowledge base and "*what we need to know*" from practice. This missing conceptual angle is the purpose of our SLR.

3.1. SLR Protocol

We started by developing a SLR protocol based on our problem identification [68], as summarized in Table 1.

Table 1. Our systematic literature review (SLR) protocol.

Sources of Search	Web of science; Ebscohost; Scopus; Science Direct; Jstor
Search terms used	A combination of: "Business Process Management" with new information technology paradigms, approaches or solutions (See Table 2)
Search strategy	All search requests were done with keywords in "Topic" (See Table 3)
Inclusion criteria	All relevant book chapters, journal articles and conference proceedings that were written in English were retrieved after applying the predefined search terms and strategy
Exclusion criteria	Duplicates and Irrelevant studies (i.e., that do not fit into BPM and new IT or digital innovations) were excluded Only recent studies from the last five years (i.e., published in 2014 or later, until May 2019) to focus on emerging technologies only
Quality criteria	Only peer-reviewed articles

3.2. Sources of Search

We selected five renowned academic databases in the field of management information systems (MIS) and business administration (i.e., Web of science (WoS), Ebscohost, Scopus, Science Direct and Jstor) because these databases are known for providing high-standing, peer-reviewed publications in a structured way and with user-friendly retrieval facilities.

3.3. Search Criteria

The next main step was to determine "*search terms*" or "*keywords*" for searching and retrieving relevant studies from the selected databases. We searched for combinations of *"business process management"* with a technology-oriented keyword using the "AND" operator (see Table 2). For instance, "Agile" or "agility" was used because this approach lead to more digital innovation within the BPM field. The term "ambidextrous" or "ambidexterity" was used because contemporary organizations are moving more towards a combination of explorative and exploitative business process management. Although cloud computing is considered as a less recent phenomena, it is still being used by organizations in different ways. Hence, keeping under observation the recent trends in information technology advancements, we used the names of various paradigms, paths, technologies and IT solutions as "*keywords*" for our search queries, as shown in Table 2.

Table 2. Our search criteria.

Keyword (1)	Operator	Keyword(s) (2)
"Business Process Management"	AND	"Agile" or "Agility"
		"Blockchain" or "Blockchains"
		"Ambidexterity" or "Ambidextrous"
		"Artificial Intelligence" or "Business Intelligence"
		"Digital Innovation" or "Digital Transformation"
		"Cloud computing" or "Cloud"
		"Industry 4.0"

3.4. Search Methods

We considered the available search options in databases (i.e., some databases only allowed us to look for publication titles while others also allowed to directly search for the main topic discussed in articles). Hence, we conducted "topic"-wise searches in order not to miss out on important research publications (i.e., in case when databases only allowed for searching by "title" and not by "topic"). As a result, Table 3 presents the search results per specific keyword combination and per database.

Initially, we retrieved 1393 studies based on our search criteria. After removing the duplicates and non-applicable papers, the sample was reduced to 849 studies. We then did an additional screening by conducting "Title"-versus-"Topic" searches (i.e., BPM in title and a technological keyword in topic) and "Title"-versus-"Title" searches (i.e., BPM in title and a technological keyword in title) in an Excel sheet. In this additional screening round, we identified 618 papers that did not apply to both keywords. For example, a paper about intelligence was dropped if it only covered artificial intelligence but not along with BPM. Thus, our final SLR sample consisted of 231 papers in total, and can be found in Appendix E. In a next phase, the 231 papers were divided into three major categories, namely (1) BPM-DI papers handling more the IS aspects, (2) BPM-DI papers covering rather managerial topics and (3) existing literature reviews on the integration of BPM and DI. The step-wise details are shown in Table 4.

Table 3. Our search methods.

Keywords \ Databases		WoS	Ebsco-Host	Scopus	Science Direct	Jstor	Total
"Business Process Management"	"Agile" OR "Agility"	35	27	60	190	2	314
"Business Process Management"	"Blockchain" OR "Blockchains"	5	8	22	21	0	56
"Business Process Management"	"Ambidexterity" OR "Ambidextrous"	10	16	14	24	0	64
"Business Process Management"	"Artificial Intelligence" OR "Business Intelligence"	10	1	57	94	1	163
"Business Process Management"	"Digital Innovation" OR "Digital Transformation"	1	1	6	5	0	13
"Business Process Management"	"Cloud computing" OR "Cloud"	62	48	99	213	1	423
"Business Process Management"	"Industry 4.0"	12	8	24	50	0	94
"Business Process Management"	"Internet of Things"	30	35	58	142	1	266
	Total	135	109	282	597	4	1393

Table 4. The filtering of retrieved papers.

Total Number of Papers Retrieved (Topic Wise Search)	**1393**		
Removed Duplicates	−502		
Removed Non-applicable papers	−42		
Additional screening (Not found in Title vs. Topic search)	−618		
Total: (Final SLR sample)	231		
Classification:			
		IS-related BPM papers	135
		Managerial BPM papers	87
		Existing literature reviews	9

3.5. Inclusion and Exclusion Criteria

We only included papers in our SLR sample that had "Business Process Management" in their title or topic, and with at least one technologic keywords (i.e., related to new IT) discussed as a topic in the entire study. This threshold was defined to acquire all relevant studies, written in English. Likewise, all duplicates and non-applicable studies were excluded. After this comprehensive screening, our final sample contained 231 studies.

3.6. Classification Scheme

After screening and obtaining our final SLR sample, we classified the 231 identified papers into three main categories, namely 135 IS-related studies, 87 managerial studies dealing with the integration of BPM and DI, and nine literature studies. This classification was based on the concept of research insights (i.e., either a study provided technical, managerial or review insights). If a single paper possessed multiple insight types, we categorized it based on its most prominent contribution (e.g., many papers present earlier studies but not necessarily as a literature review). This categorization turned out to be helpful in defining our intended scope and targeted research agendas afterwards. Furthermore, each paper was assigned a unique ID number (i.e., a sequential number) for reasons of

conciseness in our analysis. Finally, the studies were classified against the seven BPM-DI trends of [12] as an additional classification scheme, as explained in Section 2.3.

4. Results

The results section starts with the chronological and geographical distribution of the sampled papers, followed by a mapping against the seven BPM-DI trends of Section 2.3. Regarding the latter, an in-depth mapping of IS-related and managerial BPM-DI papers is given to generate new themes.

4.1. Chronological Distribution of the Sampled Papers

Figure 1 shows the chronological distribution of our SLR sample, considering the 231 observed papers based on a five-year publication range (i.e., with publication dates from May 2014 until May 2019). Figure 1 also divides our sample into the classification discussed in Section 3.6.

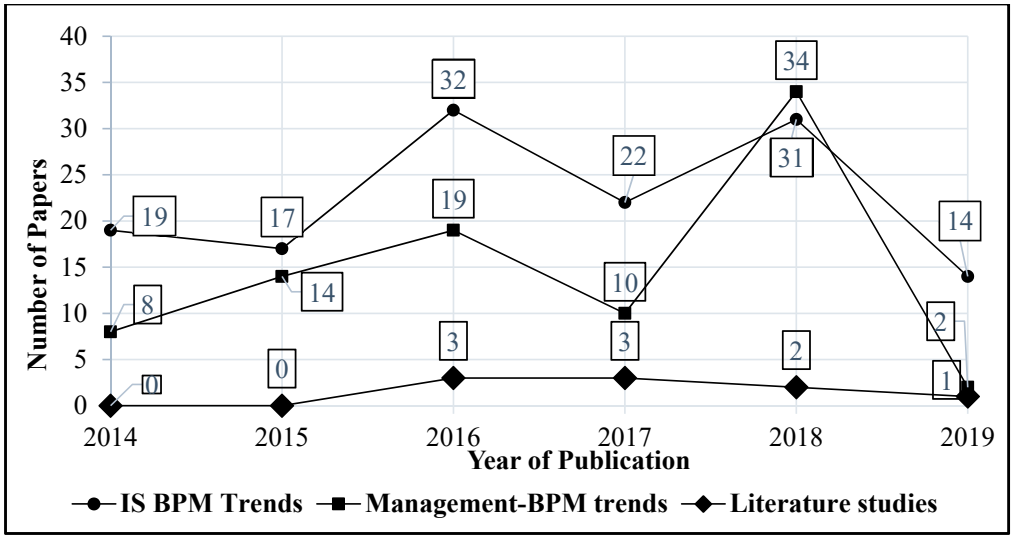

Figure 1. The chronological distribution of sampled papers (n = 231).

Figure 1 illustrates that a relatively higher amount of papers was found during 2016 and 2018, and this for both IS-related and managerial categories. During 2016, many scholars started to include cloud computing, IoT and smart devices in BPM. Especially during 2018, abundant work was observed among the managerial BPM-DI papers as compared to the IS-related papers. The strong decrease in 2019 can be explained by the fact that our sample was restricted to May 2019 (i.e., when collecting the sample).

4.2. Geographical Distribution of the Sampled Papers

Figure 2 represents the geographical distribution of our sampled papers. While studies were observed across the globe, Europe seemed to be the dominant continent over other areas, namely with a total of 131 BPM-DI studies. This remarkable finding can be explained to some extent due to the fact that there is a strong BPM community in Europe, whereas other continents might examine the emerging technologies more from the perspective of digital innovation as such, or within the context of specific BPM sub areas, such as "process mining", while our search term was "business process management" only. Asia had the second highest paper count with 46 BPM-DI papers, followed by North America with 20 papers. On the other hand, fewer papers were found in Africa (i.e., with 13 BPM-DI papers) and Australia (i.e., with 9 BPM-DI papers).

Afterwards, the analysis was focused towards the seven BPM-DI trends (Section 2.3) and conducted per category (i.e., IS-related aspects of BPM versus management-related aspects of BPM). We note that

the nine observed literature reviews could not be classified into a single trend because they were more general in nature.

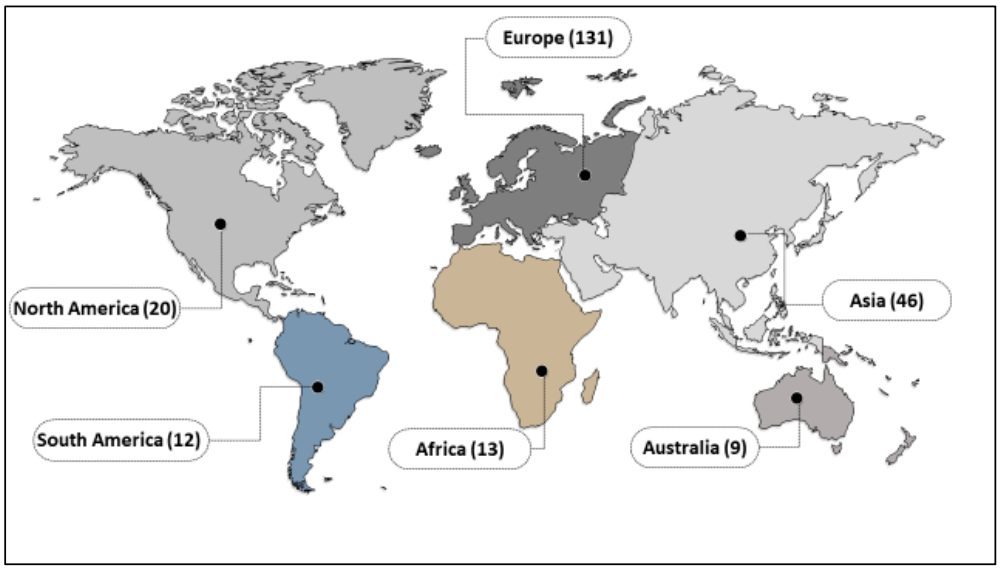

Figure 2. The geographical distribution of sampled papers per continent (n = 231).

4.3. Mapping against BPM-DI Trends

We mapped our SLR sample of 222 IS-related and managerial BPM-DI studies against the seven trends of Section 2.3, and this by assigning each paper to a corresponding BPM-DI trend.

Figure 3 shows that 35% of the 222 studies were related to trend 6 ("BPM becomes more appealing") and 32% of the studies covered trend 4 ("Increasing need for business-IT alignment"), indicating that most research was conducted in these two areas. The findings also suggest ample opportunities for future research.

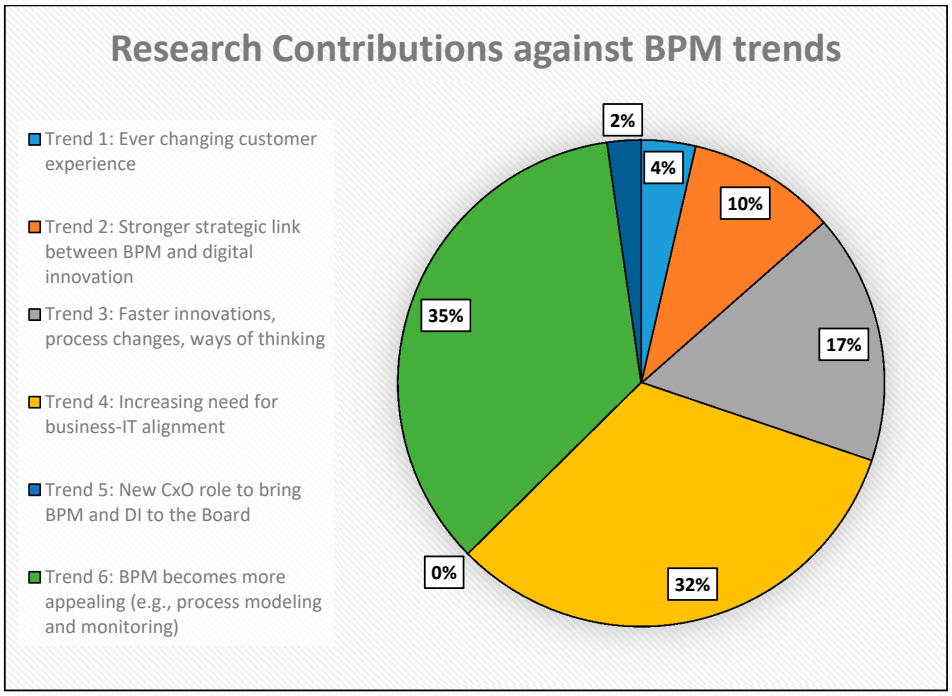

Figure 3. The distribution of sampled papers against the seven BPM-DI trends (n = 222).

4.4. Existing Research on the IS-Related Aspects of BPM

Furthermore, the subset of IS-related BPM-DI studies was taken to gain a deeper understanding.

4.4.1. Mapping of Paper ID's for IS-BPM Papers

Table 5 shows the paper ID's per BPM-DI trend, and reflects the rapid increase in research regarding trend 6 (i.e., on appealing BPM trends with process-modeling alternatives, useful process monitoring and supporting tools in knowledge-intensive BPM and intelligent BPM). The second most represented trend (trend 4) confirmed the need of business-IT alignment within the BPM domain. On the other hand, trend 5 ("New CxO role to bring BPM and DI to the Board") did not contain any paper, as most studies emphasized the technical side of BPM and DI without taking a (top) management perspective. Similarly, only one paper was observed for trend 7 on making BPM and digital innovation less change-resistant.

Table 5. Overview of IS-related BPM studies per trend (n = 135).

Initial BPM-DI Trends (Expert Panel)	Paper Count	Paper IDs
1/Ever changing customer experience	4	95, 147, 155, 228
2/Stronger strategic link between BPM and digital innovation	7	14, 27, 30, 35, 79, 98, 229
3/Faster innovations, process changes, way of working	16	2, 7, 45, 85, 86, 88, 89, 105, 106, 120, 122, 178, 182, 189, 205, 207
4/Increasing need for business-IT alignment	50	1, 4, 6, 12, 13, 50, 51, 62, 64, 65, 66, 67, 70, 71, 76, 81, 82, 84, 102, 103, 109, 110, 111, 119, 131, 133, 135, 136, 143 145, 151, 152, 161, 173, 185, 188, 190, 196, 200, 201, 202, 204, 208, 214, 215, 216, 217, 220, 227, 230
5/New CxO role to bring BPM and DI to the Board	0	No papers found
6/BPM becomes more appealing (e.g., process modeling, monitoring)	57	8, 9, 10, 11, 16, 26, 33, 49, 52, 54, 56,59, 60, 61, 63, 69, 78, 83, 91, 92, 104, 107, 112, 114, 116, 117, 123, 124, 129, 130, 132, 134, 137, 138, 139, 146, 149, 150, 156, 157, 159, 162, 163, 166, 168, 184, 186, 187, 192, 194, 199, 213, 218, 219, 221, 222, 225
7/Less resistance to BPM and digital innovation	1	46

4.4.2. Mapping of Relevant Themes for IS-Related BPM Papers

In the next step, we made threads of similar works among the IS-related papers on a per trend basis. First, we classified all studies across the seven BPM-DI trends as presented in Table 5. Next, we combined similar studies and converted them into one common theme that distinguished them from other papers in Table A1 in Appendix A. For example, we combined paper ID 37 (titled: "Blockchain-based business process management (BPM) framework for service composition in industry 4.0") with paper ID 43 (titled: "Blockchain-Based Traceability of Inter-organizational Business Processes"), and assigned them to one single theme (see Table A1 in Appendix A).

4.5. Existing Research on the Managerial Aspects of BPM

We then turn to the subset of management-related BPM-DI studies to continue our mapping with regard to the seven BPM-DI trends.

4.5.1. Mapping of Paper ID's for Managerial BPM Papers

In our final SLR sample, we categorized 87 sampled papers in the management-related aspects of the seven BPM-DI trends. Table 6 provides an overview of the mapped research contributions for the managerial aspects. While trend 2, trend 3, trend 4 and trend 6 showed similarity with the counted IS-related papers in Table 5, we now observed some studies in trend 7 as well. Overall, Table 6 shows evidence that trend 1, trend 5 and trend 7 remained highly and especially under-investigated in the past, and need much more investigation.

Table 6. Overview of managerial BPM studies per trend (n = 87).

Initial BPM-DI Trends (Expert Panel).	Paper Count	Paper IDs
1/Ever changing customer experience	4	31, 53, 87, 174
2/Stronger strategic link between BPM and digital innovation	15	37, 38, 39, 40, 41, 42, 43, 44, 80 93, 96, 99, 176, 210, 211,
3/Faster innovations, process changes, way of working	21	3, 18, 19, 20, 23, 24, 25, 28, 32, 34, 36, 47, 121, 125, 126, 177, 180, 181,206, 22, 224
4/Increasing need for business-IT alignment	22	15, 21, 29, 48, 55, 68, 73, 74, 77, 115, 141, 142, 144, 148, 170, 183, 193, 197, 198, 203, 223, 158
5/New CxO role to bring BPM and DI to the Board	0	No papers found
6/BPM becomes more appealing (e.g., process modeling, monitoring)	21	17, 57, 58, 75, 100, 108, 118, 128, 160, 163, 164, 165, 169, 171, 172, 175, 191,195, 212, 231
7/Less resistance to BPM and digital innovation	4	94, 127, 140, 226

4.5.2. Mapping of Relevant Themes for Managerial BPM Papers

Table A2 in Appendix B presents the mapping with refined sub-themes per BPM-DI trend for the 87 managerial BPM papers. We performed the same three-step procedure as for the IS-related sampled papers, namely: (1) reading each article, (2) developing separate themes and (3) combining identical papers and developing new themes after transcription.

5. Discussion

This section discusses IS-related and management-related research agendas to let the BPM field further advance in a digital economy, as well as guidelines for BPM practitioners. These research agendas and practitioners guidelines were developed from the generated themes after following our pre-defined SLR protocol. Tables A3 and A4 in Appendices C and D visualize the research agendas in bullet points, followed by a textual discussion in Sections 5.1 and 5.2. As shown in Tables A3 and A4, column three or C3 contains the list of key constructs found (e.g., "customer interaction" was an observed key variable). Next, table column four (C4) comprises trend-wise combinations of the derived themes to propose the research agendas against specific BPM-DI trends (e.g., "design time and runtime interactions" is a topic derived in the research agenda and classified under the BPM-DI trend of "ever-changing customer experience"). A similar trend-wise combination of the derived themes from Section 4 have been used to propose the research agendas for both IS- and management-related topics.

Figure 4 summarizes the derived research agendas before delving into the details.

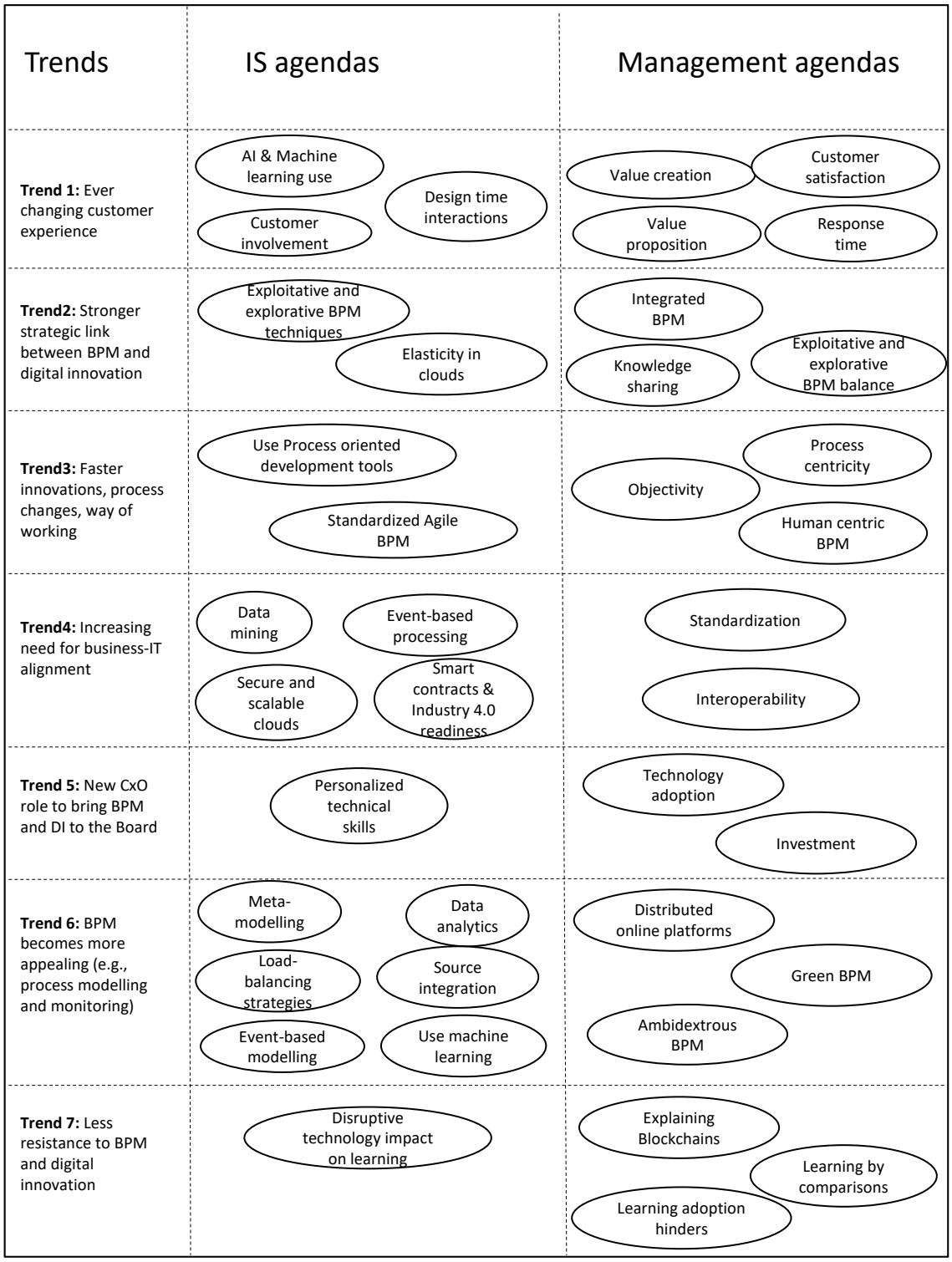

Figure 4. Summary of the derived research agendas.

5.1. IS-Related Research Agenda to Let BPM Advance in a Digital Economy

Our research agenda with IS-related aspects on the co-evolution between BPM and DI is given in Table A3 in Appendix C. The agenda strengthens the BPM-DI trends by adding a differentiation between what is already investigated (i.e., SLR findings) and which most prominent or urgent topics need further investigation to dig for deeper insights. To better explain Table A3 in the subsequent

paragraphs, we use labels like "T9" for Table A3, "R" for row(s) and "C" for column(s) together with a number (e.g., 1,2,3, etc.) in order to position a certain cell.

Trend 1. Trend 1 pinpoints towards an ever-changing customer experience, for which methods and techniques are required to become aware of the changing customer needs. Nonetheless, our SLR is only directed towards four studies covering the IS-related aspects of this trend. Those papers agreed that intelligent techniques are useful together with efficient resource management in order to improve customer interactions (T9, R1, C3). Much more research is, however, needed on customer engagement, and particularly on how customer interactions should be based on design-time and runtime interactions (T9, R1, C4). It is still unclear how customer interactions and involvement can be improved, and what role technology can play. It thus seems promising to dig deeper into how machine learning and artificial intelligence techniques should be applied to access customer needs from a big data perspective. Furthermore, since merely applying these technologies is insufficient, further research may also study how to involve customers in decision-making to acquire customer feedback throughout all BPM lifecycle phases, namely from early on during a process redesign project.

Trend 2. The SLR only covered seven papers dealing with the strategic link between BPM and DI. Nonetheless, from an IS perspective, this trend can be examined in more depth by looking at the explorative methods and techniques and the possible strategies for using new IT in order to achieve process efficiency and effectiveness. For instance, no significant work is witnessed in our SLR sample for ambidextrous BPM methods and the related balancing efforts, while research has shown that strategies for IT success help create trust in new technologies. Prior studies already revealed that if an organization needs flexible resources, then elasticity can be a possible strategy (T9, R2, C3). Nowadays, also demand-driven collaboration is a major aspect for building coordination among departments and business processes (T9, R2, C3). We also observed from the SLR sample that the process query method can be used as a strategy to handle complaints in BPM (T9, R2, C3). Nevertheless, we call for more research on finding a balance between explorative and exploitative BPM strategies, and on bringing elasticity in a BPM infrastructure (e.g., by using cloud computing) (T9, R2, C4).

Trend 3. The SLR offered 16 papers dealing with the IS aspects of faster innovations, process changes or ways of working. Typical avenues for scrutinizing this trends relate to those methods and techniques that allow for faster BPM lifecycles and for better applying agile principles. Prior studies mainly pointed towards the use of artificial intelligence for faster lifecycles (T9, R3, C3). We also observed studies on organizational and cultural support for going agile (T9, R3, C3). Moreover, our SLR showed evidence that collaboration and integration between BPM practitioners and an organization's environment are key to success (T9, R3, C3). On the other hand, some missing angles in the body of knowledge relate to quality evaluation methods in agile principles because quality should be guaranteed even when organizations go faster (T9, R3, C4). Another crucial research avenue covers process-oriented developments that also minimize project risks in software development (T9, R3, C4).

Trend 4. A relatively high number of papers on the IS side dealt with the increasing need for business-IT alignment. Studies have been published on the integration of a process architecture with an enterprise architecture in order to reduce delays, to provide scalability and to give the provision of violation control based on smart contracting in blockchains (T9, R4, C3). Cross-discipline collaborations have also been broadly encouraged in the different BPM lifecycle phases (T9, R4, C3). Nonetheless, we provide four avenues that deserve more research attention. The first avenue relates to event-based processing in the presence of digital technologies. Secondly, a cloud-oriented BPM lifecycle seems promising by aligning cloud computing technology with the process design phase, the process implementation phase and some other BPM lifecycle components. Thirdly, more research should address security and privacy issues in digital technologies to build trust: when many tasks are being performed online in virtual networks, strong authentication and accessibility schemes are required. Fourthly, scholars could focus more on supporting Industry 4.0 based on smarts tools and technologies (T9, R4, C4) such as smart waste disposal process leads to sustainability. Business processes along with digital innovations should be compatible with other available IT infrastructures in Industry 4.0.

Trend 5. Past studies have not yet addressed the importance of a new CxO role for BPM-DI integration, as seen from the IS-related aspects. Despite the fact that this trend is more related to managerial aspects, future studies could deal with the technical knowledge aspects needed for decision-making.

Trend 6. Most papers on the IS side could be linked to efforts on how to make the BPM field more attractive for both a technical and non-technical audience. They mainly dealt with risk and compliance management in general, with knowledge fusion and knowledge reuse as supporting techniques in knowledge-intensive BPM (T9, R6, C3). Regarding intelligent-based BPM, prior studies have examined process monitoring through blockchains and smart contacting (T9, R6, C3). Despite the current attempts, we see opportunities to increase BPM's attractiveness by means of process modeling alternatives, approachable monitoring tools, tools for case-driven and knowledge-intensive BPM and monitoring tools for intelligent BPM. More specifically, scholars could use more load-balancing strategies in BPM architectures. Also Metamodeling (i.e., creating a model of a model) turned out to be a promising focus in process modeling. Other ideas relate to integrating heterogeneous data sourcing or investigating a smooth and faster retrieval of information. Alternatively, one could study big data analytics and machines in terms of innovative BPM (T9, R6, C4). Despite all these emphases, scholars can focus more on the appealing style of BPM by doing research on event-based modeling and aligning business process modeling with Industry 4.0 needs in order to stimulate more BPM-DI advocacy. Process modeling in distributed online platforms (e.g., cloud and IoT) is also an interesting research avenue (T9,R6,C4).

Trend 7. Since prior research on BPM-DI resistance was limited to a single paper in our SLR, we call for much more research on how to use employee data and how to build user-friendly artifacts for non-experts. Also experienced-based learning can be studied further from an organizational point of view (T9, R7,C4).

5.2. Management-Related Research Agenda to Let BPM Advance in a Digital Economy

Similar to the IS-related research agenda in Section 5.1, the refined management-related research avenues are presented in the final column of Table A4 in Appendix D, along with the key variables uncovered in our SLR and with respect of the previously inductively created research avenues and BPM-DI trends.

Trend 1. The managerial aspects on changing customer experiences are largely neglected in the current literature. The four papers observed for this trend mainly dealt with developing trust among customers and with response time traceability for customers to monitor and manage the response times of requests related to particular business processes (T10,R1,C3). New research paths can address the co-creation of process value and the realization of customer-oriented values such as a customer understanding and an excellent customer journey. We also encourage more research on value creation together with customers and by means of business intelligence. Building value propositions for business processes, like in marketing, may also help satisfy customer needs and is worthwhile to investigate more deeply (T10,R1,C4).

Trend 2. Regarding the strategic link between BPM and DI, our SLR showed 16 papers covering topics like BPM-DI integration, balancing strategies, customization, ambidextrous BPM capabilities, as well as the coordination, knowledge sharing, performance and legitimation of BPM ambidexterity (T10,R2,C3). Since much of those topics still need further investigation, we call for more research on the critical success factors of BPM ambidexterity, a value-driven BPM approach, disruptive business models and guidelines for balancing exploitative and explorative BPM. Additionally, the integrated nature of mechanisms in business processes still has much research potential (T10,R3,C4).

Trend 3. To obtain faster innovations and operations, we found that past studies mainly focused on business process reengineering (BPR) and agile principles, as well as on quality dimensions. More specifically, studies dealt with agile functions, agile capabilities and reengineering designs as part of project management. Quality dimensions such as service quality and meeting internationally accepted

quality standards like ISO9000 should be used in agile BPM as well. Studies were also observed regarding dichotomy elimination (T10,R3,C3). Nonetheless, we call for more research on studying and improving the DI process, time and project management for process owners, as well as on maturity models facilitating BPM ambidexterity. No studies were related to time management by process managers/owners. For allowing faster digital process innovations, more research is required regarding human-centric and process-centric BPM approaches (T10,R3,C4) for obtaining more agility.

Trend 4. For business-IT alignment, the SLR incorporated many studies on IoT acceptance and resistance factors, cloud adoption in BPM, the rapid growth of Industry 4.0, and the challenges in blockchains (T10,R4,C3). All these topics still have research potential, whereas standardization in BPM-IT alignment and interoperability between BPM infrastructures and digital technologies are less covered today and are thus more promising areas (T10,R4,C4).

Trend 5. Similar to the IS-related sample, we did not observe any paper dealing with the roles of CEO, CIO or chief process managers for governing specific BPM-DI matters and duties. This finding is, however, surprising given the crucial role of top management support for BPM-DI success. Therefore, we highly encourage more research on this subject. One potential research path is to scrutinize the conflicting role division among different CxO roles. Another crucial avenue is to conduct research on investment decisions in BPM and digital technologies. Moreover, research is needed on top management support for promoting a technology transformation culture (T10,R5,C4).

Trend 6. Attempts to increase BPM's attractiveness have been widely covered in our SLR sample. For instance, we found studies on best practices, flexibility in BPM functions and technology adoptions, service integration projects, green supply chains, agile principles for knowledge sharing, value-driven BPM, ambidexterity adoption, and the use of intensive cognitions moving towards subjectivity as BPM practitioners start thinking more intellectually with the use of knowledge-intensive business processes (T10,R6,C3). We encourage more research on modeling and managing distributed online platforms as well.

Trend 7. Again, little research was observed regarding BPM-DI resistance. While we mapped four studies to the managerial side of trend 7, no studies were found that deal with useful change management models and techniques for BPM ambidexterity in particular, and about ideas on how to teach management and innovation at different school levels (e.g., in primary schools). In addition, learning through comparison with previously successful technology adoptions in the area of BPM is still a potential avenue (T10,R7,C4).

5.3. Future Recommendations for BPM Practitioners

Based on the above discussion, which have extended the seven BPM-DI trends of Van Looy and Poels [12] with research insights related to IS-related topics and research avenues of managerial studies, we encourage organizations to switch from a merely traditional BPM approach to also have a more explorative BPM to obtain ambidexterity. More specifically, our sampled papers give evidence that the use of emerging technologies such as artificial intelligence, Internet of Things and blockchain in appropriate business functions can significantly enhance an organization's business process capabilities. However, digital innovation in a business process is facilitated when careful considerations are made regarding learning and development, and about managing knowledge and cultural acceptance of the new technologies used within business processes. Moreover, adopting agile BPM also seemed crucial for business process success.

Hence, after a detailed analysis of the derived themes leading to promising research avenues (i.e., calls for research), we now suggest demonstrated practical guidelines (i.e., calls to action) for BPM managers and practitioners based on our sample of 231 papers. In the following paragraphs, we use paper IDs as references to indicate how the initial nodes and further guidelines emerged (i.e., indicated as numbers between brackets). These suggestions are based on the results tables, and summarized as technical, ambidexterity and learning guidelines.

A summary of the practical guidelines is provided in Figure 5.

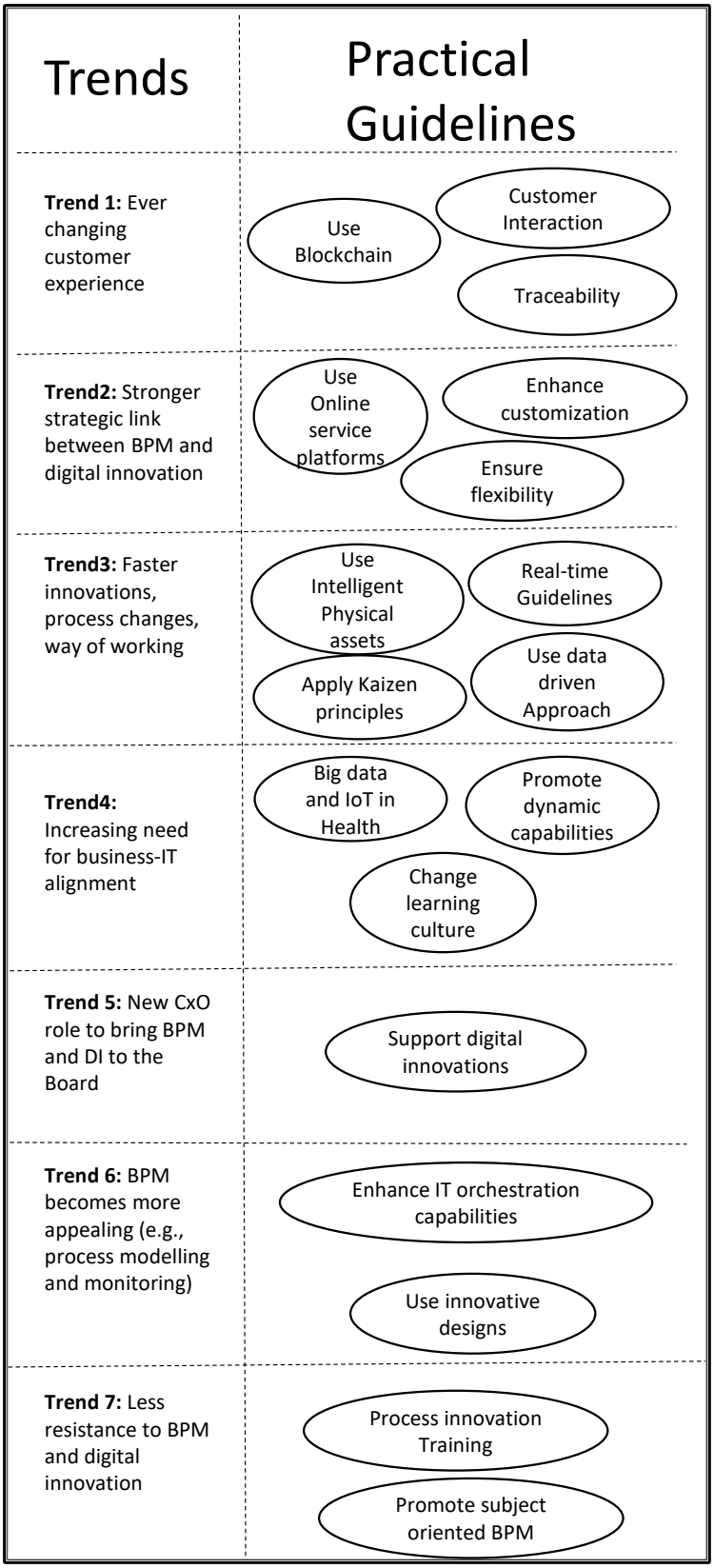

Figure 5. Summary of the derived practical guidelines.

Regarding the technical guidelines, we recommend the use of blockchain technology in customer interactions for increasing the traceability of products when building a trustworthy environment

(ID: 31). Next, organizations can develop an online service platform to enhance customization by using a secure catalogue and ensuring flexibility in each step of the BPM lifecycle (ID: 10, 49, 52). We also suggest using IoT and big data collectively (i.e., instead of separately) in various processes for real-time guidelines and for gaining access to useful information (ID: 139, 184, 192). This approach seems particularly useful in pharma and healthcare industries when using data of patients, medicines and diseases to achieve a better health treatment. We also recommend to combine intelligent physical assets (e.g., intelligent devices) and human intelligence for creating operational and strategic capabilities (ID: 56). Additionally, data of smart data factories can be used for learning, communicating predictions and handling customer complaints.

The BPM ambidexterity guidelines specifically relate to exploitation and exploration, and for creating a balance between explorative and exploitative business processes. For instance, digital innovation can be stimulated by means of an organizational learning atmosphere. Organizations should avoid unnecessary investments in exploitative BPM and IT capabilities when business process requirements are changing fast (ID: 40, 93). Instead, they should spend more on dynamic capabilities, such as business intelligence, to boost organizational performance. Furthermore, BPM practices influence the cultural values in an organization. When employees dislike the exploitative BPM practices, they might favor a more explorative culture instead (ID: 37, 38, 41, 44). In order to attain the full benefits of BPM ambidexterity, different skills and expertise are required for both explorative and exploitative business processes. Another suggestion is to apply the Kaizen principles of continuous process improvements by actively involving stakeholders in feedback and by supplementing feedback with objective performance measures (ID: 20, 180, 206). It is also important to find a balance between standardization on the one hand and process flexibility and agility on the other hand without compromising transparency in business processes (ID: 24, 40). A data-driven approach can also be used (i.e., by using data of employees, customers, managers and business intelligence data) to measure ambidexterity performance and process improvements (ID: 47). Alternatively, the capabilities for IT orchestration (e.g., automated configurations, coordination, and management of computer systems and software) can be combined with resource allocation and intensive communication between all BPM participants for transferring responsibilities to the team level in order to attain agility and performance (ID: 121, 126).

Since learning organizations become predominant, we conclude with guidelines related to the educational settings for digital process innovation. Organizations should promote an innovative culture and find the best fit between operational intelligence capabilities and the learning potential of employees while adopting new IT (ID: 96, 99). They should also use a cognitive approach rather than focusing on objectivity to promote subject-oriented BPM, which provides opportunities to employees to suggest improvements themselves and adopt new IT. Furthermore, external support and collaboration is needed to build a connection between the Triple Helix entities (i.e., academia, industry and governments) to promote a learning culture in BPM with the help of knowledge-intensive BPM (ID: 224). Finally, students should learn about the development and analysis of business processes (i.e., throughout each BPM lifecycle phase) by being more involved in real BPM projects and they should ideally get access to real-life data in BPM systems or suites (e.g., from IT departments or IT consultancy firms).

5.4. Research Limitations

We acknowledge some research limitations that are typical to the SLR research methodology (e.g., regarding the selection of databases, keywords and timeframe). Moreover, we note that our themes were coded in a qualitative way based on a text analysis. Therefore, future research can extend this study by using case studies and quantitative analyses (such as organizational surveys) to validate the themes with respect to digital innovations in an ambidextrous BPM environment. Nonetheless, our proposed research agendas can currently guide us towards promising avenues.

Moreover, this study is predominately based on the impact of digital innovations on business process management, whereas multiple factors are involved in BPM change and process improvements that have not been discussed in this paper. For instance, other internal and external factors could be considered in future studies, such as changes in social culture and work culture [67]. In addition, this paper considered recent BPM and DI trends derived from one significant study, while we acknowledge that additional BPM-DI trends can be supplemented by future studies as well.

6. Conclusions

Emerging technologies and digital innovations force us to rethink and streamline BPM. Digital process innovations help accomplish tasks in faster and smarter ways. For instance, smart cities profit from IoT devices for doing technology-enabled monitoring. Our SLR has shown that BPM combined with emerging technologies can change the value propositions of customers, which opens new avenues to develop a strategic alignment between the organizational policies or rules on the one hand and the BPM characteristics on the other hand.

We have built on the empirical work of [12] to differentiate between the yet covered BPM-DI themes in the literature and the still uncovered avenues in order to encourage relevant and well-motivated research. We therefore classified a comprehensive sample of more than two hundred papers on the co-evolution of BPM and DI into different categories and along seven BPM-DI trends.

By offering a range of calls for research and calls for action derived from the current body of knowledge, we open new gateways for BPM researchers to incorporate novel ideas in more specific sub disciplines. Furthermore, practical guidelines are discussed in various dimensions for BPM practitioners and managers to consider when taking important technology transformation decisions about BPM.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. IS Research Themes

Table A1. Research themes in IS-related BPM papers (n = 135).

Trend	IS-Related BPM Studies with a Digital Innovation Focus
1	○ How to use machine learning and artificial intelligence in BPM to meet customer expectations. (95) ○ Resource allocation per customer need at design time and runtime. (147) ○ Customer decision-making for selecting the most suitable cloud configuration. (155) ○ Smart process application development for customer interactions. (228)
2	○ Strategic decision-making by process querying methods in BPM. (98) ○ Strategic link between process improvements and IoT. (30) ○ Demand-driven collaborations between equipment manufacturers and SME's. (79) ○ Using blockchains in supply chain management, business processes and to build a trustable environment. (27, 35) ○ Developing elastic strategies and checkpoints in cloud computing services and workflows. (14, 229)

Table A1. *Cont.*

Trend	IS-Related BPM Studies with a Digital Innovation Focus
3	○ Usefulness of Artificial Intelligence in business processes and complex customer service practices. (45) ○ Quality evaluation methods in Agile BPM. (207) ○ Developing agile-oriented models, algorithms and methodologies in work practices. (2, 85, 88, 178) ○ Cloud resource configurations and use in logistics. (189, 105) ○ Agile process-oriented software development, programming, techniques, languages, applications, projects and process improvements. (7, 86, 89, 122, 182, & 205) ○ Agile-based collaborative networks and an integrated MIS architecture. (106, 120)
4	○ Industrial internet-based architecture frameworks with cloud manufacturing and mutual conceptual similarities. (65) ○ Emerging BPM techniques in the fourth industrial revolution. (76) ○ Making a sematic framework of the BPaaS model with semantic web and data mining techniques. (151) ○ Designing a middleware platform for creating and structuring an environment by cloud computing. (217) ○ Using cloud computing characteristics, e.g., scalability architecture, load balancing, resource configuration/allocation and cloud migration, to enhance ERP capacity, process orchestration and workflow efficiency. (1, 13, 50, 65, 136, 143, 185, 220). ○ Smart contracts by blockchains in various departments leading to a lean architecture in BPM. (4, 6). ○ Addressing security and privacy risk issues in cloud and IoT workflows, and making security-aware routing in business processes to ensure confidentiality. (12, 51, 67, 70, 131, 145, 152, 173, 200, 214, 216) ○ Event processing, resourcing with Internet of Things, exploring its pros and cons, and its integration with IT and BPM. (81, 82, 84, 103, 109, 201, 202, 204) ○ Cloud-based planning, design, execution, implementation, deployment and performance evaluation in various business processes. (102, 110, 111, 188, 190, 196) ○ Service-oriented architecture, service level agreements (SLAs) violation detection and SLA-based virtualization and autonomic rules in a Cloud and BPM environment. (135, 208, 215, 227) ○ Cross-discipline collaborations through privacy, preserving in communications and BPMS architectures. (62, 161) ○ Reducing delays in networks and architectures enabling a delay-tolerant BPM execution. (230, 119) ○ SAP software fulfilment of business process requirements. (71)
5	○ No papers found
6	○ Green computing and green BPM, supporting an elastic process. (137) ○ Risk and compliance management by cloud-based BPM systems to ensure quality in organizations. (61) ○ Protecting unauthorized access by security models, frameworks, rule definition, constraints and documentation, leading to performance and energy management. (16, 56, 129, 225) ○ Cost reduction strategies, risk and compliance management and solutions in a cloud environment for data transfer, storage and client satisfaction. (8, 9, 11) ○ Knowledge management aspects including knowledge sharing, knowledge fusion, reusing knowledge, process knowledge and knowledge transformation on cloud and blockchains. (26, 69, 78, 218, 221) ○ Working in blockchains to increase collaboration in BPM systems, caterpillar approach, monitoring and verification of choreographies. (33, 91, 92) ○ Application modeling, monitoring, industrial techniques, cloud and map- reducing for manufacturing, correctness, recovery actions, customization and to meet design/runtime requirements. (10, 49, 52)

Table A1. *Cont.*

Trend	IS-Related BPM Studies with a Digital Innovation Focus
6	○ Structure-based exact query or use case on process model repositories, heuristic scheduling algorithm and selection strategies in workflow systems of the cloud process itself as a service. (54, 59, 163,138, 186, 222). ○ Cloud-based privacy preservation and simulation, correct and optimal resource allocation in business process modeling. (132, 187, 213) ○ Load balancing strategies with models of different complexity and BPMN in clouds. (63, 146) ○ Metamodeling, integrating heterogeneous data sources in a BPM environment of Industry 4.0. (114, 162) ○ Use of Internet of Things in process-aware distributed deployment, IoT-aware semantic frameworks, healing distributed BPM, and distribution in workflows. (112, 116, 117, 166, 168) ○ Automating cloud migration and management processes. (130, 194). ○ Developing classifications, methodologies and requirement analyses for new technologies. (139, 149, 156, 199, 219). ○ Developing algorithms and logic-based solutions through machine learning and big data analytics.(139, 184, 192)
7	○ Impact of disruptive technologies such as cloud computing and IoT on jobs for learning purpose. (46)

Appendix B. Managerial Research Themes

Table A2. Research themes in managerial BPM papers (n = 87).

Trend	Managerial BPM Studies with a Digital Innovation Focus
1	○ How to manage blockchains that can help in goods traceability and trust interfaces for consumers by employee training. (31) ○ How customer service response time can increase in cloud control and monitoring by introducing time management attributes. (53) ○ BPM systems for knowledge-based service organizations in which BPM practitioners use knowledge and experience while performing tasks. (174) ○ Satisfying customer needs and changing requirement by using BPMN within IoT platform. (87)
2	○ Making strategic tools, doing customizations in business processes and finding the balance between structure, culture and processes in ambidextrous organizations. (37, 38, 41, 44) ○ Conceptualization and operationalization of ambidextrous BPM, IT capabilities and IT management for business processes. (40, 93) ○ Combining ambidexterity with coordination, knowledge management, and decision making in organizations. (43) ○ Creating value by business intelligence, digital process innovations for transforming technology and enhancing ambidexterity performance. (96, 99) ○ Organizational development and integration strategies by using new IT like IoT. (80, 210) ○ Finding a balance between strategic transformations and the incremental side of lean paths. (176) ○ Exploring the integrated nature of mechanisms and their involvement in intellectual capital as a single or multiple element. (211) ○ Empirical evidence for ambidexterity performance and business process innovations. (39) ○ Supporting decision-making for legitimizing ambidexterity. (42)

Table A2. *Cont.*

Trend	Managerial BPM Studies with a Digital Innovation Focus
3	○ Defining, setting directions, and highlighting the significance of blockchains for collaboration and change in BPM. (3, 28, 32, 34, 36) ○ Agile functions and capabilities for project management, development, and performance. (18, 23, 25, 177) ○ Process reengineering, combining lean and agile techniques for process improvements. (20, 180, 206) ○ Agility for digital process innovations and adaptations in BPM. (121, 126) ○ BPM reengineering designs used in project management. (19) ○ Process-centric, objective-centric and human-centric management theory with technology flexibility and agility. (24) ○ Examining the role of business intelligence and analytics in organizations. (47) ○ Developing a framework for dichotomy elimination between BPM models and pyramidal management. (181) ○ On the importance of Business Development Application (BDA)-capable BPM systems for consumer companies. (22) ○ Supporting business processes in the external collaborations of universities, using cloud computing by setting input/output quality dimensions. (224) ○ Organizational support and structural aspects for adopting agile and critical factors. (125)
4	○ Growth, struggling phases, standardizations, risk management in industry 4.0 and BPM. (15, 73, 74, 77, 115) ○ Agile strategies for teaching BPM and sharing knowledge in cloud workflows. (21, 144) ○ Introducing, integrating and discussing cloud computing, its adoption and use in software value networks, Quality of Service (QoS) characteristics, dependency, and network governance. (55, 68, 141, 142, 148, 158, 193) ○ IoT resistance and acceptance in sports industry and its applications in cold chain logistics. (170, 203) ○ Manage printing through material management. (198, 223) ○ Identifying challenges of blockchains, such as deployment, acceptance, and customer experience. (29) ○ Extending BPM's role to digital innovation. (48) ○ Identifying cloud computing risks and audit tasks. (183) ○ Providing a business model win-win solution in SME's business provider and cloud service consumer. (193)
5	○ No papers found
6	○ Proposing agile-based modeling contributions. (17, 175) ○ Cloud computing promotes flexibility, creates collaborations, learning paths, and service integration in event-based modeling. (57, 58, 100) ○ Influence of industry 4.0 modeling and mapping on green manufacturing, supply chain's economy and environment. (75, 160, 163) ○ Model development for cloud computing and an IoT environment. (108, 118) ○ Quality and speed in IoT, the role of IoT in defining smart cities, its interaction with humans and intellectual capital (intensive cognitive companies), its evolutionary impact (manufacturing), and IoT adoption for process improvement with other new IT. (128, 164, 165, 169, 171, 172) ○ Benefits and challenges of cloud computing and reshaping trends of integrated decision management support systems. (195, 212) ○ Reducing business activity towards core aspects such as value propositions, distribution channels and customers. (231)
7	○ Explaining the basics of blockchains. (127) ○ Identifying hindering factors of cloud BPM adoption. (140) ○ Supporting education in universities with cloud computing technologies. (226) ○ Increasing ambidexterity by developing knowledge management capabilities and ICT skills. (94)

Appendix C. IS Research Agenda

Table A3. IS-related research agenda for BPM-DI.

(C1) BPM-DI Trend	(C2) Initial Research Avenues by [12]	(C3) Key Variables in Our SLR	(C4) Demonstrated Research Avenues (More Research on . . .)
Trend 1	Methods and techniques for intelligent/collaboration/case-driven BPM to proactively meet changing customer needs	○ Customer interaction ○ Intelligent techniques ○ Resource management	○ Design time and runtime interactions ○ Using machine learning and AI for customer involvement ○ Involvement and engagement in decision-making
	How to use customer data (e.g., expectations, performance perceptions, satisfaction) in diagnostic/predictive/prescriptive process analytics	○ Smart process applications	
Trend 2	Explorative methods and techniques (ambidextrous BPM)	○ No results found	○ Balancing explorative and exploitative BPM ○ Elasticity using cloud
	The strategic use of new IT to improve process efficiency and effectiveness	○ Process query methods ○ Trust ○ Elasticity ○ Demand-driven collaboration	
Trend 3	Methods and techniques for faster BPM cycles	○ Using AI	○ Quality evaluations in agile methods ○ Process-oriented developments
	Applying agile principles to BPM (agile BPM)	○ Organizational support ○ Collaboration and integration	
Trend 4	How to integrate the process architecture into the overall enterprise architecture with application and technical architectures that embrace new IT	○ Reducing delays ○ Scalability ○ Violation control ○ Smart contracting ○ Data mining techniques	○ Event-based processing ○ Cloud-oriented BPM lifecycle ○ Security and privacy issues ○ Supporting Industry 4.0
	Collaboration platforms per process lifecycle stage	○ Cross-discipline collaborations	
Trend 5	New CEO role to bring BPM DI to the board	○ No results found	○ Personalized technical skills
Trend 6	Process modeling alternatives (e.g., journey mapping via comic books and video apps)	○ Supporting elastic processes	○ Load-balancing strategies ○ Metamodeling ○ Integrating heterogeneous data sources ○ Using machine learning ○ Using data analytics ○ Event-based modeling ○ Modeling aligned with the fourth industrial revolution
	How process monitoring tools can become more approachable for a wider (non-expert) audience (e.g., dashboards and tableaux techniques)	○ Risk management ○ Compliance management	
	Tools supporting case-driven BPM and knowledge-intensive/unstructured processes	○ Knowledge fusion ○ Reusing knowledge	
	Monitoring tools for intelligent BPM	○ Monitoring in blockchains	
Trend 7	How to use employee data (e.g., job satisfaction, perceived work difficulty, stress) in diagnostic/predictive/prescriptive process analytics	○ Disruptive technologies impact	○ Experienced-based learning
	User-friendly artifacts (e.g., evaluation criteria) to be accessible to non-experts	○ No results found	

Appendix D. Managerial Research Agenda

Table A4. Management-related research agenda for BPM-DI.

(C1) BPM-DI Trend	(C2) Initial Research Avenues by [12]	(C3) Key Aariables in our SLR	(C4) Demonstrated Research Avenues (More Research on . . .)
Trend 1	Co-creation of process value with end customers	○ Trust	○ Value creation by business intelligence ○ Value propositions ○ Satisfying customer requirements
	The realization of process-oriented values like customer understanding and experience (Customer Process Management)	○ Response time ○ Traceability	
Trend 2	BPM critical success factors from a DI perspective	○ No results found	○ Exploring the integrated nature of business processes
	Strategic alignment between BPM and DI (value-driven BPM)	○ Integration	
	Disruptive business models and the impact on BPM	○ Meta synthesis	
	Guidelines for balancing an exploitative and explorative approach (ambidextrous BPM)	○ Balancing strategies ○ Customization ○ Ambidextrous BPM capabilities ○ Coordination ○ Knowledge sharing ○ Performance ○ Legitimization	
Trend 3	Studying and improving the process of DI	○ Improvement through BPR and agility ○ Quality dimensions	○ Human-centric management ○ Objectivity ○ Process centricity
	Time management and project management for process owners	○ Agile functions ○ Agile capabilities ○ Reengineering design	
	Maturity models facilitating a BPM-DI adoption	○ Dichotomy elimination	
Trend 4	The degree to which traditional business-IT alignment models apply to a DI context	○ IoT acceptance ○ IoT resistance ○ Cloud Adoption ○ Industry 4.0 growth ○ Blockchain challenges	○ Standardizations ○ Interoperability
Trend 5	BPM governance, and the sometimes conflicting roles of Chief Operations/Process managers, Chief Information managers and Chief Innovation managers	○ No results found	○ Promote a culture of technology adoption ○ Investments in DI
Trend 6	Best practices and success stories to share knowledge and find BPM-DI advocates	○ Flexibility ○ Service integration ○ Green SCM ○ Green Manufacturing ○ Agile knowledge sharing ○ Value proposition ○ Increasing ambidexterity ○ Quality and speed in IoT ○ Intensive cognition	○ Managing distributed online platforms
Trend 7	How change management models and techniques offer best practices for BPM	○ No results found	○ Explaining blockchains ○ Hindering factors in BPM-IT adoption ○ Learning through comparisons with previous successful technology adoption
	New curricula in IT and BPM	○ No results found	
	How management and innovation can be taught to kids as from primary school	○ No results found	

Appendix E. SLR Sample

Bibliometric details about our SLR sample can be found here: https://docs.google.com/spreadsheets/d/1nhysmrCB2A3xgUkHtPh7oRfUGP4hQnoWBtLSiR7TNSs/edit?usp=sharing/.

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