Aligning business processes with regulatory requirements

a systematic literature review

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1 Introduction

In the context of the DBA program at Vlerick Business School a literature review is one of two deliverables of year two. The research topic is "BPM for regulatory compliance". The goal of this review is to get an overview of relevant literature and identify topics listed as possibilities for future research. The type of literature review is a systematic literature review (SLR). The SLR has been performed following the steps described in Kitchenham and Charters (2007).

Chapter 2 states the main research question, three subquestions and provides for a definition of the central concepts.

Chapter 3 is about the planning of the research. It describes the databases that were searched, the search terms used, the criteria for selecting articles and how the bibliographic data and the articles have been obtained.

Chapter 4 concerns the exection of the research. It describes the studies found, which studies have been selected, how the quality of the studies has been assessed, how the data was collected and a synthesis of the data.

Chapter 5 concerns the reporting of the research. It describes how the results of this study will be shared, limitations of the study and possibilities for further research suggesting possible improvements.

2 Research question(s)

The research question (RQ) and the three supporting sub-questions (SQ) that are addressed in this literature review are:

RQ: What are approaches for aligning business processes with regulatory requirements to achieve regulatory compliance by design?

SQ1: How can businesses identify relevant regulatory requirements?

SQ2: How can businesses analyze which business processes are affected by changes in regulatory requirements?

SQ3: How can businesses integrate compliance requirements into business process design?

The focus of this review is specifically the first question (RQ). The following is the research question repeated whereby the central terms and and concepts in this review are boxed: What are approaches for aligning business processes with regulatory requirements to achieve regulatory compliance by design ?

A definition of the three central concepts:

Business process management (BPM) is a defined as all activities performed by businesses to discover, model, automate, analyze, measure, improve and optimize business processes (Liu, Müller, and Xu (2007)). A business process coordinates the behavior of people, systems, information and things to produce business outcomes in support of a business strategy. Processes can be structured and repeatable, or unstructured and variable.

Regulatory compliance is defined as ensuring that business processes, operations, and practices are in accordance with a prescribed and/or agreed set of norms. These compliance requirements may stem from legislature and regulatory bodies (e.g., Sarbanes-Oxley, Basel II, HIPAA), standards and codes of practice (e.g., SCOR, ISO9000), and also business partner contracts (Hashmi (2015)).

Compliance by design refers to approaches and methodologies where compliance requirements are integrated into business process models (Sadiq and Governatori (2010)) and enterprise applications from the very beginning. This concept emphasizes embedding compliance within the fabric of business practices (Lohmann (2013)) rather than treating it as a separate or after-the-fact activity.

3 Review plan

3.1 Resources to be searched

An initial set of databases was selected to perform the literature search on. Both commercial and open access databases have been selected. A description for these databases in included in table A.1.

1. Web of Science (WoS), Publisher: Clarivate
2. ScienceDirect (SD), Publisher: Elsevier
3. SSNR, Publisher: Elsevier
4. arXiv, Publisher: cs
5. dblp, Publisher: dblp
6. Zenodo, Publisher: Zenodo

As a test we performed some initial searches. The results of the initial searches was reviewed. SSNR and Zenodo yielded few results as compared to the other databases. The selection of databases was reduced to WoS, SD, SSNR, ArXiv and dblp.

3.2 Search terms used

The initial search terms have been formulated as follows:

1. ("business process management" or BPM) and "regulatory compliance"
2. ("business process management" or BPM) and "legal compliance"
3. ("business process management" or BPM) and "compliance"
4. "business process management" and ("regulation" or "regulatory")
5. "business process *engineering" and "compliance"
6. "business process *engineering" and ("regulation" or "regulatory")

Here too a test has been performed using the search terms. It was found that the combination of "business process management" with "regulatory compliance" or "legal compliance" yieded few results. Consequently, 1 and 2 were skipped. We searched for "business process management" and "compliance" which includes both "regulatory compliance" and "legal compliance".

3.3 Study selection criteria

The quality of an article is assessed on the basis of the 4 criteria(QA1 through QA4). The criteria are equally weighted. An article is assigned 1 point for every QA criterium that is met. An article will thus get score of 0 through 4. Other metrics like author h-index and journal impact factor will not be considered in the selection process.

Table 3.1: Study selection criteria

criteria	code	descriptions
inclusion	IC1	the title, abstract and full text are in english
	IC2	the publication is dated between 2000 and 2024
exclusion	EC1	the reference is to a book(chapter)
	EC2	the article has been retracted
	EC3	the type of article is a conference paper or a preprint
	EC4	a search term has a different meaning
	EC5	the application relates to a specific sector
	EC6	the title, abstract and full text are not in english
quality	QA1	the article is a peer-reviewed journal article
	QA2	the article appeared in one of the legible journals
	QA3	has a citation count higher than 5 per year since the year of publication
	QA4	the first and second author have combined more than 50 publications listed on google scholar

3.4 Data extraction strategy

The innitial 6 data sources have been reduced to 4 (excluding Zenodo). For the remaining 5 data-sources queries will be formulated for each data source. The resulting records found will be listed in and excel file "slr_logbook.xlsx".

4 Review execution

4.1 Research identification

Initially 6 queries have been run against the 6 databases resulting in 84 hits as shown in table 4.1 in appendix E. After testing the initially formulated 6 queries have een reduced to 4 queries. The first two queries search for "business process management" or BPM in the title. The last two queries search for "business process engineering" or business process reengineering" in the title.

1. TI=("business process management" or BPM) AND (AB=(compliance) OR KP=(compliance))
2. TI=("business process management" or BPM) AND (AB=("regulat*") OR KP=("regulat*"))
3. TI=("business process *engineering") AND (AB=(compliance) OR KP=(compliance))
4. TI=("business process *engineering") AND (AB=(regulat*) OR KP=(regulat*))

The initial list (table E.1) contains a total of 84 records. An additional 6 records were found from other sources (table E.2). The total is 90 records. This list includes preprints and conference papers. Filtering the journal articles results in a list of 25 records (table E.3).

In the case of Web of Science (WoS) the four queries have been taken together using the "OR" operator. This final query yields 42 results when using the the Vlerick WoS subscription[1]. The search strings have be adapted to suit the specific requirements of the databases.

4.2 Selection of studies

The initial searches were done on all database fields. The search was subsequently made more specific by searching titles and abstracts. Lastly we searched titles, abstracts and keywords.

Across the 6 datasoures 84 articles have been identified, and an additional 6 records have been added from different sources. The found records are listed in Appendix E: table E.1 and table E.2.

The process to get to the final 23 papers included in this literature study is visualized in the flowchart in figure D.1 in Appendix C.

The WoS search yielded 29 hits. Excluding 4 articles with BPM in the title where BPM has a different meaning than "Business Process Management". For example where BPM is an abbreviation of "Biodiesel Particulate Matter". Excluding 1 article as it is a double, also ocuring in the dblp search.

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[1] Web of Science: Core Collection
Subscription : Vlerick Business School
Editions : A&HCI , ESCI , CPCI-SSH , CPCI-S , SCI-EXPANDED , SSCI
Date range: 2014-2024

The SD search yielded 7 hits. On the basis of article type (1 book chapter and 1 short communication) we have excluded two articles. An additional article was excluded as the title referred to "Business Process Management Map", which is a different concept.

The SSRN search yielded 2 results, both excluded as they are preprints.

The arXiv search yielded 0 records when looking for articles with "Business Process Management" or BPM in the title field. Two records where found on the basis of abstract and keyword matches. All the same these records have been subsequently excluded when the exclusion criteria have been applied.

The dblp search yielded 41 records, including 2 books and 35 conference papers. After exclusion 4 records remain, 3 journal articles and one PhD thesis. For the next step, the abstract scan, the thesis has been replaced by a journal article by the same author about the same topic.

The Zenodo search yielded 0 records when looking for articles with "Business Process Management" or BPM in the title field.

Six additional records have been included identified via different sources: 4 journal articles, 1 PhD thesis and 1 conference paper. Here too, for the next step in the process the thesis has been replaced by a journal article by the same author about the same topic.

In summary:

Table 4.1: Result set

Database	Found	Additional	Subtotal	Excluded	Result set
WoS	29		29	-19	10
SD	7		7	-7	0
SSRN	0	+2	2	-2	0
arXiv	0	+4	4	-4	0
dblp	42		42	-37	5
zenodo	0				0
aditional	0	+6	6		6
total	78	+12	90	-69	21

The abstracts of the remaining 21 articles are listed in Appendix G, table E.3.

4.3 Study Quality Assessment

The first quality indicator is about the type of journal. Peer reviewed articles are deemed to be of better quality than, for example, conference papers. The second quality indicator is an a indirect measure of both the quality of the journal and the relevance of the article to the Information Systems field. The third quality indicator is a proxy for the quality of the article. The fourth indicator is deemed to be representative for the quality of the scholars.

The outcome for QA1 through QA4 is either 1 or 0 (1 means yes, 0 means no).
QA1: the article is of the type peer-reviewed journal article
QA2: the journal is in the eligible journals list
QA3: the article has been referenced an average of 5 times per year since publication
QA4: author 1 and author 2 have together authored at least 50 articles
The detail of the calculation for QA3 en QA4 is shown in appendix F.

Table 4.2: Quality assessment

Seq	Source	QA1	QA2	QA3	QA4	Score
1	WoS_02	1	0	0	0	1
2	WoS_03	1	0	0	1	2
3	WoS_04	1	0	1	1	3
4	WoS_05	1	0	0	1	2
5	WoS_06	1	1	0	1	3
6	WoS_10	1	0	1	1	3
7	WoS_14	1	0	1	1	3
8	WoS_15	1	0	1	1	3
9	WoS_16	1	0	0	1	2
10	WoS_17	1	0	0	0	1
11	dblp_01	1	0	0	1	2
12	dblp_03	1	0	1	1	3
13	dblp_08	1	0	0	0	1
14	dblp_13	1	0	0	1	2
15	dblp_28	0	0	0	0	0
16	other_01	1	0	1	0	2
17	other_02	1	0	0	1	2
18	other_03	1	0	1	1	3
19	other_04	1	0	1	1	3
20	other_05	0	0	0	1	1
21	other_06	1	0	1	1	3

For the final list we only consider the 9 articles where three or more conditions are met (see: appendix E, table E.4).

4.4 Data collection

The output of each query has either been a bib file or a ris file. All bib files have been converted to ris files. The mapping of bibliographic elements to the ris fields differs per data sources (see table C.1). A script has been written to get to a uniform ris-format Appendix C.

The open access databases do not contain the full text articles if the articles are not open access. DBLP also doesn't contain abstracts. The absence of full text articles or abstracts is explained by constraints imposed by copyrights.

The excel file containing the article lists has been stored on zenodo for future reference ().

4.5 Synthesis of extracted data

8-12 years ago: the two oldest papers in the dataset are Vanderfeesten, Reijers, and Van Der Aalst (2011) and Hadasch, Maedche, and Gregor (2016). The article of Irene Vanderfeesten is on the subject of her PhD thesis (Vanderfeesten, Reijers, and van der Aalst (2011)). It describes the concept of a Product Data Model which, in workflow systems, can be compared to a Bill of Material in manufacturing systems. The article doesn't mention future research but does mention collaboration with industrial partners to incorporate a PDM in a commercial tool. The Hadasch paper is a quantitive study about users' process compliance as a function of process explanations either in textual or diagram format (DE/DDE). Broadly stated, the paper concludes that the better explanations result in better compliance. Other than a recommendation that the findings of the paper be leveraged in future research, there is no specific guidance about future research.

4-8 years ago: the four papers published in the 2016-2019 timeslot are Van Der Aalst (2018), Hashmi and Governatori (2018), Hashmi et al. (2018) and van der Aa, Leopold, and Reijers (2017). The van der Aalst paper compares and contrasts spreadsheet technology with process mining technology. It mentions checking for compliance as the activity whereby a process as run in reality is compared to a normative model. The article mentions future process mining research should be about automatically improving processes by changing underlying process models. The first Hashmi paper compares six Compliance Modeling Frameworks (CMFs). There are two pointers to future research directions. 1) Studying the formal semantics of the norms modeling languages. 2) Studying the useability of the norms modeling constructs in practice. The second Hashmi paper is a SLR where 79 papers were included in the study. The study provides a comprehensive overview of the attributs of compliance in BPM. There is a general direction for future research given: to improve modeling languages to take into account all compliance requirements. The article by van der Aa et al. is about the possible divergence of process descriptions and graphical process models. A quantitive analysis is performed on 53 real-life model-text pairs. One of the suggested future research directions is to also capture process information in other formats. Among the examples given of such other formats are rules and regulations.

0-4 years ago: the three most recent papers in the set are the papers and Kir and Erdogan (2021), Bernardo Junior and De Padua (2023) and Viriyasitavat et al. (2023). The Kir paper introduces *agile*BPM, a modeling methodology. The main differentiator is that next to control flow *agile*BPM also caputers knowledge, rules and goals. A prototype of the system is compared to other similar systems (ADEPT, SmartPM, Planlets, Go4Flex). The paper doesn't mention future research. The Bernardo paper includes a SLR, interviews and expert consultations. Agile BPM is defined. Future research is suggested to be on practices necessary for emperical application of BPM in organizations. The Viriyasitavat article is a SLR on the use of blockchain technology for business process compliance. The paper argues that blockchain technologies can and are applied for business process compliance. Existing work has a focus on technical implementation of the functionalities of traditional BPM systems. However the use of blockchain technologies also allows for new functionalities. The further research section specifically mentions organizational and legal aspects.

Table 4.3: Relevance to research question

	Year	Article	Alignment Concepts	Future Research
1	2011	Vanderfeesten et al.	ProductData Model	N
2	2016	Hadasch et al.	(Diagram)Descriptive Explanations	N
3	2017	Van der Aa et al.	Consistency between representation	Y (specific)
4	2018	Van Der Aalst	Prescriptive Analytics	Y (general)
5	2018	Hashmi et al.	Compliance Modeling Frameworks	Y (specific)
6	2018	Hashmi et al.	Compliance Modeling Languages	Y (general)
7	2021	Kir et al.	Context Awareness / Norm adoption	N
8	2023	Viriyasitavat et al.	Blockchain	Y (general)
9	2023	Bernardo Junior et al.	-	Y (general)

All papers mention approaches for alignment of business processes with regulatory requirements except the Bernardo Junior paper about agile BPM.

From these 9 papers reviewed, 6 mention future research directions. Two papers mention specific future research topic, for example around "consistency between different process representations" and "the useability of norm modelling constructs".

5 Review Reporting

5.1 Dissemination strategy

A subsequent version of this review will be part of the PhD work. The aim is to get three by-products out of this review:

- A poster that explains this literature review process and its results to be presented on a research day.
- A version of the software script that is installable and useable by somebody else.
- An open access publication.

5.2 Limitations

The database searches resulted in a set of relevant articles for the subject of this review. Selecting a different set of databases would have resulted in a different set of relevant articles. The selection of databases was made from the databases available to us. We did not consider databases that require additional payment for access.

It is also noted that search results may defer among different databases. If the content of two databases is identical, the same query run against both databases can yield different results. The differences stem, among others, from different search fields, different query languages, different API's and different search engines. Examples of notable differences are:

- for WoS: the search results may differ depending on the subscription that is available to the user.
- for SD: the search results may differ as query's are interpreted based on language heuristics (source). Also, SD does not support wildcards.
- for dblp: the *CompleteSearch* engine autocompletes search terms, see Bast and Weber (2006).
- for arXiv: wildcards can not be used as the first character of a search term (source). For example "*engineering" will trigger an error message.

To assess the quality of the 21 identified articles a set of 4 indicators has been considered. There are many other indicators which can be used to assess the quality of an article. Changing the number of indicators and/or changing the selection of parameters could alter which full text articles are selected for the review.

5.3 Future research

In follow-on research it maybe interesting to include openAIRE (Open Access Infrastructure for Research in Europe) as a data source. Schumm et al. (2010), p. 11 reference research that has been performed under the 2008-2011 COMPAS research project funded by the EU and coordinated by the Technische Universitaet Wien. More information about the research output of these projects will be available via OpenAIRE. When OpenAIRE will be included as a data source we will also again include Zenodo. Zenodo was created as part of the OpenAIRE initiative.

For reproducibility a future version of this literature review shall have the protocol altered. For commercial databases one and the same query can yield different results if it is run with two different licenses. This has been found to be the case with Web of Science. For the query used in this review the Vlerick Business School license of WoS yielded 42 hits while the Amsterdam University of Applied Sciences license of WoS yield 24 hits (to be included in appendix). It is assumed the average user does not have precise information of the licenses that Academic institutions hold. As such WoS is better not used in the early stages of the search. The protocol could instead dictate the use of open databases, such as OpenAlex, for the early stages of the search. Commercial databases would then be used in a later stage to get abstracts and full texts of selected articles that are not available from open databases.

For quality assesment we have now used a self-constructed indicator (QA4) that has as inputs the number of publications by the first and second author. If further research is conducted it can be considered to replace this indicator with the ubiguitous h-index (Poirrier, Moreno, and Huerta-Canepa (2021)). Also, the fact that only 1 article is from the eligible journals list seems to indicate that either the list needs to be revised. Alternatively a different indicator, such as the journal impact factor, can be a substitute quality indicator.

Finally, where it relates to compliance checks, in the literature there is a divide between "design time" and "run time". As the RQ of this research refers to compliance by design , future research may have more of different search terms to also filter research about "design time" compliance checking.

A Databases Searched

Table A.1: Databases consulted

Platform	Type	Focus	Coverage	Access
Web of Science	Citation index	Wide range of disciplines (including hard sciences, social sciences, and the humanities)	Over 18,000 academic journals, books, patents, and other scholarly publications	Subscription-based
ScienceDirect	Academic literature platform	Science, technology, medicine, and social science	Over 3,500 peer-reviewed journals	Subscription-based and open access
SSRN	Preprints	Social sciences, economics, and business	Early-stage social science, economics, and business research papers	Open access
arXiv	Preprints	Hard sciences and quantitative sciences	Early-stage research papers in a wide range of disciplines	Open access
DBLP	Bibliography database	Computer science	Scholarly publications in computer science	Open access
Zenodo	Dataset repository	Data from various disciplines	Data from research projects, surveys, and other data collection efforts	Open access

Table A.2: Other resources - not consulted

Platform	Operator	Note
Scopus	Elsevier	not available via Vlerick
OpenAlex[1]	OpenAlex	
OpenAIRE	OpenAIRE	Mentioned in connection with Zenodo and also EU Research Programs
CEUR Workshop Proceedings		

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[1] For a description of OpenAlex see Priem, Piwowar, and Orr (2022).

B List of eligible journals

The columns: level and impact factor (IF) are taken from the Vlerick Strategic Journal List (the List), effective as of January 2020. Empty means the journal is not on the List.

Table B.1: Basket of 11

Journal Title	Level	IF
MIS Quarterly (MISQ)	A*	7,268
Journal of Management Information Systems (JMIS)	A*	2,744
Information Systems Journal (ISJ)	A	4,267
Journal of the Association for Information Systems (JAIS)	A	2,839
Communications of the Association for Information Systems (CAIS)	A	?
Information Systems Research (ISR)	A*	2,301
Journal of Information Technology (JIT)	A	4,435
European Journal of Information Systems (EJIS)	A	2,819
Decision Support Systems (DSS)	A	2,819
Information & Management (IAM)	A	3,890
Information and Organization (IAO)		

Next to the basket of 11 there are other journals that are of interest. BISE is of interest because it is an european (IS) journal (as is EJIS). BPMJ and IJDG may be of interest given the subject matter their titles refer to.

Table B.2: Other journals of interest

Journal Title	Level	IF
Business Process Management Journal (BPMJ)		
Business & Information Systems Engineering (BISE)		
Journal of Disclosure and Governance (IJDG)		

C Merge Bibliographic Data

Academic literature databases typically provide for the ability to export bibliometric data in the BIB[1] or RIS[2] file format. SSRN is a notable exception. From inspecting the contents of the *.ris files it is apparent that, thought the output technically adheres to the RIS standard, the export from each database differs. The table on the next page shows how the mapping of export fields to RIS tags is different between the databases.

For a bibliometric analysis the resulting RIS file from searching multiple databases is required to be in a uniform format. For that purpose a script was written. The figure C.1 in this appendix shows the workings of the script.

Software used

We used various software scripts to assemble the dataset. Specifically:

- arxiv2bib, Get a BibTeX entry from an arXiv id number, using the arxiv.org API. (Nathan Grigg, 2017)
- bib2ris, Script to convert bibtex files to ris format. (Dumitru Duca, 2020)
- rispy, A Python 3.8+ reader/writer of RIS reference files. (Version 0.9.0); (Maik Derstappen, 2024)
- openpyXL, a Python library to read/write Excel 2010 xlsx/xlsm/xltx/xltm files(Version 3.1.2); (Development Team, 2023)
- tabulate, Pretty-print tabular data in Python, a library and a command-line utility. (Sergey Astanin, 2022)

All of the scripts use pandas (The pandas developmentteam (2020)).

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[1]BibTex is a bibliograpic flat file database (BIB)

[2]Research Information Systems (RIS)

RIS file contents

Table C.1: RIS-fields[3]

#	Field	RIS	WoS	SSNR	SD	ArXiv	dblp
1	type_of_reference	TY	x	-	x	x	x
2	authors	AU	x	-	x		?
3	(primary)title	TI	x	-		x	x
4	(primary)title	T1		-	x		x
5	secundary title	T2	x	-			
6	abstract	AB	x	-		x	
7	reference identifier	ID		-		x	
8	date	DA	x	-	x	x	x
9	year	PY	x	-	x	x	x
10	journal_name	JO		-	x		x
11	volume	VL	x	-	x		x
12	file attachment	L1		-		x	
13	note	M1		-			x
14	type of work	M3		-		x	
15	doi	DO	x	-	x	x	x
16	url	UR		-	x	x	x
17	custom6	C6	x	-			
18	custom7	C7	x	-			
19	accession_number	AN	x	-			
20	start_page	SP		-	x		x
21	end_page	EP		-			x
22	key_word	KW		-	x	x	
23	publisher	PB		-			x
24	database_provider	DP		-			x
25	data_source	DS		-			
26	ISSN, ISBN, …	SN	x	-	x		
27	ISSN, ISBN, …	SN	x	-			
28	end_of_record	ER	x	-	x		

Sample differences between the WoS en SD exports:
- In the WoS export the journal name is in field T2 (secondary title).
- In the SD export the journal name is in the field JO (journal_name).
- In the WoS export the title is in the field TI (primary)title.
- In the SD export the title is in the field T1 (primary)title.

SSRN show '-' for all fields as SSRN does not support export to RIS.

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[3]Wikipedia page RIS format

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Command line script
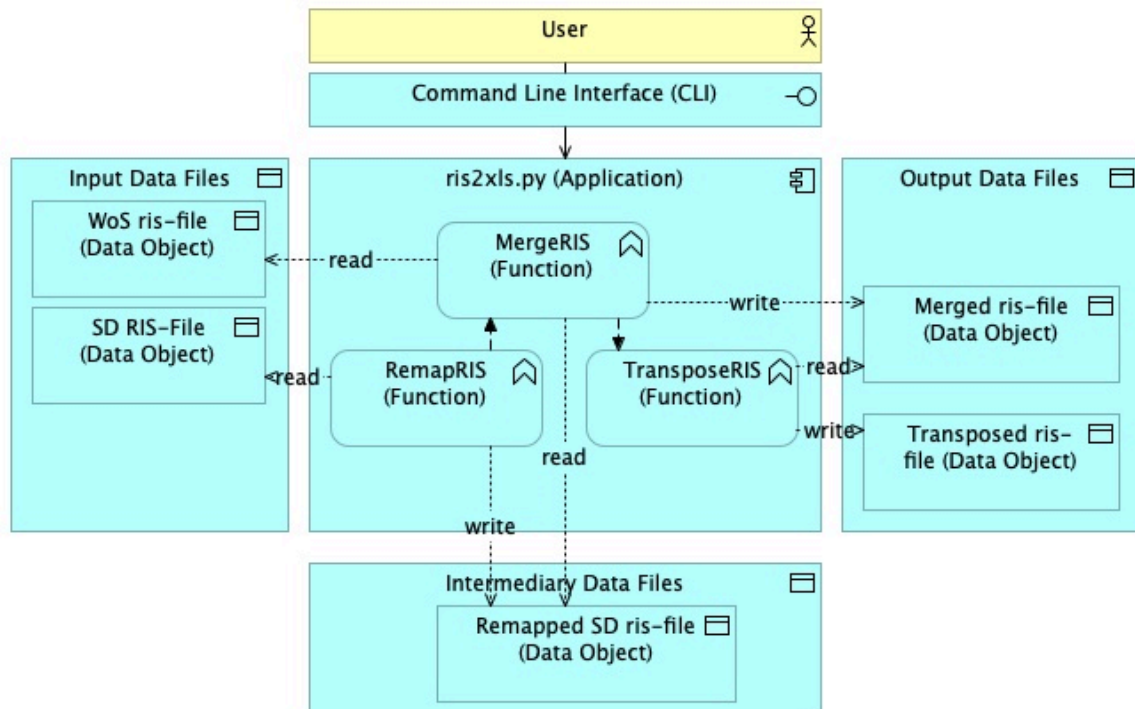
Figure C.1: ris2xls.py script structure

ris2xls.py is a script that produces an excel file on the basis of WoS and SD bibliograhy export files.

Within the script there are three functions:

- MergeRIS: Reads input files and writes a merged file.
- RemapRIS: Reads the "SD ris-File" and writes a "Remapped SD ris-file."
- TransposeRIS: Reads the "Merged ris-file" and writes a "Transposed ris-file."

Data Objects are used to represent files at different stages:

- Input Data Files: "WoS ris-file" and "SD ris-file" are the initial inputs, indicating the original exported data from Web of Science and Science Direct.
- Intermediary Data Files: "Remapped SD ris-file" is an output from the RemapRIS function where the format of the Science Direct exported data has been remapped to the ris-fields to better correspond to the Web of Science exported data.
- Output Data Files: "Merged ris-file" and "Transposed ris-file" are the final outputs after processing.

D Literature Selection

Figure D.1: Flowchart depicting literature selection.

E Literature Identified

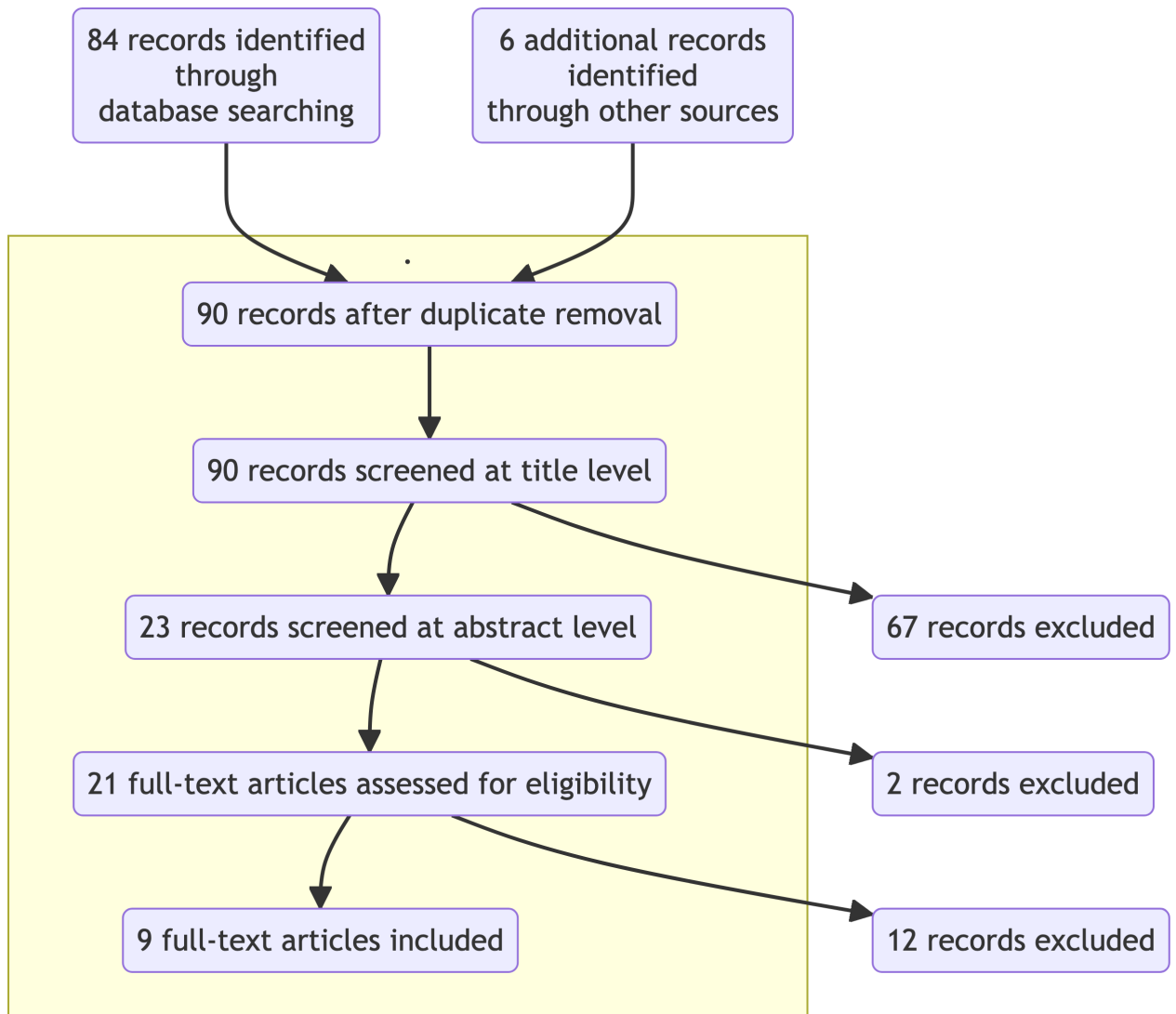The tables below show records found. Seq (sequence) shows a table row number. Source shows the data source where the record was found. Type holds the type of publication (conference proceedings, journal article, preprint, etc.) Title is the title of the publication. EC (exclusion criterion) shows the reason a record is excluded. If a record is excluded for multiple reasons, only one reason is shown. QA (quality assessment) shows the QA-score the record obtainted (0-4).

Table E.1: Identified through database searching

Seq	Source	Type	Title	EC
1	WoS_01	cpaper	Design Solutions for Business Process Reengineering of an Agricultural Enterprise	5
2	WoS_02	jour	Blockchain-as-a-Service for Business Process Management: Survey and Challenges	-
3	WoS_03	jour	Business Process Management - A Traditional Approach versus a Knowledge Based Approach	-
4	WoS_04	jour	Blockchain-based business process management (BPM) framework for service composition in industry 4.0	-
5	WoS_05	jour	Regulatory Instability, Business Process Management Technology, and BPM Skill Configurations	-
6	WoS_06	jour	The influence of directive explanations on users' business process compliance performance	-
7	WoS_07	cpaper	Business Process Management Driven by Data Governance	3
8	WoS_08	cpaper	An Open-Source Proactive Security Infrastructure For Business Process Management	3
9	WoS_09	cpaper	Cloud Based Privacy Preserving Collaborative Business Process Management	3
10	WoS_10	jour	A knowledge-intensive adaptive business process management framework	-
11	WoS_11	cpaper	Process model verifier for integrated medical healthcare systems using business process management system	5
12	WoS_12	cpaper	Agile Innovation Through Business Process Management: Realizing the Potential of Digital Transformation	3
13	WoS_13	cpaper	Managing Security Objects and -Processes Using an Extended BPM Approach and -System	3
14	WoS_14	jour	Toward agile Business Process Management: Description of concepts and a proposed definition	-
15	WoS_15	jour	Spreadsheets for business process management Using process mining to deal with "events" rather than "numbers"?	-
16	WoS_16	jour	BPM perspectives to support ICSs: Exploiting the integration of formal verifications into investment service provision processes	-
17	WoS_17	jour	Improved Compliance by BPM-Driven Workflow Automation	-
18	WoS_18	jour	Simulation of the Inventory Process in a Postharvest of Export Roses Under a Business Process Management approach	5
19	WoS_19	cpaper	Business Process Management Notation for a Costing Model Conception	5
20	WoS_20	cpaper	BPM analysis and security case study: dining rooms Cartagena military, Colombia	5
21	WoS_21	cpaper	The Value of Business Process Management to Understand Complex Asset Management Processes	5
22	WoS_22	cpaper	The Business Process Management Map - an Effective Means for Managing the Enterprise Value Chain	5

Table E.1: Identified through database searching

Seq	Source	Type	Title	EC
23	WoS_23	cpaper	Business Process Management Systems in Support of Corporate Governance: Applying Orlikowski's Theoretical Lens	3
24	WoS_24	cpaper	How do Machine Learning, Robotic Process Automation, and Blockchains Affect the Human Factor in Business Process Management?	3
25	WoS_24	jour	Multi-objective container scheduling and multi-path routing for elastic business process management in autonomic multi-tenant cloud	5
26	WoS_26	cpaper	Experiences from Selecting a BPM Notation for an Enterprise	3
27	WoS_27	jour	Compositional Analysis of Biodiesel Particulate Matter (BPM) from a Non-Road Diesel Generator	4
28	WoS_28	cpaper	BPM-CUL3 E3 ligase modulates thermotolerance by facilitating negative regulatory domain-mediated degradation of DREB2A in Arabidopsis	4
29	WoS_29	jour	The Pumilio RNA-binding protein APUM24 regulates seed maturation by fine-tuning the BPM-WRI1 module in Arabidopsis	4
30	dblp_01	jour	Business Process Modelling in Healthcare and Compliance Management: {A} Logical Framework	-
31	dblp_02	proc	Checking Compliance in Data-Driven Case Management	3
32	dblp_03	jour	Norms modeling constructs of business process compliance management frameworks: a conceptual evaluation	-
33	dblp_04	proc	Compliance Checking for Decision-Aware Process Models	3
34	dblp_05	proc	Checking Business Process Models for Compliance - Comparing Graph Matching and Temporal Logic	3
35	dblp_06	proc	Using Business Process Compliance Approaches for Compliance Management with Regard to Digitization: Evidence from a Systematic Literature Review	3
36	dblp_07	coll	Enabling Flexibility of Business Processes Using Compliance Rules: The Case of Mobiliar	3
37	dblp_08	jour	Comparative Analysis of Business Process Modelling Tools for Compliance Management Support	-
38	dblp_09	proc	Embracing Process Compliance and Flexibility Through Behavioral Consistency Checking in ACM - A Repair Service Management Case	3
39	dblp_10	coll	Managing Regulatory Compliance in Business Processes	X
40	dblp_11	proc	Online Compliance Monitoring of Service Landscapes	3
41	dblp_12	proc	Unterstützung von dynamischen Compliance Prozessen durch Business Process Management Plattformen	6
42	dblp_13	jour	Business process management enabled compliance-aware medical record sharing	-
43	dblp_14	proc	A Methodological Evaluation of Business Process Compliance Management Frameworks	3
44	dblp_15	proc	Supporting Domain Experts to Select and Configure Precise Compliance Rules	3
45	dblp_16	proc	Compliance Check in Semantic Business Process Management	3
46	dblp_17	proc	Business Process Regulatory Compliance Management Solution Frameworks: {A} Comparative Evaluation	3
47	dblp_18	proc	Towards Compliance of Cross-Organizational Processes and Their Changes - Research Challenges and State of Research	3
48	dblp_19	proc	EU Project BPM-GOSPEL - Applying Compliance Management Scenarios in Business Process Modelling for Trusted Business Coaching Programs	3
49	dblp_20	proc	Causes-based problems in business process compliance based management	3
50	dblp_21	proc	Making Compliance Measures Actionable: {A} New Compliance Analysis Approach	3
51	dblp_22	proc	Separating Compliance Management and Business Process Management	3
52	dblp_23	proc	Activity-Oriented Clustering Techniques in Large Process and Compliance Rule Repositories	3
53	dblp_24	proc	Towards an Integration of {GRC} and {BPM} - Requirements Changes for Compliance Management Caused by Externally Induced Complexity Drivers	3
54	dblp_25	proc	Compliance Oriented Process Management Using the Example of Clinical Trials	3
55	dblp_26	proc	Business Process and Regulations Compliance Management Technology	3
56	dblp_27	proc	A systematic review of goal-oriented requirements management frameworks for business process compliance	3
57	dblp_28	phdt	A compliance management framework for business process models	-
58	dblp_29	proc	Business Control Management - A Discipline to Ensure Regulatory Compliance of {SOA} Applications	3

Table E.1: Identified through database searching

Seq	Source	Type	Title	EC
59	dblp_30	proc	Business Process Compliance Tracking Using Key Performance Indicators	3
60	dblp_31	proc	Essential Aspects of Compliance Management with Focus on Business Process Automation	3
61	dblp_32	proc	Process Views to Support Compliance Management in Business Processes	3
62	dblp_33	proc	Visualization of Compliance Violation in Business Process Models	3
63	dblp_34	proc	Semantic Compliance Management in Business Process Management	3
64	dblp_35	proc	A Semantic Framework for Compliance Management in Business Process Management	3
65	dblp_36	proc	Aligning Risk Management and Compliance Considerations with Business Process Development	3
66	dblp_37	proc	Checking Compliance of Execution Traces to Business Rules	3
67	dblp_38	proc	Detecting Regulatory Compliance for Business Process Models through Semantic Annotations	3
68	dblp_39	proc	Service Contract Compliance Management in Business Process Management	3
69	dblp_40	proc	Policy-Based Semantic Compliance Checking for Business Process Management	3
70	dblp_41	proc	Compliance Aware Business Process Design	3
71	dblp_42	proc	Business Process and Business Rule Modeling Languages for Compliance Management: A Representational Analysis	3
72	SD_01	book	Chapter 4: Next-Generation Business Process Management (BPM)	1
73	SD_02	short	Business Process Reengineering of emergency management procedures: A case study	3
74	SD_03	cpaper	The Business Process Management Map – an Effective Means for Managing the Enterprise Value Chain	3
75	SD_04	cpaper	A knowledge-intensive adaptive business process management framework	3
76	SD_05	cpaper	From policy implementation to business process management: Principles for creating flexibility and agility	3
77	SD_06	cpaper	Improved Compliance by BPM-Driven Workflow Automation	3
78	SD_07	cpaper	Improving Telemedicine Processes Via BPM	5
79	SSRN_01	preprint	Efficient Vehicle Certification Management with Business Process Management	5
80	SSRN_02	preprint	Balancing Flexibility and Compliance in Response to Long-Tailed Business Process Changes	3
81	arXiv_01	preprint	Efficient Checking of Timed Order Compliance Rules over Graph-encoded Event Logs	3
82	arXiv_02	preprint	Predictive Compliance Monitoring in Process-Aware Information Systems: State of the Art, Functionalities, Research Directions	5
83	arXiv_03	preprint	Semi-automated checking for regulatory compliance in e-Health	5
84	arXiv_04	preprint	An Open-Source Integration of Process Mining Features into the Camunda Workflow Engine: Data Extraction and Challenges	3

Table E.2: Identified through other sources

Seq	Source	Type	Title	EC
1	other_01	jour	Evaluation of Compliance Rule Languages for Modelling Regulatory Compliance Requirements	-
2	other_02	jour	RegelSpraak: a CNL for Executable Tax Rules Specification	-
3	other_03	jour	Are we done with business process compliance: state of the art and challenges ahead	-
4	other_04	jour	Comparing textual descriptions to process models – The automatic detection of inconsistencies.	-
5	other_05	cpaper	Supporting domain experts to select and configure precise compliance rules	-
6	other_06_b	jour	Product-Based Workflow Support	-

Table E.3: Records screened at abstract level

Seq	Source	Type	Title	QA
1	WoS_02	jour	Blockchain-as-a-Service for Business Process Management: Survey and Challenges	1
2	WoS_03	jour	Business Process Management - A Traditional Approach versus a Knowledge Based Approach	2
3	WoS_04	jour	Blockchain-based business process management (BPM) framework for service composition in industry 4.0	3
4	WoS_05	jour	Regulatory Instability, Business Process Management Technology, and BPM Skill Configurations	2
5	WoS_06	jour	The influence of directive explanations on users' business process compliance performance	3
6	WoS_10	jour	A knowledge-intensive adaptive business process management framework	3
7	WoS_14	jour	Toward agile Business Process Management: Description of concepts and a proposed definition	3
8	WoS_15	jour	Spreadsheets for business process management Using process mining to deal with "events" rather than "numbers"?	3
9	WoS_16	jour	BPM perspectives to support ICSs: Exploiting the integration of formal verifications into investment service provision processes	2
10	WoS_17	jour	Improved Compliance by BPM-Driven Workflow Automation	1
11	dblp_01	jour	Business Process Modelling in Healthcare and Compliance Management: A Logical Framework	2
12	dblp_03	jour	Norms modeling constructs of business process compliance management frameworks: a conceptual evaluation	3
13	dblp_08	jour	Comparative Analysis of Business Process Modelling Tools for Compliance Management Support	1
14	dblp_13	jour	Business process management enabled compliance-aware medical record sharing	2
15	dblp_28	phdt	A compliance management framework for business process models	0
16	other_01	jour	Evaluation of Compliance Rule Languages for Modelling Regulatory Compliance Requirements	2
17	other_02	jour	RegelSpraak: a CNL for Executable Tax Rules Specification	2
18	other_03	jour	Are we done with business process compliance: state of the art and challenges ahead	3
19	other_04	jour	Comparing textual descriptions to process models – The automatic detection of inconsistencies.	3
20	other_05	cpaper	Supporting domain experts to select and configure precise compliance rules	1
21	other_06	jour	Product-Based Workflow Support	3

Table E.4: Records included in the study

Seq	Source	Type	Title	QA	Year
1	other_06	jour	Product-Based Workflow Support	3	2011
2	WoS_06	jour	The influence of directive explanations on users' business process compliance performance	3	2016
3	other_04	jour	Comparing textual descriptions to process models – The automatic detection of inconsistencies.	3	2017
4	WoS_15	jour	Spreadsheets for business process management Using process mining to deal with "events" rather than "numbers"?	3	2018
5	dblp_03	jour	Norms modeling constructs of business process compliance management frameworks: a conceptual evaluation	3	2018
6	other_03	jour	Are we done with business process compliance: state of the art and challenges ahead	3	2018
7	WoS_04	jour	Blockchain-based business process management (BPM) framework for service composition in industry 4.0	3	2020
8	WoS_10	jour	A knowledge-intensive adaptive business process management framework	3	2021
9	WoS_14	jour	Toward agile Business Process Management: Description of concepts and a proposed definition	3	2023

F Quality Criteria

Indicator QA3

The table shows the inputs for calculating the QA3-score. The score is 1 if the outcome of the calculation is larger than or equal to 5, otherwise it is 0. The calculation is: cited/year = number of citations / (2024 - Publication Year).

Indicator QA4

The table shows the inputs for calculating the QA4-score. The score is 1 if the outcome of the calculation is larger than or equal to 100, otherwise it is 0. The columns 'First Author' and 'Second Author' hold the number of articles by these authors on google Scholar.

Table F.1: Calculation of the QA3-score and QA4-score

Seq	Id	Citations	Year	Cited/Year	QA3-Score	First Author	Second Author	Total Articles	QA4-Score
1	WoS_02	4	2022	2	0	92	0	92	0
2	WoS_03	5	2015	0.6	0	145	0	145	1
3	WoS_04	333	2020	83.3	1	92	374	466	1
4	WoS_05	10	2019	2	0	0	134	134	1
5	WoS_06	12	2016	1.5	0	0	557	557	1
6	WoS_10	78	2021	26	1	9	99	108	1
7	WoS_14	5	2023	5	1	51	83	134	1
8	WoS_15	38	2018	6.3	1	1881	-	1881	1
9	WoS_16	8	2020	2	0	0	322	322	1
10	WoS_17	5	2014	0.5	0	0	0	0	0
11	dblp_01	4	2022	2	0	35	122	157	1
12	dblp_03	32	2018	5.3	1	46	416	462	1
13	dblp_08	8	2017	1.1	0	0	22	22	0
14	dblp_13	8	2013	0.7	0	14	93	107	1
15	dblp_28	36	2010	2.6	0	90	0	90	0
16	other_01	5	2023	5	1	0	46	46	0
17	other_02	10	2021	3.3	0	0	192	192	1
18	other_03	149	2018	24.8	1	46	416	462	1
19	other_04	70	2017	10	1	95	151	246	1
20	other_05	23	2013	2.1	0	11	189	200	1
21	other_06	110	2011	8.5	1	121	514	635	1

Meaning of the column names:
- Citations : the number of citations on google scholar
- Year : Year of Publication
- First author : the number of publications by the first author on google scholar
- Second author : the number of publications by the second author on google scholar

G Selected Abstracts

1.WS2 Blockchain-as-a-Service for Business Process Management: Survey and Challenges (Viriyasitavat et al. (2023))

Blockchain technology (BCT) has brought a paradigm shift to Business Process Management (BPM). BCT provides a trusted decentralized infrastructure to secure data and process executions using distributed ledgers and smart contract to manage complex business processes. Numerous efforts have been made to exploit BCT in supporting dynamic and trusted collaborations of business processes. This paper aims to understand recent BCT development for its BPM applications and identify the limitations and challenges for further development via a systematic literature review (SLR). It is found that numerous works have reported using BCT as technical solutions to fulfill some traditional BPM functions. This paper is distinguished from existing works, especially several relevant surveys in the sense that (1) the impact of using BCT in BPM is thoroughly explored to identify new constraints and challenges explicitly brought by blockchains; (2) the requirements for Business Process Compliance (BPC) are firstly analyzed in detail. Note that BPC is to assure the adherence of business processes to pre-defined policies, standards, specifications, **regulations**, and laws when business processes are executed. To fill the gaps of BCT applications in these two aspects, Blockchain-as-a-Service (BCaaS) is adopted in business process architecture, and the trends of BCT developments are identified accordingly.

2.WS3 Blockchain-based business process management (BPM) framework for service composition in industry 4.0 (Viriyasitavat et al. (2023))

Business process management (BPM) aims to optimize business processes to achieve better system performance such as higher profit, quicker response, and better services. BPM systems in Industry 4.0 are required to digitize and automate business process workflows and support the transparent interoperations of service vendors. The critical bottleneck to advance BPM systems is the evaluation, verification, and transformation of trustworthiness and digitized assets. Most of BPM systems rely heavily on domain experts or third parties to deal with trustworthiness. In this paper, an automated BPM solution is investigated to select and compose services in open business environment, Blockchain technology (BCT) is explored and proposed to transfer and verify the trustiness of businesses and partners, and a BPM framework is developed to illustrate how BCT can be integrated to support prompt, reliable, and cost-effective evaluation and transferring of Quality of Services in the workflow composition and management.

3.WS4 BPM perspectives to support ICSs: Exploiting the integration of formal verifications into investment service provision processes (Raucci et al. (2020))

Purpose This paper investigates the criteria for a selective integration, in the multidisciplinary business process management (BPM) areas, between information technologies tools and the company's internal control systems (ICSs) aimed at directing organizational behaviours. Adopting a process-based perspective, the authors propose a formal methodology to increase ICSs aims, related to the segregation of duties (SoDs) models, efficiently and effectively. Design/methodology/approach The authors examine the applicability of formal verifications to validate a banking process of providing investment services, which is mapped through the workflow management system. To mitigate the state explosion problem of formal methods, the authors propose an efficient methodology that has

been proved on the SoDs models in the bank ICSs, as a case study. Findings The authors' investigations suggest that in the BPM domain, the banking ICSs aims can benefit from the aforesaid methodologies, originating from the formal methods area, to increase the reliability and correctness in the design, modelling and implementation of the SoDs models. Originality/value The proposed methodology is quite general and can be efficiently applied to large-scale systems in different business contexts or areas of the BPM. Its application to the bank's SoD prevents or detects significant weaknesses, operational risks, excessive risk appetite and other undesirable behaviours in the investment services provision processes. This guarantees that the investment ordered/offered is "suitable and appropriate" with the client's risk profile, especially non-professional, required by the MiFID II Directive.

4.WS5 Business Process Compliance Management: An Integrated Proactive Approach (El-gammal et al. (2014))

Today's enterprises demand a high degree of **compliance** of business processes to meet regulations, such as Sarbanes-Oxley and Basel I-III. To ensure continuous guaranteed compliance, compliance management should be considered during all phases of the business process lifecycle; from the analysis and design to deployment, monitoring and evaluation. This paper introduces an integrated business process compliance management framework that incorporates design-time verification and runtime monitoring approaches. The nutshell of the approach is the Compliance Request Language (CRL), which is a high-level pattern-based language for the abstract specification of compliance requirements. From CRL expressions, formal compliance rules can be automatically generated, thereby eliminating the need for business and compliance experts to learn and use complex low-level formal languages. Formalized compliance rules enable automated approaches to be used for the static verification and dynamic monitoring of business processes. An integrated prototypical tool-suite is developed as a proof-of-concept to help validating the applicability of the approaches, and validated by experiment with two real-life case studies.

5.WS6 The influence of directive explanations on users' business process compliance performance

In organizations, individual user's compliance with business processes is important from a regulatory and efficiency point of view. The restriction of users' choices by implementing a restrictive information system is a typical approach in many organizations. However, restrictions and mandated compliance may affect employees' performance negatively. Especially when users need a certain degree of flexibility in completing their work activity. The purpose of this paper is to introduce the concept of directive explanations (DEs). DEs provide context-dependent feedback to users, but do not force users to comply. Design/methodology/approach The experimental study used in this paper aims at investigating how DEs influence users' process compliance. The authors used a laboratory experiment to test the proposed hypotheses. Every participant underwent four trials for which business process compliance was measured. Two trial blocks were used to cluster the four trials. Diagrammatic DEs were provided in one of the trial blocks, while textual DEs were provided in the other. Trial blocks were counterbalanced. Findings The results of the experiment show that DEs influence a user's compliance, but the effect varies for different types of DEs. The authors believe this study is significant as it empirically examines design characteristics of explanations from knowledge-based systems in the context of business processes. Research limitations/implications This study is certainly not without limitations. The sample used for this study was drawn from undergraduate information systems management students. The sample is thus not representative of the general population of organizations' IT users. However, a student sample adequately represents novice IT users, who are not very familiar with a business process. They are particularly suitable to study how users react to first-time contact with a DE. Practical implications The findings of this study are important to designers and implementers of systems that guide users to follow business processes. As the authors have illustrated with a real-world scenario, an ERP system's explanation

can lack details on how a user can resolve a blocked activity. In situations in which users bypass restricted systems, DEs can guide them to comply with a business process. Particularly diagrammatic explanations, which depict actors, activities, and constraints for a business process, have been found to increase the probability that users' behavior is business process compliant. Less time may be needed to resolve a situation, which can result in very efficient user-system cooperation. Originality/value This study makes several important contributions to research on explanations, which are provided by knowledge-based systems. First, the authors conceptualized, designed, and investigated a novel type of explanations, namely, DEs. The results of this study show how dramatic the difference in process compliance performance is when exposed to certain types of DEs (in one group from 57 percent on the initial trial to 82 percent on the fourth trial). This insight is important to derive design guidelines for DE, particularly when multimedia material is used.

6.WS10 A knowledge-intensive adaptive business process management framework? (Kir and Erdogan (2021))

Business process management has been the driving force of optimization and operational efficiency for companies until now, but the digitalization era we have been experiencing requires businesses to be agile and responsive as well. In order to be a part of this digital transformation, delivering new levels of automation-fueled agility through digitalization of BPM itself is required. However, the automation of BPM cannot be achieved by solely focusing on process space and classical planning techniques. It requires a holistic approach that also captures the social aspects of the business environment, such as corporate strategies, organization policies, negotiations, and cooperation. For this purpose, we combine BPM, knowledge-intensive systems and intelligent agent technologies, and yield one consolidated intelligent business process management framework, namely agileBPM, that governs the entire BPM life-cycle. Accordingly, agileBPM proposes a modeling methodology to semantically capture the business interests, enterprise environment and process space in accordance with the agent-oriented software engineering paradigm. The proposed agent-based process execution environment provides cognitive capabilities (such as goal-driven planning, norm compliance, knowledge-driven actions, and dynamic cooperation) on top of the developed business models to support knowledge workers' multicriteria decision making tasks. The context awareness and exception handling capabilities of the proposed approach have been presented with experimental studies. Through comparative evaluations, it is shown that agileBPM is the most comprehensive knowledge-intensive process management solution.

7.WOS14 Toward agile Business Process Management: Description of concepts and a proposed definition (Bernardo Junior and De Padua (2023))

Business Process Management (BPM) needs to be adjusted quickly and flexibly to cope with the dynamics of the business environment, so the demand for the incorporation of agility has reached BPM. To contribute to the theoretical consolidation of Agile BPM, it is necessary to develop a conceptualization for the term, that is, to describe the essential attributes for its understanding. Communicating the meaning of the concept in reduced words occurs through the definition, so the main objective of this study is to develop a scientific definition for Agile BPM. This study was performed in three phases. First, a systematic literature review was conducted to investigate how the scientific literature has addressed Agile BPM. Next, a deductive analysis was performed to conceptualize Agile BPM. In the third phase, a consultation with experts was conducted to refine the conceptual view and critique a tentative definition, preceded by judges' analysis to consolidate the definition. As a result, the concept of Agile BPM was elaborated, and based on the reduction of this conceptualization, a scientific definition was presented which describes that Agile BPM is "the promotion of BPM in which practitioners stimulate change quickly and flexibly in order to meet organizational demands with compliance and provide a better customer experience". There is a pioneering spirit in the present study regarding the deliberate conceptualization of Agile BPM, which provides the basis

for discussion of the topic, and helps scientific dissemination through a definition, contributing to the development of a theory of Agile BPM.

8.WOS15 Spreadsheets for business process management Using process mining to deal with "events" rather than "numbers"? (Van Der Aalst (2018))

Purpose – Process mining provides a generic collection of techniques to turn event data into valuable insights, improvement ideas, predictions, and recommendations. This paper uses spreadsheets as a metaphor to introduce process mining as an essential tool for data scientists and business analysts. The purpose of this paper is to illustrate that process mining can do with events what spreadsheets can do with numbers. Design/methodology/approach – The paper discusses the main concepts in both spreadsheets and process mining. Using a concrete data set as a running example, the different types of process mining are explained. Where spreadsheets work with numbers, process mining starts from event data with the aim to analyze processes. Findings – Differences and commonalities between spreadsheets and process mining are described. Unlike process mining tools like ProM, spreadsheets programs cannot be used to discover processes, check compliance, analyze bottlenecks, animate event data, and provide operational process support. Pointers to existing process mining tools and their functionality are given. Practical implications – Event logs and operational processes can be found everywhere and process mining techniques are not limited to specific application domains. Comparable to spreadsheet software widely used in finance, production, sales, education, and sports, process mining software can be used in a broad range of organizations. Originality/value – The paper provides an original view on process mining by relating it to the spreadsheets. The value of spreadsheet-like technology tailored toward the analysis of behavior rather than numbers is illustrated by the over 20 commercial process mining tools available today and the growing adoption in a variety of application domains.

Keywords Process mining, Business process management (BPM), Spreadsheets, Data science Paper type Viewpoint

9.WOS16 BPM perspectives to support ICSs: Exploiting the integration of formal verifications into investment service provision processes (Raucci et al. (2020))

Purpose This paper investigates the criteria for a selective integration, in the multidisciplinary business process management (BPM) areas, between information technologies tools and the company's internal control systems (ICSs) aimed at directing organizational behaviours. Adopting a process-based perspective, the authors propose a formal methodology to increase ICSs aims, related to the segregation of duties (SoDs) models, efficiently and effectively. Design/methodology/approach The authors examine the applicability of formal verifications to validate a banking process of providing investment services, which is mapped through the workflow management system. To mitigate the state explosion problem of formal methods, the authors propose an efficient methodology that has been proved on the SoDs models in the bank ICSs, as a case study. Findings The authors' investigations suggest that in the BPM domain, the banking ICSs aims can benefit from the aforesaid methodologies, originating from the formal methods area, to increase the reliability and correctness in the design, modelling and implementation of the SoDs models. Originality/value The proposed methodology is quite general and can be efficiently applied to large-scale systems in different business contexts or areas of the BPM. Its application to the bank's SoD prevents or detects significant weaknesses, operational risks, excessive risk appetite and other undesirable behaviours in the investment services provision processes. This guarantees that the investment ordered/offered is "suitable and appropriate" with the client's risk profile, especially non-professional, required by the MiFID II Directive.

10.WOS17 Improved Compliance by BPM-Driven Workflow Automation (Holzmüller-Laue et al. (2014))

Using methods and technologies of business process management (BPM) for the laboratory automation has important benefits (i.e., the agility of high-level automation processes, rapid interdisciplinary prototyping and implementation of laboratory tasks and procedures, and efficient real-time process documentation). A principal goal of the model-driven development is the improved transparency of processes and the alignment of process diagrams and technical code. First experiences of using the business process model and notation (BPMN) show that easy-to-read graphical process models can achieve and provide standardization of laboratory workflows. The model-based development allows one to change processes quickly and an easy adaption to changing requirements. The process models are able to host work procedures and their scheduling in compliance with predefined guidelines and policies. Finally, the process-controlled documentation of complex workflow results addresses modern laboratory needs of quality assurance. BPMN 2.0 as an automation language to control every kind of activity or subprocess is directed to complete workflows in end-to-end relationships. BPMN is applicable as a system-independent and cross-disciplinary graphical language to document all methods in laboratories (i.e., screening procedures or analytical processes). That means, with the BPM standard, a communication method of sharing process knowledge of laboratories is also available.

11.SD2 Business Process Reengineering of emergency management procedures: A case study (Bevilacqua, Ciarapica, and Paciarotti (2012))

The production and storage of dangerous substances in an industrial establishment creates risks for man, environment and properties in the surrounding area. Safety **regulations** require the establishment of a preventive information campaign regarding industrial risks and self-defence measures to adopt in an emergency situation. In the case of a major accident, people must be promptly made aware of the appropriate self-defence actions and behaviours to adopt. This strategic activity can reduce the panic effect, make citizens more cooperative and guarantee the effectiveness of any emergency plan. In this paper, the information chain is studied as an industrial process modelled by the IDEFO language. Through this method, each link in the chain has been deeply analysed. For each function of the process, the inputs, outputs and necessary controls and resources have been identified. Starting from a clear view of the current state, the process of re-engineering has been implemented to minimise or eliminate downtime, deficiencies and illnesses and, thus, consequent time losses. The main contribution of the IDEFO application in emergency management is to provide a clear view of the whole system, a communication system between emergency actors, a rich information source and a structured base for the re-engineering process.

12.arXiv1 Blockchains for Business Process Management - Challenges and Opportunities (Mendling et al. (2018))

Blockchain technology offers a sizable promise to rethink the way inter-organizational business processes are managed because of its potential to realize execution without a central party serving as a single point of trust (and failure). To stimulate research on this promise and the limits thereof, in this paper we outline the challenges and opportunities of blockchain for Business Process Management (BPM). We first reflect how blockchains could be used in the context of the established BPM lifecycle and second how they might become relevant beyond. We conclude our discourse with a summary of seven research directions for investigating the application of blockchain technology in the context of BPM.

13.arXiv2 Recognizing and Splitting Conditional Sentences for Automation of Business Processes Management (Vo et al. (2021))

Business Process Management (BPM) is the discipline which is responsible for management of discovering, analyzing, redesigning, monitoring, and controlling business processes. One of the most crucial tasks of BPM is discovering and modelling business processes from text documents. In this paper, we present our system that resolves an end-to-end problem consisting of 1) recognizing

conditional sentences from technical documents, 2) finding boundaries to extract conditional and resultant clauses from each conditional sentence, and 3) categorizing resultant clause as Action or Consequence which later helps to generate new steps in our business process model automatically. We created a new dataset and three models solve this problem. Our best model achieved very promising results of 83.82, 87.84, and 85.75 for Precision, Recall, and F1, respectively, for extracting Condition, Action, and Consequence clauses using Exact Match metric.

14.dblp1 A compliance management framework for business process models (Awad (2010))

Companies develop process models to explicitly describe their business operations. In the same time, business operations, business processes, must adhere to various types of compliance requirements. **Regulations**, e.g., Sarbanes Oxley Act of 2002, internal policies, best practices are just a few sources of compliance requirements. In some cases, non-adherence to compliance requirements makes the organization subject to legal punishment. In other cases, non-adherence to compliance leads to loss of competitive advantage and thus loss of market share. Unlike the classical domain-independent behavioral correctness of business processes, compliance requirements are domain-specific. Moreover, compliance requirements change over time. New requirements might appear due to change in laws and adoption of new policies. Compliance requirements are offered or enforced by different entities that have different objectives behind these requirements. Finally, compliance requirements might affect different aspects of business processes, e.g., control flow and data flow. As a result, it is infeasible to hard-code compliance checks in tools. Rather, a repeatable process of modeling compliance rules and checking them against business processes automatically is needed. This thesis provides a formal approach to support process design-time compliance checking. Using visual patterns, it is possible to model compliance requirements concerning control flow, data flow and conditional flow rules. Each pattern is mapped into a temporal logic formula. The thesis addresses the problem of consistency checking among various compliance requirements, as they might stem from divergent sources. Also, the thesis contributes to automatically check compliance requirements against process models using model checking. We show that extra domain knowledge, other than expressed in compliance rules, is needed to reach correct decisions. In case of violations, we are able to provide a useful feedback to the user. The feedback is in the form of parts of the process model whose execution causes the violation. In some cases, our approach is capable of providing automated remedy of the violation.

15.dblp3 Comparative Analysis of Business Process Modelling Tools for Compliance Management Support (Koncevics et al. (2017))

The paper presents results of the comparative analysis of business process modelling tools for supporting automated compliance management in organisations. By **compliance** in the paper we mean compliance to legislation, **regulations** of municipalities, external regulatory requirements and also internal organisational policies. The goal of the research is (1) to identify main attributes of business process modelling tools relevant in compliance management, and (2) to use the identified attributes for analysis of the tools to better understand the scope of their capability to support compliance management. The attributes of the tools have been derived from the related research. The analysis of the tools has been performed by installing each tool and evaluating it against a set of the identified attributes. The obtained results are useful in choosing the tools for compliance management in general and for open source solutions to develop new compliance management tools in particular.

16.dblp4 Norms modeling constructs of business process compliance management frameworks: a conceptual evaluation (Hashmi and Governatori (2018))

The effectiveness of a **compliance** management framework (CMF) can be guaranteed only if the framework is based on sound conceptual and formal foundations. In particular, the formal language used in the CMF is able to expressively represent the specifications of normative requirements (hereafter, norms) that impose constraints on various activities of a business process. However, if the

language used lacks expressiveness and the modelling constructs proposed in the CMF are not able to properly represent different types of norms, it can significantly impede the reliability of the compliance results produced by the CMF. This paper investigates whether existing CMFs are able to provide reasoning and modeling support for various types of normative requirements by evaluating the conceptual foundations of the modeling constructs that existing CMFs use to represent a specific type of norm. The evaluation results portray somewhat a bleak picture of the state-of-the-affairs when it comes to represent norms as none of the existing CMFs is able to provide a comprehensive reasoning and modeling support. Also, it points to the shortcomings of the CMFs and emphasises exigent need of new modeling languages with sound theoretical and formal foundations for representing legal norms.

17.aa1 Evaluation of Compliance Rule Languages for Modelling Regulatory Compliance Requirements (Zasada et al. (2023))

Compliance in business processes has become a fundamental requirement given the constant rise in regulatory requirements and competitive pressures that have emerged in recent decades. While in other areas of business process modelling and execution, considerable progress towards automation has been made (e.g., process discovery, executable process models), the interpretation and implementation of compliance requirements is still a highly complex task requiring human effort and time. To increase the level of "mechanization" when implementing **regulations** in business processes, compliance research seeks to formalize compliance requirements. Formal representations of compliance requirements should, then, be leveraged to design correct process models and, ideally, would also serve for the automated detection of violations. To formally specify compliance requirements, however, multiple process perspectives, such as control flow, data, time and resources, have to be considered. This leads to the challenge of representing such complex constraints which affect different process perspectives. To this end, current approaches in business process compliance make use of a varied set of languages. However, every approach has been devised based on different assumptions and motivating scenarios. In addition, these languages and their presentation usually abstract from real-world requirements which often would imply introducing a substantial amount of domain knowledge and interpretation, thus hampering the evaluation of their expressiveness. This is a serious problem, since comparisons of different formal languages based on real-world compliance requirements are lacking, meaning that users of such languages are not able to make informed decisions about which language to choose. To close this gap and to establish a uniform evaluation basis, we introduce a running example for evaluating the expressiveness and complexity of compliance rule languages. For language selection, we conducted a literature review. Next, we briefly introduce and demonstrate the languages' grammars and vocabularies based on the representation of a number of legal requirements. In doing so, we pay attention to semantic subtleties which we evaluate by adopting a normative classification framework which differentiates between different deontic assignments. Finally, on top of that, we apply Halstead's well-known metrics for calculating the relevant characteristics of the different languages in our comparison, such as the volume, difficulty and effort for each language. With this, we are finally able to better understand the lexical complexity of the languages in relation to their expressiveness. In sum, we provide a systematic comparison of different compliance rule languages based on real-world compliance requirements which may inform future users and developers of these languages. Finally, we advocate for a more user-aware development of compliance languages which should consider a trade off between expressiveness, complexity and usability.

18.aa2 RegelSpraak: a CNL for Executable Tax Rules Specification (Lokin (2020))

RegelSpraak is a CNL developed at the Dutch Tax Administration (DTA) over the last decade. Keeping up with frequently changing tax rules poses a formidable challenge to the DTA IT department. RegelSpraak is a central asset in ongoing efforts of the DTA to attune their tax IT systems

to automatic execution of tax law. RegelSpraak now is part of the operational process of rule specification and execution. In this practice-oriented paper, we present the history of RegelSpraak, its properties and the context of its use, emphasizing its double functionality as a language readable by non-technical tax experts but also directly interpretable in a software generating setup.

19.aa3 Are we done with business process compliance: state of the art and challenges ahead (Hashmi et al. (2018))

Literature on business process compliance (BPC) has predominantly focused on the alignment of the regulatory rules with the design, verification and validation of business processes. Previously surveys on BPC have been conducted with specific context in mind; however, the literature on BPC management research is largely sparse and does not accumulate a detailed understanding on existing literature and related issues faced by the domain. This survey provides a holistic view of the literature on existing BPC management approaches, and categories them based on di□erent compliance management strategies in the context of formulated research questions. A systematic literature approach is used where search terms pertaining keywords were used to identify literature related to the research questions from scholarly databases. From initially 183 papers, we selected 79 papers related to the themes of this survey published between 2000–2015. The survey results reveal that mostly compliance management approaches center around three distinct categories namely: design-time (28%), run-time (32%) and auditing (10%). Also, organisational and internal control based compliance management frameworks (21%) and hybrid approaches make (9%) of the surveyed approaches. Furthermore, open research challenges and gaps are identified and discussed with respect to the compliance problem.

Keywords: Business processes · Business process compliance · Norms compliance · Normative requirements · Compliance Management Frameworks

20.aa4 Comparing textual descriptions to process models – The automatic detection of inconsistencies (van der Aa, Leopold, and Reijers (2017))

Many organizations maintain textual process descriptions alongside graphical process models. The purpose is to make process information accessible to various stakeholders, including those who are not familiar with reading and interpreting the complex execution logic of process models. Despite this merit, there is a clear risk that model and text become misaligned when changes are not applied to both descriptions consistently. For organizations with hundreds of different processes, the effort required to identify and clear up such conflicts is considerable. To support organizations in keeping their process descriptions consistent, we present an approach to automatically identify inconsistencies between a process model and a corresponding textual description. Our approach detects cases where the two process representations describe activities in different orders and detect process model activities not contained in the textual description. A quantitative evaluation with 53 real-life model-text pairs demonstrates that our approach accurately identifies inconsistencies between model and text.

21.aa5 Supporting domain experts to select and configure precise compliance rules (Ramezani, Fahland, and van der Aalst (2013))

Compliance specifications concisely describe selected aspects of what a business operation should adhere to. To enable automated techniques for compliance checking, it is important that these requirements are specified correctly and precisely, describing exactly the behavior intended. Although there are rigorous mathematical formalisms for representing compliance rules, these are often perceived to be difficult to use for business users. Regardless of notation, however, there are often subtle but important details in compliance requirements that need to be considered. The main challenge in compliance checking is to bridge the gap between informal description and a precise specification of all requirements. In this paper, we present an approach which aims to facilitate creating

and understanding formal compliance requirements by providing configurable templates that capture these details as options for commonly-required compliance requirements. These options are configured interactively with end-users, using question trees and natural language. The approach is implemented in the Process Mining Toolkit ProM.

Keywords: compliance specification, compliance checking, configurable compliance rules, auditing, question tree

22.aa6 Product-based workflow support (Vanderfeesten, Reijers, and Van Der Aalst (2011))

Despite the industrial need for the improvement of information-intensive business processes, few scientifically grounded approaches exist to support such initiatives. In this paper, we propose a new approach that builds on concepts that are part of a product-oriented view on process optimization. Essentially, this approach allows end users to flexibly decide on the best possible way to create an informational product within the limits that are imposed by regulations and logical dependencies. We argue that this provides various benefits in comparison to earlier work. To support the end user in making sensible decisions, we describe two alternative approaches to provide her with recommendations to this end. We formalize these alternatives and discuss their relative strengths and weaknesses. The feasibility of the overall approach, which we refer to as Product-Based Workflow Support, is demonstrated by a workflow system realized using ProM and DECLARE.

H Journals, authors, keywords

Table H.1: Journals

Journal	Publisher	ISSN
Applied Computer Systems	De Gruyter Poland Sp. z o.o.	2255-8691
Artificial Intelligence and Law	Springer-Verlag	0924-8463
Government Information Quarterly	Elsevier	0740-624X
Information Systems	Elsevier	0306-4379
Knowledge and Information Systems	Springer-Verlag	0219-1377
Knowledge and Process Management	Wiley (John Wiley & Sons)	1092-4604
SLAS Technology	Elsevier	2472-6303
Safety Science	Elsevier	0925-7535
Software	Elsevier	2352-7110

The publisher and the ISSN number have been looked up at crossref using the journal name in the bibtex file.

Table H.2: Authors

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Irene Vanderfeesten	Hajo A. Reijers, Wil van der Aalst

Table H.3: Keywords

Citation Key	Keywords
gong2012policy	Flexibility, Agility, Business process management, Business services, Service orientation, Policy-making, Compliance
holzmüller_laue	laboratory automation, end-to-end workflow, systems integration, model-based application development, BPMN
kir2021knowledg	business process management, knowledge-intensive processes, Process modelling and execution, Process adaption, Agent-based business process management, Agile business process management
raucci2020bpm	Business Process Management, Internal Control Systems, Segregation of Duties, Formal Methods, Banking Processes, Investment Services
BernardoJuniorU	critical success factors, operations strategy, bpm governance, knowledge systems, implementation capabilities, organization, challenges, intuition
aa2017comparing	Business process management, Inconsistency detection, Compliance checking, Business process modeling, Natural language processing, Matching
hashmi2018are	Business processes, Business process compliance, Norms compliance, Normative requirements, Compliance Management Frameworks
bevilacqua2012b	Emergency management, IDEF0, Information system, Information supply, Risk information, Public, Safety management
hashmi2017norms	Norms, Compliance, Business Processes, Modelling Constructs, Modelling Languages, Compliance Management Frameworks
koncevičs2017co	Business process compliance, compliance management, compliance management tools, open source business process modelling tools
lohmann2013comp	Artifact-centric business processes, Process synthesis, Compliance management, Compliance by design
sadiq2010managi	Business Process, Control Objective, Linear Temporal Logic, Business Process Management, Semantic Annotation
schumm2010busin	Compliance, Business Process Management, Process Fragment, Formal Modeling, Proces Verification
zasada2023evalu	conceptual modelling, compliance rules modelling, regulatory compliance, business process expressiveness, language complexity
ramezani2014sup	compliance specification, compliance checking, configurabe compliance rules, auditing, question tree
vanderfeesten20	Business process modeling, Workflow management, Product Data Model

The keywords have been added to the bibtex file after consulting the publishers website and/or the web of science service.

Literature

Awad, Ahmed Mahmoud Hany Aly. 2010. "A Compliance Management Framework for Business Process Models." PhD thesis, University of Potsdam.

Bast, Holger, and Ingmar Weber. 2006. "Type Less, Find More: Fast Autocompletion Search with a Succinct Index." In *Proceedings of the 29th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, 364–71. Seattle Washington USA: ACM. https://doi.org/10.1145/1148170.1148234.

Bernardo Junior, Ronaldo, and Silvia Ines Dallavalle De Padua. 2023. "Toward Agile Business Process Management: Description of Concepts and a Proposed Definition." *Knowledge and Process Management* 30 (1): 14–32. https://doi.org/10.1002/kpm.1737.

Bevilacqua, M., F. E. Ciarapica, and C. Paciarotti. 2012. "Business Process Reengineering of Emergency Management Procedures: A Case Study." *Safety Science* 50 (5): 1368–76. https://doi.org/10.1016/j.ssci.2012.01.002.

Elgammal, A, S Sebahi, O Turetken, MS Hacid, MP Papazoglou, and WJ van den Heuvel. 2014. "Business Process Compliance Management: An Integrated Proactive Approach." In *CRAFTING GLOBAL COMPETITIVE ECONOMIES: 2020 VISION STRATEGIC PLANNING & SMART IMPLEMENTATION, VOLS I-IV*, edited by KS Soliman, 764–81.

Hadasch, Frank, Alexander Maedche, and Shirley Gregor. 2016. "The Influence of Directive Explanations on Users' Business Process Compliance Performance." *Business Process Management Journal* 22 (3): 458–83. https://doi.org/10.1108/BPMJ-05-2015-0067.

Hashmi, Mustafa. 2015. "Evaluating Business Process Compliance Management Frameworks." PhD thesis, Queensland University of Technology.

Hashmi, Mustafa, and Guido Governatori. 2018. "Norms Modeling Constructs of Business Process Compliance Management Frameworks: A Conceptual Evaluation" 26 (3): 251–305. https://doi.org/10.1007/S10506-017-9215-8.

Hashmi, Mustafa, Guido Governatori, Ho-Pun Lam, and Moe Thandar Wynn. 2018. "Are We Done with Business Process Compliance: State of the Art and Challenges Ahead." *Knowledge and Information Systems* 57 (1): 79–133. https://doi.org/10.1007/s10115-017-1142-1.

Holzmüller-Laue, Silke, Bernd Göde, Heidi Fleischer, and Kerstin Thurow. 2014. "Improved Compliance by BPM-Driven Workflow Automation." *SLAS Technology* 19 (6): 528–45. https://doi.org/10.1177/2211068214549626.

Kir, Huseyin, and Nadia Erdogan. 2021. "A Knowledge-Intensive Adaptive Business Process Management Framework." *Information Systems* 95 (January): 101639. https://doi.org/10.1016/j.is.2020.101639.

Kitchenham, Barbara, and Stuart Charters. 2007. "Guidelines for Performing Systematic Literature Reviews in Software Engineering."

Koncevics, Rolands, Ludmila Penicina, Andrejs Gaidukovs, Maris Dargis, Rita Burbo, and Ainars Auzins. 2017. "Comparative Analysis of Business Process Modelling Tools for Compliance Management Support" 21 (1): 22–27. https://doi.org/10.1515/ACSS-2017-0003.

Liu, Y., S. Müller, and K. Xu. 2007. "A Static Compliance-Checking Framework for Business Process Models." *IBM Systems Journal* 46 (2): 335–61.

Lohmann, Niels. 2013. "Compliance by Design for Artifact-Centric Business Processes." *Information Systems* 38 (4): 606–18. https://doi.org/10.1016/j.is.2012.07.003.

Lokin, Mariette. 2020. "Agile Law Making." In *Enterprise Ontology: A Human Centric Approach in Understanding the Essence of Organisation*, 416–17. Springer, Cham.

Mendling, Jan, Ingo Weber, Wil Van Der Aalst, Jan Vom Brocke, Cristina Cabanillas, Florian Daniel, Søren Debois, Claudio Di Ciccio, Marlon Dumas, and Schahram Dustdar. 2018. "Blockchains for Business Process Management-Challenges and Opportunities." *ACM Transactions on Management Information Systems (TMIS)* 9 (1): 1–16.

Poirrier, Maurice, Sebastian Moreno, and Gonzalo Huerta-Canepa. 2021. "Robust h-Index." Article. *SCIENTOMETRICS* 126 (3): 1969–81. https://doi.org/10.1007/s11192-020-03857-z.

Priem, Jason, Heather Piwowar, and Richard Orr. 2022. "OpenAlex: A Fully-Open Index of Scholarly Works, Authors, Venues, Institutions, and Concepts."

Ramezani, Elham, Dirk Fahland, and Wil M. P. van der Aalst. 2013. "Supporting Domain Experts to Select and Configure Precise Compliance Rules." In *Business Process Management Workshops - BPM 2013 International Workshops, Beijing, China, August 26, 2013, Revised Papers*, edited by Niels Lohmann, Minseok Song, and Petia Wohed, 171:498–512. Lecture Notes in Business Information Processing. Springer. https://doi.org/10.1007/978-3-319-06257-0/_39.

Raucci, Domenico, Antonella Santone, Francesco Mercaldo, and Tomasz Dyczkowski. 2020. "BPM Perspectives to Support ICSs: Exploiting the Integration of Formal Verifications into Investment Service Provision Processes." *Industrial Management & Data Systems* 120 (7): 1383–1400. https://doi.org/10.1108/IMDS-11-2019-0593.

Sadiq, Shazia, and Guido Governatori. 2010. "Managing Regulatory Compliance in Business Processes." In *Handbook on Business Process Management 2*, edited by Jan vom Brocke and Michael Rosemann, 159–75. Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-01982-1_8.

Schumm, David, Oktay Turetken, Natallia Kokash, Amal Elgammal, Frank Leymann, and Willem-Jan Van Den Heuvel. 2010. "Business Process Compliance Through Reusable Units of Compliant Processes." In *Current Trends in Web Engineering*, edited by Florian Daniel and Federico Michele Facca, 6385:325–37. Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-16985-4_29.

The pandas developmentteam. 2020. "Pandas-Dev/Pandas: Pandas." Zenodo. https://doi.org/10.5281/zenodo.3509134.

van der Aa, Han, Henrik Leopold, and Hajo A. Reijers. 2017. "Comparing Textual Descriptions to Process Models – The Automatic Detection of Inconsistencies." *Information Systems* 64 (March): 447–60. https://doi.org/10.1016/j.is.2016.07.010.

Van Der Aalst, Wil. 2018. "Spreadsheets for Business Process Management: Using Process Mining to Deal with 'Events' Rather Than 'Numbers'?" *Business Process Management Journal* 24 (1): 105–27. https://doi.org/10.1108/BPMJ-10-2016-0190.

Vanderfeesten, Irene, Hajo A. Reijers, and Wil van der Aalst. 2011. "Product-Based Workflow Support." *Information Systems* 36 (April): 517–35. https://doi.org/10.1016/j.is.2010.09.008.

Vanderfeesten, Irene, Hajo A. Reijers, and Wil M. P. Van Der Aalst. 2011. "Product-Based Workflow Support." *Information Systems* 36 (2): 517–35. https://doi.org/10.1016/j.is.2010.09.008.

Viriyasitavat, Wattana, Li Da Xu, Gaurav Dhiman, and Zhuming Bi. 2023. "Blockchain-as-a-Service for Business Process Management: Survey and Challenges." *IEEE Transactions on Services Computing* 16 (3): 2299–2314. https://doi.org/10.1109/TSC.2022.3199232.

Vo, Ngoc Phuoc An, Irene Manotas, Octavian Popescu, Algimantas Cerniauskas, and Vadim Sheinin. 2021. "Recognizing and Splitting Conditional Sentences for Automation of Business Processes Management." arXiv. https://arxiv.org/abs/2104.00660.

Zasada, Andrea, Mustafa Hashmi, Michael Fellmann, and David Knuplesch. 2023. "Evaluation of Compliance Rule Languages for Modelling Regulatory Compliance Requirements." *Software* 2 (1): 71–120. https://doi.org/10.3390/software2010004.