# Aligning business processes with regulatory requirements

**Selected abstracts**

12/06/2024

# Table of contents

# Introduction

Abstracts contains a collections of abstracts (and keywords) of 38 items identified via the literature searches. The keywords of the articles have been collected and are shown below. The paragraph Studies (reference) shows what the subject of the articles is and the type of study that has been performed. The paragraph Concepts (reference) lists the concepts mentioned in the articles. Finally Abstracts (reference) lists the abstracts of the individual articles.

# Keywords

Table 1: Keywords

| Citation Key | Keywords |
|---|---|
| amantea2022Busi | No keywords |
| bernardojunior2 | Agility,bpm governance,Business And Economics–Management,Business process management,challenges,Communication,critical success factors,Customer satisfaction,implementation capabilities,intuition,knowledge systems,Literature reviews,operations strategy,organization,Systematic review |
| bevilacqua2012B | Emergency management,IDEF0,Information supply,Information system,Public,Risk information,Safety management |
| corsius2021Rege | CNL |
| DBLP:conf/bpm/S | Business process compliance,Compliance management life-cycle,Digitization |
| DBLP:journals/r | Business process compliance,compliance management,compliance management tools,open source business process modelling tools |
| DBLP:phd/de/Awa | Business Process Models,Compliance,Temporal Logic,Violation Explanation,Violation Resolution |
| elgammal2014Bus | Compliance Patterns,Design-time Compliance Management,Regulatory Compliance,Runtime Compliance Monitoring |
| hadasch2016Infl | Business Process Compliance,Explanations,Organizational Processes,Process,User-system cooperation |
| hashmi2017norms | Business Processes,Compliance,Compliance Management Frameworks,Modelling Constructs,Modelling Languages,Norms |
| hashmi2018AreWe | Business process compliance,Business processes,Compliance Management Frameworks,Normative requirements,Norms compliance |
| hashmi2018Legal | law and regulations,legal compliance by design,legal compliance through design,legal dimensions,literature review,regulatory compliance |
| holzmuller-laue | BPMN,end-to-end workflow,laboratory automation,model-based application development,systems integration |
| kir2021Knowledg | Agent-based business process management,Agile business process management,Business process management,Knowledge-intensive processes,Process adaptation,Process modeling and execution |
| lohmann2013Comp | Artifact-centric business processes,Compliance by design,Compliance management,Process synthesis |
| loreti2018Distr | Business process management,Distributed compliance monitoring,MapReduce,Stream processing |
| mendling2018Blo | Blockchain,Business Process Management,Research Challenges |
| ramezani2011Sep | compliance checking,compliance management life-cycle, compliance requirements, compliance |

Table 1: Keywords

| Citation Key | Keywords |
|---|---|
| raucci2020BPMPe | Banking Processes,Business Process Management,Formal Methods,Internal Control Systems,Investment Services,Segregation of Duties |
| vanderaa2017Com | Business process management,Business process modeling,Compliance checking,Inconsistency detection,Matching,Natural language processing |
| vanderaalst2018 | Business Process Management,Data Science,Process Mining,Spreadsheets |
| vanderfeesten20 | Business Process Modelling,Product Data Model,Workflow Management |
| viriyasitavat20 | Block-chain technology (BCT),Business process management (BPM),Industry 4.0,Internet of Things (IoT),Quality of Service (QoS),Service selection and composition,Smart contracts,Trustworthiness |
| viriyasitavat20 | Blockchain Technology,Blockchain-as-a-services,Business Process Compliance,Business Process Management,Business Processes,Smart Contracts,Systematic Literature Review |
| zasada2023Evalu | business processes,compliance rules modelling,conceptual modelling,expressiveness,language complexity,regulatory compliance |
| 10.1007/978-3-0 | /unread,BPM function,BPM professionals,BPM skills,BPM taxonomy |
| 10.1007/s10270- | /unread,Business Process Modelling,Conceptual Modelling,Meta-Models |
| 10.1109/NCM.200 | /unread,Business Process Management System,Customization,Open Source |
| 10.1145/1089551 | /unread,business process management,decision making,knowledge management,RTE,system dynamics |
| 10.1145/1141277 | /unread,business process modelling,meta-model |
| 10.1145/2723839 | /unread,BPM,business process management,empirical study,maturity,SME |
| 10.1145/3329007 | /unread,agility,business process management,maturity model,transformation |
| 10.5555/1351542 | /unread |
| 10.5555/1761141 | /unread,business process management,formal methods,workflow management |
| 10.5555/1761141 | /unread |
| 10.5555/2555523 | /unread |
| 4814996 | /unread,Computer integrated manufacturing,Computer science,Costs,Data analysis,Educational institutions,Middleware,Object oriented modeling,Ontologies,Petri nets,Vocabulary |
| 6642899 | /unread,Audit Management,Enterprise Management System,Organizations,Planning,Process control,Process Pyramid,Software,Standards organizations,Strategic and Operational BPM |
| doi:10.1504/IJC | /unread |

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

# Studies

| Paper | Study | Type |
|---|---|---|
| Aa2017 | A quantitative evaluation with 53 real-life model-text pairs demonstrates that our approach accurately identifies inconsistencies between model and text. | |
| Adamo2021 | The goal of this work is to provide the first extensive systematic literature review (SLR) of business process meta-models. | Literature Review |
| Amantea222 | This work describes a methodological approach to investigate Compliance Management in healthcare based on a BPM perspective, exploring an application in an innovative hospital service. | Case Study |
| Bernardojunior2023 | First, a systematic literature review was conducted to investigate how the scientific literature has addressed Agile BPM. | Literature Review |
| Bevilacqua2012 | The production and storage of dangerous substances in an industrial establishment creates risks for man, environment and properties in the surrounding area. In this paper, the information chain is studied as an industrial process modelled by the IDEF0 language. | Case Study |
| Corsius2021 | RegelSpraak is a CNL developed at the Dutch Tax Administration (DTA) over the last decade. | Case Study |
| Elgammal2014 | This paper introduces an integrated business process compliance management framework that incorporates design-time verification and runtime monitoring approaches. | Design Science? |
| Hadasch2016 | 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. | User Interaction |
| Hashmi2017 | 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. | |
| Hashmi2018 | In this paper we present the preliminary results of a literature survey on legal compliance by design (LCbD) and legal compliance through design (LCtD). | Literature Review |
| Holzmüller-Laue2014 | 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). | Case Study |

| Paper | Study | Type |
|---|---|---|
| Kir2021 | 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. | Comparative Analysis? |
| Koncevics2017 | The paper presents results of the comparative analysis of business process modelling tools for supporting automated compliance management in organisations. | Comparative Analysis |
| Lederer2019 | This article collected 17 known agility models relevant for BPM based on a literature review. | Literature Review |
| Limam2021 | the BPMN metamodel lacks formal specification of well-formed rules. In this context, we propose an object constraint language (OCL)-based approach to enhance the expressivity of the BPMN model to hold the information needed and to express resource allocation constraints | Design Science? |
| List2006 | Conceptual Business Process Modelling Languages (BPMLs) express certain aspects of processes. We propose a generic meta-model that captures a wide range of process concepts and evaluate seven BPMLs based on this meta-model | |
| Lohmann2013 | rules can be already taken into account while modeling the business process to result in a business process that is compliant by design. | Design Science? |
| Lohmann2019 | This paper investigates how firms configure their business process management efforts in different industries. We generate a business process management (BPM) skills taxonomy through the computational linguistic analysis of job ads. | |
| Loreti2018 | This work investigates the possibility of spreading the compliance monitoring task over a network of computing nodes, achieving the desired scalability. | |
| Low2007 | In this paper, we propose a symbiotic simulation system. A case study of an aerospace spare parts logistics system was carried out to investigate the viability of the system. | Case Study |
| Lux2013 | The paper describes an enterprise management system which provides an integrated approach to tackle management relevant topics like business process management, quality management, audit management, internal risk and control management, enterprise architecture management, compliance management and so on within a single information system. | |
| Mcdermid2003 | This paper describes a state-based approach to capturing business rules that has been tested with different stakeholders in several business process applications. | |
| Mendling2018 | This paper analyzes the impact of blockchain on business process management (BPM). | |
| Poernomo2008 | This paper addresses the problem of describing and analyzing data manipulation within business process workflow specifications. We apply a model-driven approach. | |

| Paper | Study | Type |
|---|---|---|
| Ramezani2011 | In this paper, the authors advocate to adapt the business process management (BPM) life cycle to manage compliance in a similar way. We propose to use a common business vocabulary based on BPM to specify compliance rules, and to separate the business operation from the process of compliance checking. Rather than inserting controls in the business process directly, we propose a specialized engine for CM that communicates with existing IS. | |
| Raucci2020 | 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. | |
| Sackmann2018 | Based on a systematic literature review, we examined several approaches for Business Process Compliance (BPC) in terms of their suitability for supporting the CM life-cycle phases in support of the digitization of compliance. | Literature Review |
| Singer2015 | This study aims to focus on the examination of business process management (BPM) maturity levels within small-and medium-sized enterprises (SME) and their relationship with the company's economic success. | Mixed Method Approach |
| Tchemeube2013 | This paper presents the development of a location-aware business process management system (LA-BPMS) for monitoring a cardiac care delivery process in a hospital and in real-time. | Case Study |
| Vanderaalst2003 | In this paper, we try to demystify the acronyms in the BPM domain, describe the state-of-the-art technology, and argue that BPM could benefit from formal methods/languages | |
| Vanderaalst2018 | This paper uses spreadsheets as a metaphor to introduce process mining as an essential tool for data scientists and business analysts. | |
| Vanderfeesten2011 | In this paper, we propose a new approach that builds on concepts that are part of a product-oriented view on process optimization. | Method Development |
| Viriyasitavat2020 | 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. | |
| Viriyasitavat2023 | 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). | Literature Review |
| Yang2008 | In this paper the limited customization support of commercial and academic BPMS is reviewed in favor of open source BPMS. | Comparative Analysis |
| Yim2005 | RTE is a new management paradigm on which core processes are executed and managed with the latest information. | |

| Paper | Study | Type |
|---|---|---|
| Zasada2023 | In order to establish a uniform evaluation basis for languages in which compliance requirements are expressed, this article introduces a running example for evaluating the expressiveness and complexity of compliance rule languages. | |

# Concepts

| Paper | Concept |
|---|---|
| Aa2017 | Linguistic Analysis, Information Retrieval Metrics |
| Adamo2021 | Business Process Meta Models |
| Amantea222 | |
| Bernardojunior2023 | Agile BPM |
| Bevilacqua2012 | Internal Emergency Plan (IEP), External Emergency Plan (EEP),Structured Analysis and Design Technique (SADT), Function Modeling Method (IDEF0) |
| Corsius2021 | |
| Elgammal2014 | Compliance Request Language, Design-time Compliance Verification, Runtime Compliance Monitoring, Linear Temporal Logic, Compliance Management |
| Hadasch2016 | Directive Explanations (DEs), Diagrammatic DEs, Textual DEs, Business Process Compliance (BPC) performance |
| Hashmi2017 | |
| Hashmi2018 | Compliance Management Framework (CMF), Compliance Checking Approach, Norms Modeling, Norm Linking, Level of Compliance Management |
| Holzmüller-Laue2014 | BPMN, Laboratory Automation, Laboratory Information Management System (LIMS), Business Process Execution Language (BPEL), Process Control Systems (PCS) |
| Kir2021 | Agile BPM |
| Koncevics2017 | |
| Lederer2019 | Agility Models for BPM |
| Limam2021 | |
| List2006 | |
| Lohmann2013 | |
| Lohmann2019 | |
| Loreti2018 | |
| Low2007 | |
| Lux2013 | |
| Mcdermid2003 | |
| Mendling2018 | |
| Poernomo2008 | |
| Ramezani2011 | Compliance Management, |
| Raucci2020 | |
| Sackmann2018 | |
| Singer2015 | |
| Tchemeube2013 | |
| Vanderaalst2003 | |
| Vanderaalst2018 | |
| Vanderfeesten2011 | |

| Paper | Concept |
|---|---|
| Viriyasitavat2020 | |
| Viriyasitavat2023 | |
| Yang2008 | |
| Yim2005 | |
| Zasada2023 | |

# 1 Aa2017

### Title

Comparing Textual Descriptions to Process Models – The Automatic Detection of Inconsistencies (van der Aa, Leopold, and Reijers (2017))


### Abstract

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.



### Keywords

Business process management, Business process modeling, Compliance checking, Inconsistency detection, Matching, Natural language processing

# 2 Adamo2021

### Title

What Is a Process Model Composed of? A Systematic Literature Review of Meta-Models in BPM (Adamo, Ghidini, and Di Francescomarino (2021))


### Abstract

Business process modelling languages typically enable the representation of business process models by employing (graphical) symbols. These symbols can vary depending upon the verbosity of the language, the modelling paradigm, the focus of the language and so on. To make explicit different constructs and rules employed by a specific language, as well as bridge the gap across different languages, meta-models have been proposed in the literature. These meta-models are a crucial source of knowledge on what state-of-the-art literature considers relevant to describe business processes. The goal of this work is to provide the first extensive systematic literature review (SLR) of business process meta-models. This SLR aims to answer research questions concerning: (1) the kind of meta-models proposed in the literature, (2) the recurring constructs they contain, (3) their purposes and (4) their evaluations. The SRL was performed manually considering papers automatically retrieved from reference paper repositories as well as proceedings of the main conferences in the Business Process Management research area. Sixty-five papers were selected and evaluated against four research questions. The results indicate the existence of a reasonable body of work conducted in this specific area, but not a full maturity. In particular, in answering the research questions several challenges have (re-)emerged for the Business Process Community, concerning: (1) the type of elements that constitute a Business Process and their meaning, (2) the absence of a (or several) reference meta-model(s) for the community, (3) the purpose for which meta-models are introduced in the literature and (4) a framework for the evaluation of the meta-models themselves. Moreover, the classification framework devised to answer the four research questions can provide a reference structure for future descriptive categorizations.



### Keywords

Business Process Modelling, Conceptual Modelling, Meta-Models

# 3 Amantea2022

### Title

Business Process Modelling in Healthcare and Compliance Management: A Logical Framework (Amantea et al. (2022))


### Abstract

This work describes a methodological approach to investigate Compliance Management in healthcare based on a BPM perspective, exploring an application in an innovative hospital service. Firstly, we present a business process analysis by modeling the process with the adoption of a standard language. Secondly, we encode a set of rules in LegalRuleML, an XML formalism designed to be a standard for representing the semantic and logical content of legal documents. The rules represent some provisions of the General Data Protection Regulation (GDPR) that are involved in the health process analyzed. Moreover, in order to perform the regulatory compliance check automatically, we converted the set of rules into Defeasible Deontic Logic format (DDL), readable by the Regorous compliance checker developed at CSIRO. Overall, the paper shows a methodology to automate regulatory compliance checking of a real hospital process with actual regulations and norms. The codes in the LegalRuleML and DDL formats used in the work are available online.



### Keywords

No keywords available

# 4 Awad2010

### Title

A Compliance Management Framework for Business Process Models (Awad (2010))

### Abstract

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.

### Keywords

Business Process Models, Compliance, Temporal Logic, Violation Explanation, Violation Resolution

# 5 BernardoJunior2023

### Title

Toward Agile Business Process Management: Description of Concepts and a Proposed Definition (Bernardo Junior and De Padua (2023))


### Abstract

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.



### Keywords

Agility, bpm governance, Business And Economics–Management, Business process management, challenges, Communication, critical success factors, Customer satisfaction, implementation capabilities, intuition, knowledge systems, Literature reviews, operations strategy, organization, Systematic review

# 6 Bevilacqua2012

### Title

Business Process Reengineering of Emergency Management Procedures: A Case Study (Bevilacqua, Ciarapica, and Paciarotti (2012))


### Abstract

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 IDEF0 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 IDEF0 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.



### Keywords

Emergency management, IDEF0, Information supply, Information system, Public, Risk information, Safety management

# 7 Corsius2021

### Title

RegelSpraak: A CNL for Executable Tax Rules Specification (Corsius et al. (2021))


### Abstract

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.



### Keywords

CNL

# 8 Elgammal2014

### Title

Business Process Compliance Management: An Integrated Proactive Approach (Elgammal et al. (2014))


### Abstract

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.



### Keywords

Compliance Patterns, Design-time Compliance Management, Regulatory Compliance, Runtime Compliance Monitoring

# 9 Hadasch2016

### Title

The Influence of Directive Explanations on Users' Business Process Compliance Performance (Hadasch, Maedche, and Gregor (2016))


### Abstract

Purpose – 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.



### Keywords

Business Process Compliance, Explanations, Organizational Processes, Process, User-system cooperation

# 10 Hashmi2017

### Title

Norms Modeling Constructs of Business Process Compliance Management Frameworks: A Conceptual Evaluation (Hashmi and Governatori (2017))


### Abstract

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.



### Keywords

Business Processes, Compliance, Compliance Management Frameworks, Modelling Constructs, Modelling Languages, Norms

# 11 Hashmi2018

### Title

Legal Compliance Through Design: Preliminary Results of a Literature Survey (Hashmi, Casanovas, and de Koker (2018))


### Abstract

In this paper we present the preliminary results of a literature survey conducted in the context of a larger research project on legal compliance by design (LCbD) and legal compliance through design (LCtD). Even though a rich set of approaches and frameworks are available, our analysis shows that there is less focus on legal compliance in general, and LCbD and LCtD in particular. The technical literature on compliance has been concentrated on specific aspects of the law, i.e. mainly on those related to corporate and administrative management (including those of law firms and government). Other legal dimensions such as public law, case law, constitutional, virtual ethics etc., have been put aside.



### Keywords

law and regulations, legal compliance by design, legal compliance through design, legal dimensions, literature review, regulatory compliance

# 12 Holzmüller-Laue2014

### Title

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

### Abstract

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.

### Keywords

BPMN, end-to-end workflow, laboratory automation, model-based application development, systems integration

# 13 Kir2021

### Title

A Knowledge-Intensive Adaptive Business Process Management Framework (Kir and Erdogan (2021))


### Abstract

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' multi-criteria 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.



### Keywords

Agent-based business process management, Agile business process management, Business process management, Knowledge-intensive processes, Process adaptation, Process modeling and execution

# 14 Koncevics2017

### Title

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


### Abstract

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.



### Keywords

Business process compliance, compliance management, compliance management tools, open source business process modelling tools

# 15 Lederer2019

### Title

Can You See the Wood for the Trees? Collection and Compilation of Agility Models for BPM (Lederer, Popova, and Schmid (2019))


### Abstract

Agility is considered as a key concept to increase flexibility in company environments. Especially in times of digital disruptions, attempts are made to transfer the software engineering methods and rules (e.g., SCRUM) to other processes from other domains without having BPM standards so far. This article collected 17 known agility models relevant for BPM based on a literature review. Twelve essential dimensions to increase agility are described (e.g., communication, technology, process team, change), which might serve with specific values (e.g., frequency, channel and structure) as potential development paths for increasing agility in business processes.



### Keywords

agility, business process management, maturity model, transformation

# 16 Limam2021

### Title

A New Approach for Business Process Management Enhancement: Mobile Hospital Case Study (Limam, Bouderbela, and Akaichi (2021))


### Abstract

Nowadays, business process model and notation (BPMN) is the tool used to support business process management and business users to bridge the communication gap between business process design and implementation. However, the BPMN metamodel lacks formal specification of well-formed rules. In this context, we propose an object constraint language (OCL)-based approach to enhance the expressivity of the BPMN model to hold the information needed and to express resource allocation constraints. Furthermore, we propose an algorithm that verifies if the BPMN model has bad marks in order to verify the correctness of the enhanced model. The whole approach has been tested in the medical field. In particular, it has been used to model, check and improve the care process of a mobile hospital.



### Keywords

# 17 List2006

### Title

An Evaluation of Conceptual Business Process Modelling Languages (List and Korherr (2006))


### Abstract

Conceptual Business Process Modelling Languages (BPMLs) express certain aspects of processes (e.g. activities, roles, interactions, data, etc.) and address different application areas. To evaluate BPMLs, a general framework is required. Although a lot of BPMLs are available in research and industry, an established evaluation framework as well as a comprehensive evaluation of BPMLs is missing. To bridge this gap, we propose a generic meta-model that captures a wide range of process concepts and evaluate seven BPMLs based on this meta-model.



### Keywords

business process modelling, meta-model

# 18 Lohmann2013

### Title

Compliance by Design for Artifact-Centric Business Processes (N. Lohmann (2013))


### Abstract

Compliance to legal regulations, internal policies, or best practices is becoming a more and more important aspect in business processes management. Compliance requirements are usually formulated in a set of rules that can be checked during or after the execution of the business process, called compliance by detection. If noncompliant behavior is detected, the business process needs to be redesigned. Alternatively, the rules can be already taken into account while modeling the business process to result in a business process that is compliant by design. This technique has the advantage that a subsequent verification of compliance is not required.



### Keywords

Artifact-centric business processes, Compliance by design, Compliance management, Process synthesis

# 19 Lohmann2019

### Title

Regulatory Instability, Business Process Management Technology, and BPM Skill Configurations (P. Lohmann and zur Muehlen (2019))


### Abstract

This paper investigates how firms configure their business process management efforts in different industries. We generate a business process management (BPM) skills taxonomy through the computational linguistic analysis of job ads from . We apply the taxonomy to resumes of professionals employed at retailer Walmart, pharmaceutical company Pfizer, and investment bank Goldman Sachs. We find that Walmart and Pfizer distribute change- and operations-related BPM skills among the same roles whereas Goldman Sachs distributes both kinds of skills among more separate roles. This separation reflects a trilateral configuration where line managers and analysts focus on operational BPM tasks related to running processes while change-related tasks are covered by project managers. At Walmart and Pfizer the tasks of the BPM project manager are shared among managers and analysts, reflecting a bilateral configuration. Comparing each firm's regulatory environments and BPM technology capabilities, we conjecture that the organizational configuration pattern is influenced by a firm's ability to reliably automate business processes, since this affects how much attention line managers and analysts have to spend on monitoring processes and on reconciling issues and exceptions. This attention could otherwise be spent on regulatory-imposed process change efforts. This configural logic suggests a reconfiguration of BPM professionals towards a bilateral configuration when an organization transforms its business with digital technology, because the focus of such efforts includes process and decision automation.



### Keywords

BPM function, BPM professionals, BPM skills, BPM taxonomy

# 20 Loreti2018

### Title

A Distributed Approach to Compliance Monitoring of Business Process Event Streams (Loreti et al. (2018))


### Abstract

In recent years, the significant advantages brought to business processes by process mining account for its evolution as a major concern in both industrial and academic research. In particular, increasing attention has been turned to compliance monitoring as a way to identify when a sequence of events deviates from the expected behaviour. As we are entering the IoT era, an increasing variety of smart objects can be introduced in business processes (e.g., tags to track products in a plant, smartphones and badge swiping to draw the activities of customers and employees in a shopping centre, etc.). All these objects produce large volumes of log data in the form of streams, which need to be run-time analysed to extract further knowledge about the underlying business process and to identify unexpected, non-conforming events. Albeit rather straightforward on a small log file, compliance verification techniques may show poor performances when dealing with big data and streams, thus calling for scalable approaches. This work investigates the possibility of spreading the compliance monitoring task over a network of computing nodes, achieving the desired scalability. The monitor is realised through the existing SCIFF framework for compliance checking, which provides a high level logic-based language for expressing the properties to be monitored and nicely supports the partitioning of the monitoring task. The distributed computation is achieved through a MapReduce approach and the adoption of an existing general engine for large scale stream processing. Experimental results show the feasibility of the approach as well as the advantages in performance brought to the compliance monitoring task.



### Keywords

Business process management, Distributed compliance monitoring, MapReduce, Stream processing

# 21 Low2007

### Title

Symbiotic Simulation for Business Process Re-Engineering in High-Tech Manufacturing and Service Networks (Low et al. (2007))

### Abstract

In today's highly competitive business environment, the speed of a company's response to changes by adapting its own business processes is vital to its survival. In this paper, we propose a symbiotic simulation system that can monitor the real-world operations of high-tech manufacturing and service networks, carry out what-if analysis and optimization on service-oriented based business workflow, and dynamically deploy the optimized business workflow onto the real-world operations. A case study of an aerospace spare parts logistics system was carried out to investigate the viability of the system.

### Keywords

# 22 Lux2013

### Title

Business Process Management as Basis for Enterprise Management Systems (Lux, Hess, and Herterich (2013))

### Abstract

The paper describes an enterprise management system which provides an integrated approach to tackle management relevant topics like business process management, quality management, audit management, internal risk and control management, enterprise architecture management, compliance management and so on within a single information system. The term "enterprise management system (EMS)" is introduced for such a kind of management system. A business process pyramid is defined to link the strategic with the operational level of processes and all attached management-relevant information, e.g. audits, risks, etc. The approach was successfully implemented in the enterprise management system DHC VISION, which is used today worldwide by medium- and large-sized enterprises.

### Keywords

Audit Management, Enterprise Management System, Organizations, Planning, Process control, Process Pyramid, Software, Standards organizations, Strategic and Operational BPM

# 23 McDermid2003

### Title

Integrated Business Process Management: Using State-Based Business Rules to Communicate between Disparate Stakeholders (McDermid (2003))


### Abstract

We need to put more emphasis on managing the communication between different types of stakeholders and in particular we need to use diagrammatic constructs that support that communication process. This paper describes a state-based approach to capturing business rules that has been tested with different stakeholders in several business process applications. The examples provided in this paper show the benefits of using this notation as a means of communicating between three different groups of stakeholders.



### Keywords

# 24 Mendling2018

### Title

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


### Abstract

Blockchain technology promises a sizable potential for executing inter-organizational business processes without requiring a central party serving as a single point of trust (and failure). This paper analyzes its impact on business process management (BPM). We structure the discussion using two BPM frameworks, namely the six BPM core capabilities and the BPM lifecycle. This paper provides research directions for investigating the application of blockchain technology to BPM.



### Keywords

Blockchain, Business Process Management, Research Challenges

# 25 Poernomo2008

### Title

Normative Ontologies for Data-Centric Business Process Management (Poernomo and Umarov (2008))

### Abstract

This paper addresses the problem of describing and analyzing data manipulation within business process workflow specifications. We apply a model-driven approach. We begin with business requirement specifications, consisting of an ontology and an associated set of normative rules, that define the ways in which business processes can interact. We then transform this specification into a Petri Net workflow model and, separately, an Event B specification. The former models can be submitted to further behavioural analysis to ensure, for instance, satisfaction of liveness and safety properties. The latter specifications are important as we can use theorem proving techniques to check and refine data representation with respect to process evolution. An important property of the transformation is semantic equivalence between the Petri net model and Event-B model.

### Keywords

Computer integrated manufacturing, Computer science, Costs, Data analysis, Educational institutions, Middleware, Object oriented modeling, Ontologies, Petri nets, Vocabulary

# 26 Ramezani2011

### Title

Separating Compliance Management and Business Process Management (Ramezani et al. (2011))


### Abstract

The ever growing set of regulations and laws organizations have to comply to, introduces many new challenges. Current approaches that check for compliance by implementing controls in an existing information system (IS) decrease the maintainability of both the set of compliance rules and the IS. In this position paper, we advocate the separation of the compliance process from the organization's business processes. We introduce a life cycle for the management of compliance rules. A separate compliance engine is used to define and check compliance rules independent from the existing IS within an organization.



### Keywords

compliance checking, compliance management life-cycle, compliance requirements, compliance

# 27 Raucci2020

### Title

BPM Perspectives to Support ICSs: Exploiting the Integration of Formal Verifications into Investment Service Provision Processes (Raucci et al. (2020))


### Abstract

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.



### Keywords

Banking Processes, Business Process Management, Formal Methods, Internal Control Systems, Investment Services, Segregation of Duties

# 28 Sackmann2018

### Title

Using Business Process Compliance Approaches for Compliance Management with Regard to Digitization: Evidence from a Systematic Literature Review (Sackmann, Kühnel, and Seyffarth (2018))

### Abstract

Business Process Compliance (BPC) means ensuring that business processes are in accordance with relevant compliance requirements. Thus, BPC is an essential part of both business process management (BPM) and compliance management (CM). Digitization has also been referred to as a "digital revolution" that describes a technological change that has extended to many organi- zational areas and tasks, including compliance. Current efforts to digitize, e.g., by realizing cyber-physical systems, rely on the automation and interoperability of systems. In order for CM not to hamper these efforts, it becomes an increasingly relevant issue to digitize compliance as well. The managerial perspective of compliance comprises several phases, which together represent a CM life-cycle. Efforts to digitize compliance require bundling interoperable BPC technologies, methods, and tools supporting this life-cycle in a consolidated manner. Several approaches addressing the field of BPC have already been developed and explored. Based on a systematic literature review, we examined these approaches in terms of their suitability for supporting the CM life-cycle phases in support of the digitization of compliance. The results of our literature review show which CM life-cycle phases are supported by BPC approaches and which phases are the focus of research. Moreover, the results show that a purely sequential clustering, as specified in a CM life-cycle, is not always suitable for the bundling of BPC approaches in support of the digitization of compliance. Consequently, we propose a novel, task-oriented clustering of BPC approaches that is particularly oriented toward interoperability.

### Keywords

Business process compliance, Compliance management life-cycle, Digitization

# 29 Singer2015

### Title

Business Process Management in Small- and Medium-Sized Enterprises: An Empirical Study (Singer (2015))


### Abstract

This study aims to focus on the examination of business process management (BPM) maturity levels within small-and medium-sized enterprises (SME) and their relationship with the company's economic success. A further aim is to evaluate the understanding of the term BPM in the field. The findings result from a mixed-method approach combining qualitative and quantitative empirical methods. The qualitative study collected data carrying out 20 interviews in 11 enterprises. On the basis of these findings, a web-questionnaire for the quantitative study was developed. In order to evaluate the maturity levels, an adapted version of Hammers Process and Enterprise Maturity Model (PEMM) had to be developed. Data collected within quantitative research suggests higher maturity levels in comparison with data collected within qualitative research. A weak statistical connection between maturity level and economic success can be found. However, the data suggest that there is a lack in common understanding of the term business process management in praxis. Due to the reactivity of qualitative interviews a different sample may provide other findings. Whilst accessibility is a considerable advantage of web-surveys, a disadvantage of web-surveys is the lack of regulation of the sample. Hence, the findings of this study are not statistically representative for all SMEs.



### Keywords

BPM, business process management, empirical study, maturity, SME

# 30 Tchemeube2013

### Title

Location-Aware Business Process Management for Real-Time Monitoring of a Cardiac Care Process (Tchemeube, Amyot, and Mouttham (2013))


### Abstract

Long wait times are a global issue in the Canadian healthcare system. Patient flow management relies on flow managers to manually detect, investigate and mitigate wait time issues. However, existing data that could support this activity is usually not accurate (because of possible human errors), incomplete, late, and scattered across various information systems in a typical hospital. Yet, in the case of cardiac patients, ensuring a prompt, smooth and continuous care delivery becomes extremely important and motivates improvement of data support for patient flow management activities. This paper presents the development of a location-aware business process management system (LA-BPMS) for monitoring a cardiac care delivery process in a hospital and in real-time. The system provides a better visibility of process execution to patient flow managers who can rely on accurate and real-time information about patient process states, as well as wait time measurements to control patient flow efficiently. We show how an intelligent approach of combining location awareness and business process automation allow this to be possible. A real cardiac care process from an Ontario hospital is used as an example.



### Keywords

# 31 VanDerAalst2003

### Title

Business Process Management: A Survey (W. M. P. Van Der Aalst, Hofstede, and Weske (2003))


### Abstract

Business Process Management (BPM) includes methods, techniques, and tools to support the design, enactment, management, and analysis of operational business processes. It can be considered as an extension of classical Workflow Management (WFM) systems and approaches. Although the practical relevance of BPM is undisputed, a clear definition of BPM and related acronyms such as BAM, BPA, and STP are missing. Moreover, a clear scientific foundation is missing. In this paper, we try to demystify the acronyms in this domain, describe the state-of-the-art technology, and argue that BPM could benefit from formal methods/languages (cf. Petri nets, process algebras, etc.).



### Keywords

business process management, formal methods, workflow management

# 32 VanDerAalst2018

### Title

Spreadsheets for Business Process Management: Using Process Mining to Deal with “Events” Rather than “Numbers”? (W. Van Der Aalst (2018))


### Abstract

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.



### Keywords

Business Process Management, Data Science, Process Mining, Spreadsheets

# 33 Vanderfeesten2011

### Title

Product-Based Workflow Support (Vanderfeesten, Reijers, and Van Der Aalst (2011))


### Abstract

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.



### Keywords

Business Process Modelling, Product Data Model, Workflow Management

# 34 Viriyasitavat2020

### Title

Blockchain-Based Business Process Management (BPM) Framework for Service Composition in Industry 4.0 (Viriyasitavat (2020))


### Abstract

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.



### Keywords

Block-chain technology (BCT), Business process management (BPM), Industry 4.0, Internet of Things (IoT), Quality of Service (QoS), Service selection and composition, Smart contracts, Trustworthiness

# 35 Viriyasitavat2023

### Title

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


### Abstract

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-aService (BCaaS) is adopted in business process architecture, and the trends of BCT developments are identified accordingly.



### Keywords

Blockchain Technology, Blockchain-as-a-services, Business Process Compliance, Business Process Management, Business Processes, Smart Contracts, Systematic Literature Review

# 36 Yang2008

### Title

API and Component Based Customization of an Open Source Business Process Management System: uEngine (Yang, Choi, and Jang (2008))


### Abstract

There is no doubt that Business Process Management (BPM) has added tremendous value to organizations in virtually every industry. By utilizing Business Process Management Systems (BPMS), organizations can streamline and automate tasks, reduce turnaround time, and help ensure regulatory compliance. The foremost considerations when enterprises deploy BPM solutions involve supportive system functions, friendly Graphical User Interfaces (GUI) and maximal Return on Investment (ROI), based on the specific processes required, organizational management, and working style of their particular business environment. In order to address the problems associated with BPMS customization, for the flexible coverage of various requirements, this paper takes a three step approach. First, limited customization support of commercial and academic BPMS is reviewed in favor of open source BPMS. Then, advantageous features of uEngine, an open source BPMS which supports flexible customization, are introduced. Finally, API-based and component-based customization in building a BPM application utilizing uEngine is introduced with illustrative examples.



### Keywords

Business Process Management System, Customization, Open Source

# 37 Yim2005

### Title

Strategic Decision Making Support Model on RTE Approach from the BPM (Yim and Choi (2005))


### Abstract

RTE is a new management paradigm on which core processes are executed and managed with the latest information. This concept is a needful concept to continuously strengthen corporate competitiveness in an era of unbridled competition with the collapse of traditional value chain and accelerated flow of information. Paradigm of AI (Artificial Intelligence), which is based on the assumption that existing business processing types or expertise in a predefined and limited management environment can help to make a right decision in the new future environment, and expert system should overcome rule based and model based limitations. In RTE, rather than existing business types or expertise, it is important to monitor the event or information at the present point of time that can provide support in the current situation.In this research, a model that integrates KM (Knowledge Management), BI (Business Intelligence) with business process is presented, which are essential for decision making in a real-time based corporate environment. Furthermore, in a dynamic management environment of real world, a decision making support model that can overcome three limitations that are posed by AI, Expert system paradigm shall be presented in this research.



### Keywords

business process management, decision making, knowledge management, RTE, system dynamics

# 38 Zasada2023

### Title

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

### Abstract

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.

### Keywords

business processes, compliance rules modelling, conceptual modelling, expressiveness, language complexity, regulatory compliance

Aa, Han van der, 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.

Adamo, Greta, Chiara Ghidini, and Chiara Di Francescomarino. 2021. "What Is a Process Model Composed of? A Systematic Literature Review of Meta-Models in BPM." *Softw. Syst. Model.* 20 (4): 1215–43. https://doi.org/10.1007/s10270-020-00847-w.

Amantea, Ilaria Angela, Livio Robaldo, Emilio Sulis, Guido Governatori, and Guido Boella. 2022. "Business Process Modelling in Healthcare and Compliance Management: A Logical Framework." *FLAP* 9 (4): 1131–54. https://collegepublications.co.uk/ifcolog/?00056.

Awad, Ahmed Mahmoud Hany Aly. 2010. "A Compliance Management Framework for Business Process Models." PhD thesis, University of Potsdam. http://opus.kobv.de/ubp/volltexte/2010/4922/.

Bernardo Junior, Ronaldo, and Silvia Ines Dallavalle De Padua. 2023. "Toward Agile Business Process Management: Description of Concepts and a Proposed Definition." *Knowl Process Manag* 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.

Corsius, Mischa, Stijn Hoppenbrouwers, Mariette Lokin, Elian Baars, Gertrude Sangers-Van Cappellen, and Ilona Wilmont. 2021. "RegelSpraak: A CNL for Executable Tax Rules Specification." In *Proceedings of the Seventh International Workshop on Controlled Natural Language (CNL 2020/21)*.

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, 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, Pompeu Casanovas, and Louis de Koker. 2018. "Legal Compliance Through Design: Preliminary Results of a Literature Survey." In *Technologies for Regulatory Compliance*. Groningen. CEUR-WS.org/Vol-2309/06.pdf.

Hashmi, Mustafa, and Guido Governatori. 2017. "Norms Modeling Constructs of Business Process Compliance Management Frameworks: A Conceptual Evaluation." *Artificial Intelligence and Law* 26 (September): 251–305. https://doi.org/10.1007/s10506-017-9215-8.

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.

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." *Appl. Comput. Syst.* 21 (1): 22–27. https://doi.org/10.1515/ACSS-2017-0003.

Lederer, Matthias, Oleksandra Popova, and Patrick Schmid. 2019. "Can You See the Wood for

the Trees? Collection and Compilation of Agility Models for BPM." In *Proceedings of the 11th International Conference on Subject-Oriented Business Process Management*. S-Bpm One '19. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/3329007.3329016.

Limam, Hela, Amal Bouderbela, and Jalel Akaichi. 2021. "A New Approach for Business Process Management Enhancement: Mobile Hospital Case Study." *International Journal of Computational Intelligence Studies* 10 (4): 272–85. https://doi.org/10.1504/IJCISTUDIES.2021.120514.

List, Beate, and Birgit Korherr. 2006. "An Evaluation of Conceptual Business Process Modelling Languages." In *Proceedings of the 2006 ACM Symposium on Applied Computing*, 1532–39. Sac '06. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/1141277.1141633.

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.

Lohmann, Patrick, and Michael zur Muehlen. 2019. "Regulatory Instability, Business Process Management Technology, and BPM Skill Configurations." In *Business Process Management: 17th International Conference, BPM 2019, Vienna, Austria, September 1–6, 2019, Proceedings*, 419–35. Berlin, Heidelberg: Springer-Verlag. https://doi.org/10.1007/978-3-030-26619-6_27.

Loreti, Daniela, Federico Chesani, Anna Ciampolini, and Paola Mello. 2018. "A Distributed Approach to Compliance Monitoring of Business Process Event Streams." *Future Generation Computer Systems* 82 (May): 104–18. https://doi.org/10.1016/j.future.2017.12.043.

Low, Malcolm Y. H., Stephen J. Turner, Ding Ling, Hai L. Peng, Lai P. Chan, Peter Lendermann, and Steve Buckley. 2007. "Symbiotic Simulation for Business Process Re-Engineering in High-Tech Manufacturing and Service Networks." In *Proceedings of the 39th Conference on Winter Simulation: 40 Years! The Best Is yet to Come*, 568–76. Wsc '07. Washington D.C.: IEEE Press.

Lux, Andreas, Jörg Hess, and Rudi Herterich. 2013. "Business Process Management as Basis for Enterprise Management Systems." In *2013 IEEE 15th Conference on Business Informatics*, 350–55. https://doi.org/10.1109/CBI.2013.57.

McDermid, Donald C. 2003. "Integrated Business Process Management: Using State-Based Business Rules to Communicate Between Disparate Stakeholders." In *Proceedings of the 2003 International Conference on Business Process Management*, 58–71. BPM'03. Berlin, Heidelberg: Springer-Verlag.

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.

Poernomo, Iman, and Timur Umarov. 2008. "Normative Ontologies for Data-Centric Business Process Management." In *2008 12th Enterprise Distributed Object Computing Conference Workshops*, 23–34. https://doi.org/10.1109/EDOCW.2008.47.

Ramezani, Elham, Dirk Fahland, Jan Martijn van der Werf, and Peter Mattheis. 2011. "Separating Compliance Management and Business Process Management." In *International Conference on Business Process Management*, 459–64. Springer.

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.

Sackmann, Stefan, Stephan Kühnel, and Tobias Seyffarth. 2018. "Using Business Process Compliance Approaches for Compliance Management with Regard to Digitization: Evidence from a Systematic Literature Review." In *Business Process Management - 16th International Conference, BPM 2018, Sydney, NSW, Australia, September 9-14, 2018, Proceedings*, edited by Mathias Weske, Marco Montali, Ingo Weber, and Jan vom Brocke, 11080:409–25. Lecture Notes in Computer Science. Springer. https://doi.org/10.1007/978-3-319-98648-7/_24.

Singer, Robert. 2015. "Business Process Management in Small- and Medium-Sized Enterprises: An Empirical Study." In *Proceedings of the 7th International Conference on Subject-Oriented Business Process Management*. S-Bpm One '15. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/2723839.2723849.

Tchemeube, Renaud Bougueng, Daniel Amyot, and Alain Mouttham. 2013. "Location-Aware Business Process Management for Real-Time Monitoring of a Cardiac Care Process." In *Proceedings of the 2013 Conference of the Center for Advanced Studies on Collaborative Research*, 230–44. Cascon '13. USA: IBM Corp.

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

Van Der Aalst, Wil M. P., Arthur H. M. Ter Hofstede, and Mathias Weske. 2003. "Business Process Management: A Survey." In *Proceedings of the 2003 International Conference on Business Process Management*, 1–12. BPM'03. Berlin, Heidelberg: Springer-Verlag.

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. 2020. "Blockchain-Based Business Process Management (BPM) Framework for Service Composition in Industry 4.0." *Journal of Intelligent Manufacturing*.

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

Yang, Le, Yongsun Choi, and Jinyoung Jang. 2008. "API and Component Based Customization of an Open Source Business Process Management System: uEngine." In *Proceedings of the 2008 Fourth International Conference on Networked Computing and Advanced Information Management - Volume 02*, 226–31. Ncm '08. USA: IEEE Computer Society. https://doi.org/10.1109/NCM.2008.149.

Yim, Nam-Hong, and Sung-Kyu Choi. 2005. "Strategic Decision Making Support Model on RTE Approach from the BPM." In *Proceedings of the 7th International Conference on Electronic Commerce*, 400–407. Icec '05. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/1089551.1089625.

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.