PhD Proposal: Conformance Checking with Regulations for Sustainability

Finn Klessascheck[1,2]

[1]Technical University of Berlin, Einsteinufer 17, 10587 Berlin, Germany
[2]Technical University of Munich, Bildungscampus 2, 74076 Heilbronn, Germany

Abstract
Checking the conformance of business processes with respect to regulations, laws, standards, and guidelines that impose constraints upon them is an important factor for organizational success. Given the increasing importance of organizational sustainability in the face of recent developments, asserting the adherence to sustainability regulations is equally increasing in importance. However, no practical approaches have yet been proposed and evaluated that identify which process dimensions play a role in sustainability regulations and allow business users to actionably visualize and diagnose deviations. This proposal aims to outline the challenges an approach needs to tackle in order to fill this gap.

Keywords
PhD Proposal, Sustainability, Conformance Checking, Regulations

1. Introduction

Business processes are usually subject to rules and regulations: they are not enacted in a void, but in the real world, where certain (potentially overlapping or contradicting) rules, constraints, regulations, standards, and guidelines apply. A procurement process, e.g., might be governed by general auditing rules and additional internal guidelines [1], and a clinical treatment process for a specific disease governed by recommended treatment guidelines and regulations specific to a hospital [2]. Given the increasing concern that climate issues have met in both business and legislation, it can only be expected that the number of sustainability-related aspects of processes in general, and environmental aspects in particular, that are being governed by regulations will increase. The compliance with these regulations needs to be assessed to guarantee organizational success: do processes follow the environmental regulations, where do deviations occur, and how could the process be improved to more closely follow the requirements?

The discipline of process mining, a field related to data mining, is based on recorded business process executions and has been shown to provide adequate tools for an evidence-based assessment of process conformance, i.e., the relation between designed and observed behaviour [3]. Various approaches exist that aim at measuring discrepancies between the two. Usually, the intended behaviour is explicitly provided as a process model, or restricted by a set of

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klessascheck@tu-berlin.de (F. Klessascheck)
0000-0001-6961-1828 (F. Klessascheck)

constraints, while the actual behaviour is either also explicitly modelled, or, with the help of process discovery, extracted from event data that an information system recorded during process execution.

However, it is not yet fully clear what process dimensions are potentially impacted by sustainability regulations. The formalization of regulatory requirements towards business process sustainability is also not yet clear, as well as the realization of communication and visualization to ensure compliance with relevant regulations.

2. Existing Research

Compliance Checking and Conformance Checking with Regulations. Conformance checking, with the aim of comparing actual execution with normative or descriptive references, requires process execution information in the form of an event log, and a process description. The process description, serving as a reference to the expected behaviour, can be represented in various more or less formal languages, either graphically or as other rule-based constraints. Further, these reference models can either be imperative (i.e., they only explicitly allow certain behaviour) or declarative (i.e., they prohibit a range of behaviour, and everything else is allowed) [4]. Conformance checking thereby constitutes an evidenced-based technique for compliance checking. Compliance checking aims at checking whether business processes comply with certain regulations [4]. In relevant literature, conformance checking with regulation has found application across various processes, regulations and domains, with different underlying approaches and techniques. Process domains include, among others, healthcare [5] and banking [1], while regulations are e.g. the *General Data Protection Regulation (GDPR)* [6] or clinical guidelines regarding hip surgery [5]. These regulations are translated, largely manually, to declarative or imperative reference models (see e.g. [1, 5]). Notably, no regulation applied in the literature explicitly touches on sustainability as of now, nor do the involved process dimensions explicitly relate to sustainability.

Sustainability. The notion of *sustainability* has been gaining attention over the last few years: both in general and in the area of business process management in particular, the need for integrating *economic*, *social*, and *ecological* perspectives to "[meet] the needs of the present without compromising the ability of future generations to meet their own needs" [7] has received increasing consideration. Across multiple disciplines, sustainability has come to be understood to comprise three facets needing to be considered in conjunction, although a formal definition that is shared across disciplines is still missing, and thus, its understanding depends on the context [8]. Nonetheless, it is increasingly clear that sustainability concerns, especially environmental ones, need to be addressed in many areas, including in businesses and their processes. In the context of BPM research, means to integrate sustainability have been identified as a potential area of investigation [9]. Fritsch et al. observe that until now, most research effort has focussed on modelling approaches to express environmental aspects in a process model, and little has been done in terms of optimization and management [10]. Further, my Master's thesis [11] proposes a framework for sustainability-oriented business process improvement by combining *Life Cycle Assessment (LCA)* and business process simulation. This might provide a

foundation for further data-driven approaches.

Sustainability Regulations. In the area of conformance checking, some approaches have been proposed to address sustainability-related aspects (see e.g., [12, 13]). There, no concrete regulatory aspects are considered, instead, the main aim is to identify potential for reducing the overall environmental impact of processes by investigating the process for unsustainable patterns. While this is arguably an important contribution in itself, just reducing (in whatever way it is being assessed) the environmental impact of a process does not automatically guarantee compliance with sustainability regulations. Relevant regulation might, for example, include the *EU directive on disclosure of non-financial and diversity information* [14] or the German *Lieferkettensorgfaltspflichtengesetz (Supply Chain Act)* [15]. Further, given current environmental developments, it is conceivable that other aspects of businesses and their processes will be subject to sustainability-addressing regulations, e.g. the emissions caused per process instance, or the overall environmental impact. Notably, as of now, no current research work assesses the conformance of a concrete business process to a specific sustainability regulation.

3. Challenges to be addressed

The current state of research being considered above summarily underlines the following research gaps in relation to conformance checking with sustainability-related regulations:

Formalization of Sustainability-related Regulations. Firstly, sustainability-related regulations need to be formalized in a manner that they can be utilized for conformance checking of business processes across a wide spectrum of process domains. Currently, the creation of the required reference models is a manual, domain-specific procedure and has not been systematically investigated with a focus on sustainability regulations. An approach for this is still missing.

Generalized Conformance Checking Approach. Secondly, a generalized approach of conformance checking of sustainability regulations has not yet been established. It would need to consider all process dimensions that are relevant for sustainability regulations (i.e., among others, resources, time, and control flow aspects). Further, a mechanism with which the results of conformance checking can be visualized meaningfully need to be found, so that business users (i.e., stakeholders having an interest in investigating and improving process conformance) can take appropriate measures. These aspects arguably have not been considered sufficiently in research, which instead is limited to generic or numeric measures or highlighting individual deviations, which does not aid in ensuring overall compliance with sustainability regulations.

4. Proposed Approach

In the following, a generalizable approach as envisioned by this proposal is outlined, and displayed in Fig. 1. Methods and tasks to achieve this contribution are also discussed. The approach has three main goals:

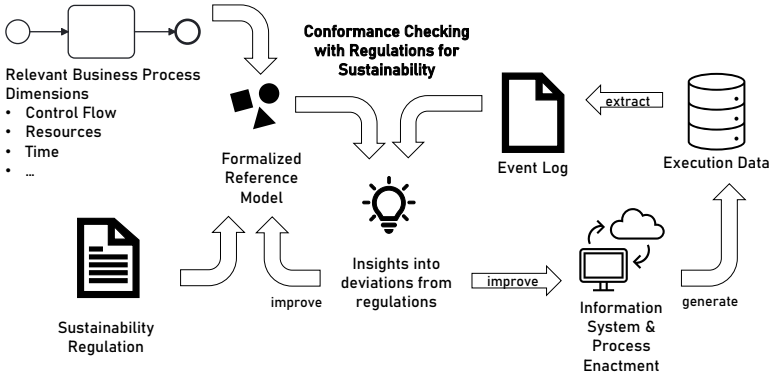

Figure 1: A schematic illustration of the approach outlined in this proposal. Apart from the event log extraction, all steps explicitly need to be addressed.

1. Identification and Formalization of Sustainability-related Regulatory Aspects. Conformance checking requires a formalized reference model that captures and formalizes regulatory aspects, with which the process conformance is checked. This translation of regulations into a model, which is usually done manually, has not yet been systematized to include aspects of relevant sustainability regulations. Thus, these aspects need to be identified, and a technique needs to be designed to formalize them as sustainability-related reference models, with relation to processes under consideration. Moreover, potential contradictions between regulations might need to be addressed and resolved systematically in the formalized reference model. This could be done based, e.g., on the priority of the conflicting regulations, and a weighting of the consequences of non-compliance, and warrants further investigation. To appropriately scope this goal, the investigated regulations could be limited by considering, e.g., only those explicitly concerned with environmental sustainability, or only those applicable to certain businesses in processes in certain regions.

2. Extension of Existing Approaches. Existing approaches that check the conformance of processes with respect to certain regulations usually consider a set of process dimensions derived from the relevant regulation, such as control flow, temporal, resource. and data aspects, which are commonly utilized in the area of conformance checking [16]. Sustainability regulations might either require considering how they can be assessed by the aforementioned dimensions, or might require checking of process dimensions that are not yet covered in general. For this, existing approaches might need to be leveraged and extended. Further, the resulting approach should be able to use a set of relevant sustainability regulations and check for their compliance on multiple processes across domains. One objective thus is extending existing approaches for conformance checking of regulations accordingly. Also of importance here is the consideration of requirements posed on the execution data by the approach and the dimensions considered to be relevant, i.e., what information needs to be present in the event log to allow for conformance checking of the relevant regulations. Consequently, some regulations might be more difficult to operationalize, e.g. those pertaining to social sustainability. It might be a potential solution to enrich the event log with additional contextual data.

3. Visualization of Results. Finally, the results of conformance checking sustainability regulations, i.e., insights into deviations from thse regulations, need to be communicated visually to business users in a way that is meaningful and actionable. Notably, the impact of sustainability violations might be misinterpreted when being expressed (as existing approaches commonly do) by using fitness measures or highlighting individual deviations. Thus, one objective is the identification of business needs for visualization, and of developing techniques that adequately illustrate deviations from sustainability regulations, and express their impact accordingly. As shown in [17], visual analytics could provide a benefit when addressing this objective. Further, practical user studies might be useful, to assess the real-life implications of visualization techniques of sustainability deviations.

Methods and Tasks. In order to develop an approach that addresses the challenges outlined above, this work proposes the application of several methods. First, sustainability regulations will be identified through a systematic literature review, and a taxonomy to characterize and classify these regulations and the process dimensions they pertain to will be created. This particular taxonomy allows a structured analysis of the regulations and their relations [18]. Second, a design science research (DSR) approach will be applied, in order to iteratively develop mechanisms for formalizing sustainability regulations, checking their conformance on business processes, and visualizing the results appropriately. DSR is a methodology that aims at solving problems in the area of information systems research by creating and evaluating artefacts in a specific context, and thus creating knowledge and understanding of these problems [19]. Here, this includes providing new methods for formalizing sustainability regulations and adapting conformance checking algorithms. And third, this contribution will be evaluated in practical settings, e.g., through a case study, with partners in industry and academia.

5. Conclusion

By considering the need for checking the conformance of business processes to sustainability regulations, this proposal has illustrated a gap in the current scientific support to formally assess and check sustainability regulations. Consequently, the challenges that need to be addressed, and the methods for closing this gap, have been outlined. The number and complexity of relevant regulations might make finding a general approach difficult. However, limiting the considered regulations to a specific dimension of sustainability, or considering only a limited set of processes for which relevant regulations are investigated, can address this problem. Finally, this work has motivated further research into the conformance checking of sustainability regulations, and lays a foundation for future studies in this area.

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