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Process Mining as a Strategy of Inquiry: Understanding Design Interventions and the Development of Business Processes

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Abstract. Process (re-)design and improvement are important aspects of the Business Process Management (BPM) life-cycle. Yet, there is little empirical evidence on how design interventions materialize in actual process execution, leading to repeated failure of such initiatives. In this dissertation I use the emerging affordances of process mining algorithms to address this important limitation. In particular, I devise a method that combines process mining and grounded theory to study processual phenomena. Consequently, this method is applied to investigate change in business processes. This thesis contributes to the body of knowledge in BPM and bordering disciplines by demonstrating how process mining can be used as a method to study processual phenomena. Further this research sheds light on the impact of design interventions on actual process execution and vica versa.

Keywords: Process Mining · Methods · Computational-intensive Theory Development · Stability and Change · Process Design · Business Process Management.

1 Motivation and Related Work

Business processes and organizational routines can both be described as "structured set of action". While both phenomena deal with how work is being executed in organizations, there is little empirical evidence on how their design and redesign influences actual execution and vice versa. Thus, when processes and routines are (re-)designed, companies stick to guidelines that are based on experience, at best.

As a consequence, this limited understanding of how design interventions materialize in process execution has led to repeated failure of such initiatives [18] and the questioning of the role of artifacts in achieving process change [16].

In my dissertation I want to address this limitation by investigating the research question: *How does change in business processes take place?*

I aim to answer this research question using a combination of traditional grounded theory methodology and traditional computational theory development [3]. On the one hand, I will use process mining algorithms [1, 2] to identify

process variants [11] and evolutionary drifts in business processes [14]. On the other hand, I will employ grounded theory methodology [19, 21] to complement the computational theory development process and make sense of the data by considering context information derived in interviews. With this work I expect to identify motors of change in business processes [22] that will be used to explain how process change takes place.

The remainder of this Ph.D. research proposal is structured as follows. In the next section, I present an initial draft of the method I want to employ for analyzing business processes, i.e. a combination of automated and manual theory development [3]. In particular, I elaborate on the different types of data I plan to use and how I intend to interpret them. Additionally, I show how process mining algorithms can be used to detect change in business processes. Finally, I provide a brief summary and outline the expected contribution of this work.

2 Process Mining as a Strategy of Inquiry for Processual Phenomena

In this dissertation I suggest the complementary use of traditional grounded theory methodology [7, 20] and computational theory development [8]. In a recent article, Berente and associates [3] outlined the advantages of such computationally-intensive theory development approaches that make use of the opportunities that the ubiquity of digital trace-data provides.

2.1 Data and Sense-making

For this research, three types of data will be used: Trace-data in form of log-files, qualitative interview data, and data on process documentation, i.e. process models, process guidelines and other documentation materials. Table 1 gives and overview over the different types of data employed, how they will be analyzed, and what kind of information each of them provides for theory generation.

human activity

Type of Data	Trace Data (event-logs)	Process Documentation	Interviews
Type of analysis/ interpretation	Process Mining	Grounded Theory Method/	Grounded Theory Method
Type of Information/ Level of Analysis	Descriptive/ Ontological perspective – i.e. what is?	Teleological and normative perspective – i.e. what is the goal and how should it be?	Why is it as it is?

computation

Fig. 1. Overview of Data and Analysis Techniques

First, trace-data will be analyzed using process mining techniques. Employing variant analysis [11] and drift detection [14] allows to compare different process variants and understand how a process evolves over time. At this stage, the main goal is to derive a descriptive overview of the relevant processes.

Second, process documentation, i.e. process models, process guidelines, and the like, are examined. Here, the main questions are of a teleological and normative nature. I.e., I want to collect information about the goals of a process and how the process should be performed according to its designated design. For example, different goals of a business process can be considered [5, 6].

Third, qualitative interviews with process experts and process managers provide contextual knowledge. The interviews will be interpreted using the grounded theory method [7], relying on a lexicon [3] from BPM and routines research. This knowledge further enriches the insights gained in the prior stages. In this stage, I focus in particular on explanations about why the process is executed as it is the case and why certain changes in the process occurred.

2.2 Process Mining Techniques for Detecting Patterns of Stability and Change

Process mining is usually used for process discovery, conformance checking, and enhancement [1]. However, more and more algorithms are developed that can be used to compare different variants of the same process [11, 13] or detect changes in processes over time [10, 12]. Both of these types of algorithms are fundamental when it comes to detecting and understanding change in business processes.

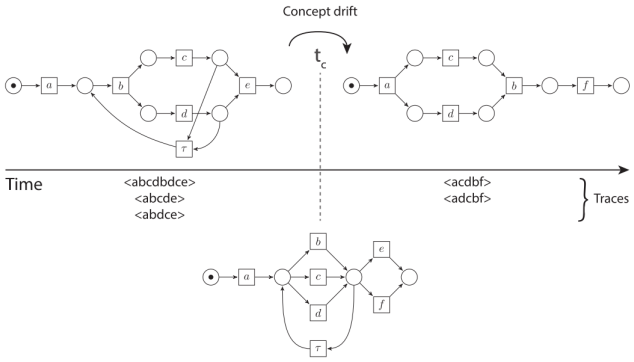

Fig. 2. Example of Process Drift [10]

Figure 2 presents an example for (concept) drift [10]. Instead of analyzing the whole log, the log is broken down in multiple parts, each of which is analyzed individually. For this reason, it is essential to detect the change point (tc), i.e.

the point in time when the change takes place, and accordingly divide the log-file [4]. Based on this procedure, differences between different process versions can be mapped out.

Drifts, i.e. changes, in processes can either take place gradually or suddenly [4, 14]. Sudden drifts are major changes that emerge at a particular point in time. They can be an indicator for major changes in the design of the business process, e.g. when a newly designed process version is introduced. Gradual drifts are small changes that appear over a stretched period of time [14]. They suggest a slight alteration to the process behavior. This change in process execution can be attributed to smaller design changes or to changes that can be attributed to process participants. In fact, gradual drifts can be a hint for the presence of positive deviance [15, 17].

2.3 Contextualization of derived Patterns

The presented algorithms give an example how process mining can enable insights about how change and stability in business processes occur. However, process mining alone can only determine that changes took place. Why changes occur, the exact dynamics behind these changes, and the motivation for these changes currently remain a black box. Together with interviews and process guidelines/ documentation, a sense-making process can take place that contextualizes the detected patterns and gives reason to not only that changes happened, but provide additional knowledge how and why certain changes came about.

3 Expected Contribution

In this Ph.D. research proposal, I outlined the research background and design of my doctoral dissertation. I presented a synthesis of process mining techniques, qualitative interviews, and supplementary document analysis I want to employ. This combination of computational and traditional techniques for inductive theory development will be used in order to inductively generate theory that explains patterns of stability and change in business processes.

The contribution of this Ph.D. twofold. First, the devised method can be used to study organizational processes. By iterating between trace-data and qualitative data analysis, researchers can zoom in and out [9] on investigated patterns; they can study patterns of actions as observed through process mining and enrich this information by qualitative deep-dive. Second, the identification of motors of change [22] in business processes sheds light on the impact of process design on process execution and vica versa. Having those motors identified, future studies can investigate further conditions for each motor to occur and the exact mechanics how each motor operates. Consequently, guidelines can be specified that help to support (re-)design initiatives.

This work is relevant for practice as well. Practitioners can use the identified motors of change to anticipate how changes in process design affect changes in process execution and the underlying routines. This enables management to proactively accompany business process change initiatives.

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