

Patterns of Stability and Change in Business Processes

Using Process Mining to Capture Reality in Flight

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Abstract: With the ubiquity of information systems in business and everyday life, people are increasingly leaving digital traces of their activities. Using this trace data alongside with other – more traditional – data collection techniques, such as interviews and document analysis, researchers can enhance their understanding of organizational processes and the different actors involved in these. In this Ph.D. research proposal, I outline an innovative approach that uses process mining techniques to capture “reality in flight”. Additionally, information stored in process model repositories and derived through expert interviews help to complement this perspective and make sense how stability and change occur in organizational processes.

Keywords: Theory Development, Business Process Management, Process Mining, Business Process Change, Business Process Standardization, Trace Data Analysis, Grounded Theory Method.

1 Motivation and Related Work

Business process management (BPM) and organization science have both recognized the importance of studying organizational processes [Du13, LT17, BR10a, BR10b]. However, the perspectives these research streams take on processes as a unit of analysis vary greatly. In BPM processes are often implicitly treated as simplistic and deterministic [MP00]. Process design and improvement often follows a top-down approach, not considering how business processes emerge as organizational routines [Be14]. On the contrary, organizational science perceives processes as “perpetually in the making” [GJT08], they are under constant change and permanently renewing themselves.

While BPM leaves behavioral aspects and intentions of process participants aside, research on routines masks out the role design decisions and artifacts play when it comes to executing the process. This is problematic, because each of these perspectives is limited due to its particular focus leaving the interplay of routines and top-down business processes unconsidered [Be14]. In particular, there is a very limited understanding how changes in process design and changes in routines affect each other. To evolve into a true process science and to develop strong process theory [PRK17], both fields of research need to join their strengths.

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The purpose of this doctoral dissertation is thus to address this research gap by building strong process theory [LT17] that explains stability and change in business processes. Accordingly, the research question I pursue reads as follows:

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 [BSS18]. On the one hand, I will use process mining algorithms [Aa11, AD12] to identify process variants [Ho15a] and evolutionary drifts in business processes [Ma17]. On the other hand, I will employ grounded theory methodology [SR09, ULM10] 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 [VP95] that will be used to explain how process change takes place. Furthermore, a method will be developed that allows to use process mining techniques for organizational research.

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 [BSS18]. 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 Method

In this Ph.D. research proposal, I suggest the complementary use of traditional grounded theory methodology [Ch96, SC94] and computational theory development [DLT07] to inductively develop strong process theory [PRK17]. In a recent article, Berente and associates [BSS18] outlined the advantages of such computationally-intensive theory development approaches that make use of the opportunities that the ubiquity of trace-data provides. Examples for studies that employed computationally-intensive theory development include, but are not limited to, Lindberg et al. [Li16], Vaast et al. [Va17], Miranda et al. [MKS15], and Pentland et al. [PRW17].

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 an 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.

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	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?

Table 1: Overview of Materials for Theory Generation

First, trace-data will be analyzed using process mining techniques. Employing variant analysis [Ho15a] and drift detection [Ma17] 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 [BM18, BZS16].

Third, qualitative interviews with process experts and process managers provide contextual knowledge. The interviews will be interpreted using the grounded theory method [Ch96]. 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.

Independent of the exact sense-making strategies employed, sense-making ultimately remains a cognitive process [GW14], which requires inspiration and creativity by the researcher [La99].

2.2 Process Mining Techniques for Detecting Patterns of Stability and Change

Process mining is usually used for process discovery, conformance checking, and enhancement [Aa11]. However, more and more algorithms are developed that can be used to compare different variants of the same process [Ho15a, LS12] or detect changes in processes over time [Ho15b, LT15]. Both of these types of algorithms are fundamental when it comes to detecting and understanding change in business processes.

Figure 1 below presents an example for (concept) drift [Ho15b]. 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 (t_c), i.e. the point in time when the change takes place, and accordingly divide the log-file [Bo11]. Based on this procedure, differences between different process versions can be mapped out.

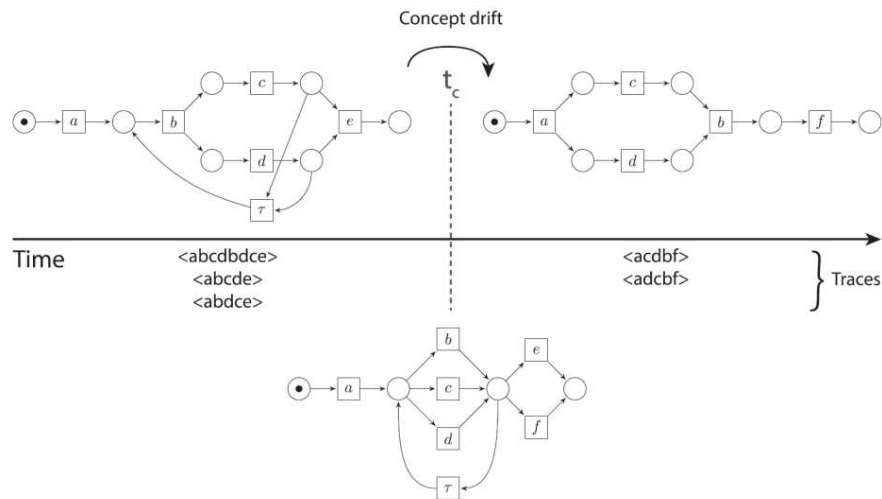


Figure 1: Example of process drift [Ho15b, p. 96].

Drifts, i.e. changes, in processes can either take place gradually or suddenly [Bo11, Ma17]. 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. Yet, there might be a time lag between the change of the business process' design and the change occurring in the actual log (i.e. the enactment of the process design by process participants). Having said that, gradual drifts are small changes that appear over a stretched period of time [Ma17]. 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 clue for the presence of positive deviance [Me16, Re15].

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 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.

Based on the explicated methods, there are two main contributions as a result of the proposed dissertation.

The first main contribution is the derived method. Work on process mining is centered around the development of algorithms for process discovery, conformance checking, and enhancement. Only recently research has been gaining momentum that uses process mining and other data-centered techniques to investigate business processes from an organizational science lens. The method presents an alternative to ThreadNet [PRK17, PRW16], sequence approaches [Ga14], and network analysis [Bo09] and thus helps to view business processes and routines from a different perspective. Taking into consideration not only qualitative data (i.e. interviews), but also trace data using process mining allows for well-grounded inferences. Hence, the dissertation strives for an approach, which is not only novel but also very rich in terms of the different data types taken into account for theory generation. Even though such a method can help to systematically investigate business processes, theory development also requires the researcher's inspiration [La99].

The second contribution lies in the application of that method to identify motors of change [VP95] in business processes. Having those motors identified, future work can further theorize about business processes and organizational routines. In particular, future studies can investigate further conditions for each motor to occur and the exact mechanics how each motor operates. I hope that this Ph.D. research can contribute to pave the way towards a strong process science [PRK17] and more rigorous theorizing about business processes.

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 within its organization.

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