Exploring the Impact of Process Diversity on Business Process Performance (Extended Abstract)

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I. Introduction

The complexity of business processes increases with the number and interdependence of process entities, such as activities, resources and data. High complexity makes it more difficult to manage a process and therefore business process standardization is a feasible countermeasure. It aims to decrease the variability of business process execution, while improving overall process performance. But in reality, the standardization of complex business processes is neither always possible [1], nor is it always desirable, due to the creation of negative side effects [2]. For this reason, it is important to distinguish the different causes and implications of complexity. One important cause for complexity is process diversity, which refers to the variability of control flow, resources and other attributes within a process. While more diversity implies higher complexity, it can also lead to more resilience and innovation [3]. In this PhD project we want to explore the impact of diversity on business process outcomes and use this knowledge in order to better guide business process improvement efforts. For this purpose, we want to apply existing diversity measures from different research fields such as biology [4] and economics [5]. These measures can for example be used to discover reference models from event logs, which provide a balance between process performance (i.e., standardization) and resilience (i.e., diversity). To further investigate the impact of process diversity on long-term process performance, we will also conduct empirical analyzes based on real business processes. In this way we want to show that diversity is an important indicator when it comes to business process improvement. In addition, we will also use diversity measures to discover multiple process variants from one event log, based on quality-diversity algorithms [6]. This enables better business process customization, since each discovered process variant represents an alternative to ensure high process performance.

II. Research Objectives and Motivation

Process complexity can be defined based on four main characteristics [7]: structure, interconnection, dynamics and uncertainty. To a certain extent, these properties are necessary for business processes in order to operate in volatile and complex business environments. But the complexity of a business processes alone does not explain how well a process is prepared to face such operational challenges. Hence, instead of only looking at process complexity in general, one has to look at how complexity contributes to process diversity. In system theory, diversity is considered as a strategy to make a system more resilient against uncertainty, to support innovation and to produce better outcomes over the long run [3]. An important difference to the general concept of process complexity is, that diversity also considers the degree of dissimilarity among a set of objects and not simply, whether there exist differences among objects. In this PhD project we want to explore this viewpoint, by analyzing process diversity from multiple perspectives – in particular control flow, resources and data – and by using diversity as guidance for business process improvement. Hence, the objectives are threefold:

1) Define process diversity measures, which reflect the dissimilarity of process traces, based on multiple perspectives.

2) Use the defined diversity measures in combination with performance measures to discover reference–models for process improvemenr.

3) Empirically investigate the impact of business process diversity on process performance.

While process diversity in terms of variability of execution traces, has not been specifically investigate in BPM research so far, a lot of research has focused on the complexity of business process models [8]. Several measures have been developed, which consider the number of process model components and their interconnectivity, to assess the overall complexity of the model. However most of these measures only focus on the control-flow perspective and none of the measures actually considers process diversity. By adapting some of these measures, such that they can be applied for the assessment of event logs, it will be possible to also assess other process perspectives and to reflect diversity to a certain extent (objective 1). We will also investigate, how to extend existing measures, such that they can be applied to object-centric event logs [9], since they provide very detailed information regarding the interconnection of process objects. To further extend the existing measures and to find new ones, we will also consider diversity theory [4, 5]. Diversity theory has been applied in different fields such as biology and economics, with the general purpose to assess the dissimilarity among a set of objects, e.g. populations or product portfolios. The existing measures in these fields, can provide different perspectives on diversity, depending on the underlying assumptions. For example, whether dissimilarity is understood as a cardinal or ordinal concept, can significantly change the outcome of the assessment. Hence, a thorough analysis and evaluation of the different approaches is necessary, to develop suitable diversity measures for business processes.

The next step of this PhD project (objective 2) is to use the identified measures in combination with fitness and additional performance measures as quality metrics for process discovery. In this way it will be possible to discover reference models, for business process standardization, which provide a certain degree of diversity and therefore decreases the risk of negative side-effects and failure. Similar to [10] we will use genetic process mining in order to

combine different quality metrics for process discovery. However, we will use a different evolutionary approach, called quality-diversity algorithm [6]. Due to an efficient exploration of the given search space, the approach decreases the risk of convergence towards local optima and it allows to discover multiple process models, with an equally high diversity level. These models can then be analyzed and selected for process standardization based on preferences regarding control-flow, resources and data. A further important benefit of the quality-diversity algorithm is that this approach is able to develop different scenarios, how a process might evolve in the future and to show whether a process is able to adjust to changing conditions, in terms of resilience.

In order to provide further guidance on process standardization, we will empirically investigate the impact of diversity on business process performance and evolution (objective 3). Based on the developed diversity measures we want to show how diversity evolves over time and how this impacts long-term process performance. Eventually this leads to a theoretical model, which is able to explain, to which extend and under which circumstances process diversity is able to improve performance.

III. Research Methodology

The first step of the PhD project is to identify existing process complexity measures that can be applied to process models and event logs. As a starting point we use the literature review on process model complexity provided by Polančič and Cegnar [8]. The existing measures will be analyzed and adapted, such that they reflect the multiple perspectives of process diversity. We will also look at other related research fields, such as software engineering and project management to identify potentially new measures. In addition, we will adapt measures from diversity theory [4, 5], in order to capture the dissimilarity between traces and events in an event log. The evaluation of the identified measures will be based on defined mathematical axioms, which ensure consistent results across different data. In addition, the measures will be compared based on standard as well as object-centric event logs. Some of the event logs will be artificially generated, such that different parameters can be adjusted (e.g., number and interdependence of resources and activities) in order to see how well these changes are reflected by the measures. In order to see whether, the measures can actually be used for the analysis of complexity in reality, we will also use real event log data from BPI challenges.

In order to use the defined measures as guidance for business process standardization, we apply them as quality measures for business process discovery. In particular we will use the quality-diversity algorithm [6] to discover multiple reference models with a high diversity. We will compare the results with other process discovery algorithms, which are also able to consider multiple quality dimensions (e.g., [10]). The comparison will be based on the level of diversity, which the discovered models exhibit and how well the algorithms perform in terms of computation. For this purpose, we will use publicly available event logs from past BPI challenges to create a benchmark.

These event logs will also be used for the empirical analyses part of this PhD project. We will first use cluster algorithms to identify different process variants based on changes over time and measure the evolution of diversity accordingly. We will additionally use statistical inference to analyse the impact of diversity on business process performance.

IV. Related Research

[11] is the only study we could identify, which also relates event log complexity to process discovery. The study proposes to use graph entropy as a measure for complexity. This measure only refers to the control-flow complexity and does not consider process diversity. However, the approach can potentially be extended to incorporate this perspective. Based on this extension it would be interesting to analyse how different process discovery algorithms are able to reflect process diversity.

There also exists some research regarding business process standardization based on event logs. One of the earliest attempts is described in [12]. However, the main goal of this approach is to discover a reference process model, with a minimal distance to the existing process variants. If a process exhibits very high diversity in terms of control-flow, resources and data, the approach most likely does not reflect this in the reference model. In contrast, our approach allows to discover multiple reference models, which also consider diversity and performance.

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