Why Am I Waiting? Analyzing Waiting Times in Business Processes from Event Logs
(Extended Abstract)

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Abstract—**Business analysts are in a continuous effort to improve the cycle time of a process by identifying waiting time bottlenecks and adapting strategies to improve the business processes by reducing delays. However, there are several sources of waiting times. Therefore, it is a challenge for a business analyst to categorize and quantify the sources of waiting time and discover changes that may reduce or eliminate these delays. We will empirically address this research problem by first identifying the sources of waiting time from the process execution logs and quantifying the share of waiting time attributable to each of the sources. Secondly, we will identify the interventions to reduce or eliminate the waiting time in business processes. Our proposed approach will be evaluated in two phases. In the first phase, it will be evaluated using BPI challenges, and in the second phase, we will conduct a case study with industrial partners to further validate our approach.**

Index Terms—**Waiting Time, Process Mining, Event Logs.**

I. INTRODUCTION AND PROBLEM DEFINITION

Reducing delays in business processes is a recurrent problem in the field of business process management. To address this problem, analysts need to discover and quantify the sources of waiting time in a process and then design interventions to mitigate them. The sources of waiting time are manifold [1], [2]. Some sources of waiting are external to the process (e.g. waiting for a response from a customer, waiting for a delivery from a supplier) [3]. Others are due to factors internal to the process, including but not limited to:

1) **Resource Contention:** Resource contention occurs when there is more work to be done than the resources available to accomplish it [4].
2) **Batch Processing:** In batch processing [5]–[8], resources bundle several cases together so that they can be processed as a group. This will infuse waiting time since the resource will wait for a batch to be available for processing. Hence, this introduces waiting time due to batch creation.
3) **Resource Unavailability:** A particular resource in a business process that does not operate on weekends will eventually introduce the waiting time in a process due to resource unavailability [9], [10].
4) **Work Prioritization:** There may be some tasks in a process that the resource may prioritize to improve the throughput of the process. However, the benefit decreases with an increase in prioritization, such as

the unimportant tasks suffer the most and hence, their waiting time increases [11].

In this setting, the problem addressed in this thesis is two-fold. First, the thesis addresses the challenge of identifying the *internal* sources of waiting time from an event log of a business process, and quantifying the share of waiting time attributable to each of these internal sources. Second, it addresses the problem of recommending interventions to reduce the waiting time. Accordingly, the research questions of this study are:

1) What are the possible sources of waiting time in a business process (e.g. batching, prioritization, etc.)?
2) How to automatically detect the sources of waiting time from an event log?
3) How to recommend interventions in view of minimizing the amount of waiting time?

A solution should fulfil the following requirements:

R1: The recommended interventions should be accurate. Accuracy can be measured in terms of the error between the predicted and the actual outcome after the intervention.

R2: The proposed approach should recommend interventions in an acceptable computation time.

The outcome of this research will be a set of techniques that take event log of a business process as an input, produces a diagnostic of the causes of waiting time and recommends actions to reduce or eliminate the waiting time in a business process as illustrated in Figure 1.
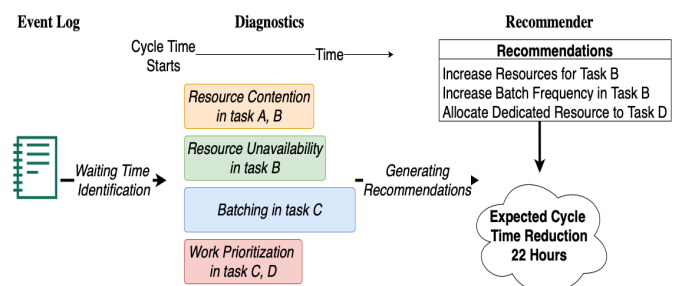

Fig. 1. Illustrative Example

II. METHODOLOGY

The proposed research will adopt Design Science Research (DSR) [12] for identifying the sources for the delay in a

business process. We will follow an iterative approach consisting of design, prototyping, and evaluation. We will start by conducting a systematic literature review of sources of delays and waiting waste in business processes, drawing for example into the literature on Lean management [1], [13]. Based on this review, we will develop a taxonomy of sources of waiting time in business processes. This analysis will inform the development of a framework for identifying sources of waiting waste in a process based on execution data. We will then develop techniques to quantify the share of waiting time attributable to each of the sources identified in the taxonomy and to recommend interventions to reduce or eliminate the waiting time. The proposed framework evaluation will be in two phases. In the first phase, we will evaluate our approach using synthetic event logs as well as real-life event logs, such as those released by the BPI challenge series.[1] In this setting, we will compare the findings of our proposed techniques with those of the participants in these challenges. Based on the insights gained from this first evaluation phase, we will improve our proposed approach. We will then conduct a case study in a real setting in order to further validate our approach in a second phase.

III. APPROACH

Enterprise systems record events corresponding to an execution of a task. These event records are extracted from the database and represented as an event log. The goal of this doctoral study is to develop techniques to identify the sources of waiting times in business processes using event logs as an input. A second goal is to develop techniques to recommend actions (interventions) to reduce waiting waste by identifying improvement opportunities in business processes.

Figure 2 captures an initial architecture of the envisaged solution. The presented architecture is a pipeline that starts with a module that takes event log as input and identifies waiting time in a business process. Here, we will leverage existing techniques to discover sources of waiting times from event logs, such as batching [5] or prioritisation [11]. This module is complemented by a second module, which quantifies the share of waiting time attributable to each of the identified sources. We envisage that this step can be tackled by determining the enabling time of each event in the log using log replay techniques. We will further analyze the log in order to discover, for each activity instance in the log, the time when the corresponding resource became available to perform that activity instance. With the help of these inputs, we will separate the waiting time due to resource contention or unavailability from the waiting time due to other sources. We will then develop techniques to identify the volume of waiting time attributable to batch processing, work prioritization, and other sources of waiting time identified in the literature review. The third module will be responsible for identifying possible interventions to address each source of waste, with the help of a domain expert. Finally, the fourth module will select a

combination of possible interventions to reduce the waiting time in the process, taking into consideration constraints on other performance measures, such as cost. The impact of these interventions will be evaluated by means of data-driven simulation techniques [14], [15].
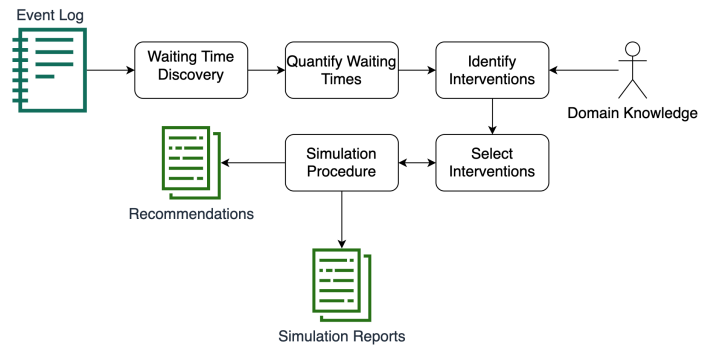

Fig. 2. Overall Research Design

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