# Towards a Framework for Context-Aware Resource Behaviour Analysis

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**Abstract.** For the successful and efficient execution of business processes, resources are essential. However, it is difficult to predict or plan executions appropriately, as the behaviour of resources, especially human workers, highly varies depending on the individual and the context. Although there are several metrics to describe resource behaviour in research, the reasons for their behaviour and the influence of the environment, like the workload, have been less explored. Extracting resource-related metrics from event logs and analysing them for possible relationships opens the opportunity to understand resource behaviour and improve working conditions. In this work, a framework for analysing correlations between resource behaviour and environment is motivated and briefly sketched.

**Keywords:** Resource Behaviour, Business Processes, Process Mining

## 1 Introduction

Resources play a crucial role for the correct execution of business processes [2] and their behaviour heavily affects the overall performance of the processes they are involved in [4]. But unlike machines, human resources do not show constant behaviour at work: their working speed varies, they might batch work or are only available part-time [9]. In addition, humans have different preferences regarding their work-items or co-workers, which is reflected in their behaviour [1].

From a temporal perspective, workers most likely change their behaviour and preferences over time due to personal development or adjustments to a new environment or circumstances. In the area of work psychology, for example, the arousal, i.e. stress, of workers is recognised to be related to their performance, known as the Yerkes-Dodson law [10].

In the context of business process technology, the behaviour and decisions of resources, as well as process-related circumstances, are incidentally captured in event logs. Metrics like workload, processing speed, waiting times and preferences in terms of task selection can, for example, be derived from the event log [1, 6], provided resource information is available for tasks. However, even though many researchers state that human resources and their behaviour greatly affect overall

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process performance, there is only little research on mining and, more importantly, understanding the behaviour of human resources in the context of the process execution [7].

In the remainder of the paper, related work regarding resource metrics is presented in Sect. 2. Section 3 introduces the concept for a new framework for resource behaviour analysis.

## 2 Foundations

So far, several metrics to measure the behaviour and performance of human resources have been proposed. For example, Swennen et al. [8] introduce the notions of *Resource Frequency*, *Resource Involvement*, and *Resource Specialisation*, indicating how active resources are and in how many cases they participate. In terms of resource behaviour, Suriadi et al. [7] describe how to extract the queuing discipline (bounded to FIFO, LIFO or Priority) that resources show and Martin et al. [3] propose an approach for detecting batching in resource behaviour. In addition, Pika et al. [6] provide examples for metrics in the following categories: *Skills*, *Utilisation*, *Preference*, *Productivity* and *Collaboration*.

Although several papers describe different metrics for resource behaviour, only a few consider them in context. But former research already showed that correlations between resource-related metrics can be found in process logs: Nakatumba et al. [4] confirmed the Yerkes-Dodson law by extracting the workload and processing times from process logs and performing a regression analysis.

Another exception in the context of correlating resource metrics is the comprehensive framework developed by Pika et al. [6]: They present an approach for extracting time series of Resource Behaviour Indicators (RBI) from event logs using SQL-like queries. In later work, this framework was extended to include the aspect of the connections between resource behaviour and different outcomes by including a regression analysis of their RBIs [5]. However, there are some points for improvements, e.g. regarding the scope and complexity of the metrics available for analysis and the reuse or export of calculations.

## 3 A Framework for Context-Aware Resource Behaviour Analysis

Due to the limitations of existing work, we plan to develop a framework for context-aware resource analysis with a three-step approach as shown in Fig. 1.

*Metric Selection* For examining the behaviour of resources not only the analysis-part plays an important role but also the metrics themselves must be considered in detail beforehand. Metrics are measurements used to quantify performance aspects and can be calculated from data for a point in time or time spans. In the context of resources and processes, examples are the number of activities a resource is working on, or how many activities are assigned to a resource but have not yet been started.

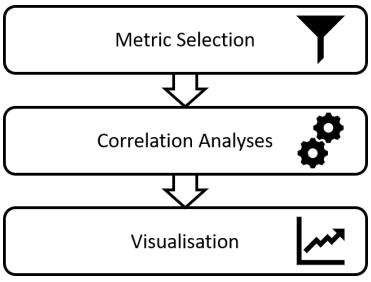


**Fig. 1.** Framework Steps

The framework will include, but not be limited to, a collection of resource-related metrics from the literature. To guide the selection of metrics for analysis, we will furthermore classify them into *environmental* metrics (influencing behaviour) and *behavioural* metrics (expressing behaviour), which should support more targeted and meaningful analyses. Additionally, the framework will not be limited to directly resource-related metrics, since case-related or event-related information, such as the case duration or the time of day, may also have an effect on the behaviour or decisions of resources and will therefore be available for analysis as well.

Each metric comes with its own extraction logic and imposes, often implicitly, certain requirements on the data set, such as certain attributes or meta-information needed for computation. However, requirements for the process log are often not mentioned in literature. Besides these demands, metrics can also have different calculation techniques that differ in their requirements and quality based on assumptions. The processing time, for example, could be extracted by taking the timestamps of start and end events into account, or the required time is specified directly in the log as an attribute. Some logs may even lack this information, but an estimation of processing times could still be made, e.g. by considering the subsequent event and assuming waiting times. The framework for computing such metrics should therefore be aware of these variations and prerequisites and be extendable with new metrics and calculation techniques. This allows for a flexible and general application on a wide range of event log variants.

*Correlation Analyses* After the metric-computation, correlation analysis can be used to determine if there is a relationship between them. By automatically executing the analyses for selected metrics, the framework is able to reveal interesting insights for further manual investigation. For this, the separation into environmental metrics and behavioural metrics might help to detect more relevant results, as it indicates the direction of possible causalities.

To enable future research based on resource behaviour, the data and time series calculated by the framework should be exportable, e.g. by enriching the process log with new data and attributes, such as the workload or the current work prioritisation pattern. This would facilitate further processing of the data series, e.g. with techniques from the field of machine learning. The resulting models could be used not only to anticipate the resources' reactions to impending environmental changes but also to achieve a more powerful and realistic process simulation regarding resources.

*Visualisation* The visualisation component plays an important role as it is used to communicate the outcome of the analysis. On the one hand, it should include the resulting numbers and graphs for a comprehensive evaluation by experts; on the other hand, the visualisation should quickly point out interesting findings and provide assistance in interpreting the results.

The concept for a new framework for analysing resource behaviour based on event logs as presented in this paper suggests and encourages further research on this topic. There are several points for future work, including a comprehensive and practical overview of resource-related metrics or new possibilities to combine and analyse metrics, also with regard to other research areas, such as psychology.

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