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Assessing and governing IT-staff behavior by performance-based simulation

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ABSTRACT

When optimizing IT operations organizations typically aim to optimize resource usage. In general, there are two kinds of IT resources – IT infrastructures and IT staff. An optimized utilization of these resources requires both quantitative and qualitative analysis. While IT infrastructures can offer raw data for such analyses, data about IT staff often requires additional preparation and augmentation. One source for IT staff-related data can be provided by incident management and ticketing systems. While performance data from such systems is often stored in logfiles it is rarely evaluated extensively. In this article we propose the usage of such data sources for IT staff behavior evaluation and also present the relevant augmentation techniques. We claim that our approach is able to provide more in-depth insights as compared to typical data visualization and dashboard techniques. Our modeling methodology is based on the approach of system dynamics.

We also provide formal models and simulation results where we demonstrate the feasibility of the approach using real-life logfiles from an international telecommunication provider.

1. Introduction

Todays enterprises and organizations conduct a wide range of operative processes electronically. This results not only in improved processing with respect to time and quality, but also in an (more or less) automatically stored performance data about the processing (e.g., how many requests were processed, what was the duration of each processing task). Furthermore, data gathered by such operative systems often hides other nontrivial insights. Visualization is often a first step towards a more detailed data analysis. This is the application domain of the business dashboards. One specific example is the usage of Google analytics[1] to visualize web server logfiles. More complex application scenarios involve the aggregation of multiple data sources and the subsequent analytical processing of data within a data warehouse.

Operative data can provide insights about two distinct types of measurements – key goal indicators (KGIs) which provide insights about the results of an operative task, and key performance indicators (KPIs) which define the way these results were achieved (e.g., speed, transaction rate). When we define such indicators with respect to specific business processes we can apply an approach known as process mining (Gerke & Tamm, 2009).

In this article[2] we extend this approach as follows: (1) we aim to assess utilization of IT staff (as a specific IT resource) based on analysis of its human behavior, and (2) we introduce and use more complex simulation techniques.

Our focus lies on KPIs and we address the question whether an extended data analysis using simulation methodologies can provide an additional value as compared to standard data visualization. Main contribution of this work is the introduction of a straightforward approach for assessing human behavior of IT specialists based on typical available IT KPIs.

The rest of this article is structured as follows: Section 2 presents the state of the art in the measurement of process indicators, the terminology we use, as well as related work in the area of computers in human behavior. In Section 3 we propose our hypothesis and give an overview of our assessment framework for indicators in the area of IT operations. In Section 4 we describe how we applied the system dynamics approach (Forrester, 1995) to verify our hypothesis. It includes results regarding a specific data transformation, model creation, and simulation process that we have assessed based on real-life data from an international telecommunications

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[1] www.google.com/analytics/.

[2] This article is an extended version of a paper we presented at WSKS 2011.

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provider. Section 5 contains a discussion of our results and outlook on our future research activities.

2. Preliminaries

In this section we introduce the motivation for performance and output metrics. Furthermore, we discuss the motivation for data and logfile analysis in this context and also reflect on relevant human aspects.

2.1. Concepts of indicators

As stated above, indicators can be generally divided into two groups – key performance indicators (KPIs) and key goal indicators (KGIs). KPIs measure how well a process is performing and are expressed in precisely measurable terms. KGIs represent a description of the outcome of the process, often have a customer and financial focus and can be typically measured after the fact has occurred (Grembergen, 2003). While KGIs specify what should be achieved KPIs specify how it should be achieved.

2.2. Objectives of data and logfile analysis

Various algorithms (de Medeiros, Weijters, & van der Aalst, 2007; van der Aalst et al., 2003) have been proposed to discover different types of models based on a logfile. A special issue of Computers in Industry on process mining (van der Aalst & Weijters, 2004) offers more insights. In the context of process model verification there are several notions for equivalence of process specifications such as behavioral equivalence (Van der Aalst, de Medeiros, & Weijters, 2006; van Dongen, Dijkman, & Mendling, 2008), trace equivalence, and bisimulation (Van Glabbeek & Weijland, 1996) that have been developed. Traditional equivalence notions like bisimulation or trace equivalence are defined as a verification property which yields a yes-or-no boolean value, but no insights on the degree of equivalence. When comparing a reference model with a process model, it is not realistic to assume that their granularities are the same. Therefore, the equivalence analysis with classical equivalence notions will most likely not be conclusive. In the context of process mining we should apply notions searching for behavioral similarity. Examples include causal footprint (van Dongen et al., 2008) and fitness function (Van der Aalst et al., 2006). In (van Dongen et al., 2008), the authors introduce an approach for determining the similarity between process models by comparing the footprint of such models. Thereby the footprint describes two relationships between activities – the soc. look-back and look-ahead links and returns the degree of the process similarity expressed in [0, 1]. This value is not conclusive and requires further explanation. It is not possible to trace the missing or differing activities. Since traceability is an important requirement of the organization, the approach is not suitable in general. In (Van der Aalst et al., 2006), the authors introduce the behavioral and the structural precision and recall. The behavioral equivalence of the process models compares a process model with respect to some typical behavior recorded in log files. The structural precision and recall equate the term "'structure'" with all firing sequences of a Petri net that may occur in a process model. Other related works exist in the areas of pattern matching or semantic matching. Existing approaches (Ehrig, Koschmider, & Oberweis, 2007) assume that the correspondence of activities can be established automatically. Since they suppose that the same label implies same function, they try to identify the content of an activity by using an automated semantic matching algorithm based on the label of activities. One specific approach for quality improvement in compliance is IT supported compliance evaluation (Sackmann & Kaehmer, 2008). The notion of compliance has also been discussed in the context of business alignment (van der Aalst, 2005).

2.3. Aspects of human behavior

A long-standing focus of computer-related research in the context of human behavior is the subject of computer anxiety. Mostly based on the Computer Anxiety Rating Scale (CARS), presented in Heinssen et al. (1987), studies tried to evaluate anxiety in the usage and perception of computers in different demographics. Examples include studies of representative samples from older population as presented in Laguna and Babcock (1997), as well as East European (specifically Romanian) population groups as presented in Durndell and Haag (2002). A meta analysis published in Chua, Chen, and Wong (1999) provided the following insights: (1) female university undergraduates are in general more anxious than male undergraduates; (2) instruments measuring computer anxiety can be considered reliable, although not compatible with one another; and (3) computer anxiety is inversely related to computer experience, although the strength of this relationship remains inconclusive.

Other works focused on the gender differences (see Whitley et al. (1997) as example), or on the creation of specific models for the evaluation of qualitative differences (see Todman & Monaghan (1995) as example).

Another specific focus was the concept of online trust (see Wang & Emurian (2005) for an overview). Online trust is particularly challenging since the (first time) user typically does not know experience and trust properties of the online service. This is a particular challenge for online marketplaces and a typical approach to address it is to provide information substitutes for the marketplace users. Marketplaces for tangible goods (such as ebay[3]) typically need to provide such substitutes to establish trust in the seller of the goods. Examples include user ratings and comments. Marketplaces of non-tangible goods such as electronic services or software-as-a-service (SaaS) need to provide such substitutes both for the provider and the service itself (see Tamm & Günther (2005) for a framework for such substitutes and the Cloud marketplace Asperado[4] that was based on this framework).

Aspects that come closer to our hypotheses include the impact of computer anxiety on employees' performance and satisfaction (see Murrell & Sprinkle (1993)) and the impact of IT staff on the perceived quality of standard information systems (see Wu & Wang (2007) for an example that focuses on enterprise resource planing (ERP) systems). There are also works that look at ways to overcome hesitation and resistance during the adoption of new managerial approaches in IT (e.g., an approach to use a human-oriented maturity model in the context of ITIL is presented in Gama, Nunes da Silva, & Mira da Silva (2011)). In the area of software development aspects of managerial decision making in software development were analyzed quantitatively by Garcia-Crespo, Colomo-Palacios, Soto-Acosta, and Ruano-Mayoral (2010) and an approach to measure effects of emotions was presented in Colomo-Palacios, Casado-Lumbreras, Soto-Acosta, and Garcia-Crespo (2011).

3. Research hypothesis and assessment framework for IT governance

3.1. Research hypothesis

Analysis of log data can in general provide a clear picture of performance and utilization of IT infrastructure components. Such data can even be used to dynamically reconfigure systems for better performance at different architectural levels (the definition of

[3] http://www.ebay.com.
[4] http://www.asperado.com.