



An integrated approach based on execution measures for the continuous improvement of business processes realized by services



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ABSTRACT

Context: Organizations are rapidly adopting Business Process Management (BPM) as they focus on their business processes (BPs), seeing them to be key elements in controlling and improving the way they perform their business. Business Process Intelligence (BPI) takes as its focus the collection and analysis of information from the execution of BPs for the support of decision making, based on the discovery of improvement opportunities. Realizing BPs by services introduces an intermediate service layer that enables us to separate the specification of BPs in terms of models from the technologies implementing them, thus improving their modifiability by decoupling the model from its implementation.

Objective: To provide an approach for the continuous improvement of BPs, based on their realization with services and execution measurement. It comprises an improvement process to integrate the improvements into the BPs and services, an execution measurement model defining and categorizing several measures for BPs and service execution, and tool support for both.

Method: We carried out a systematic literature review, to collect existing proposals related to our research work. Then, in close collaboration with business experts from the Hospital General de Ciudad Real (HGCR), Spain, and following design science principles, we developed the methods and artifacts described in this paper, which were validated by means of a case study.

Results: We defined an improvement process extending the BP lifecycle with measurement and improvement activities, integrating an execution measurement model comprising a set of execution measures. Moreover, we developed a plug-in for the ProM framework to visualize the measurement results as a proof-of-concept prototype. The case study with the HGCR has shown its feasibility.

Conclusions: Our improvement vision, based on BPs realized by services and on measurement of their execution, in conjunction with a systematic approach to integrate the detected improvements, provides useful guidance to organizations.

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1. Introduction

The complexity and size of the current systems to support the business of organizations has grown considerably in recent years, thus increasing the difficulty in managing them properly. Business Process Management (BPM) [1–3] is becoming increasingly important for those organizations which need to gain a better insight into the way their business processes (BPs) are executed. BPM helps organizations to manage their BPs, assisting them in checking that their outputs are maintained in the range defined as suc-

cessful with respect to the business goals of the organization. BPM provides the means for guiding and supporting the modeling, implementation, deployment, execution, and evaluation of BPs in an organization, based on the BP lifecycle [1], which establishes the main phases and activities that organizations have to carry out in their efforts to manage BPs: Design & Analysis, Configuration, Enactment and Evaluation of BPs. In the Design & Analysis phase, BPs are first identified and modeled and then validated and verified; in the Configuration phase BPs are implemented in the chosen technology, and then tested and deployed in the selected platform. The Enactment phase involves the execution and monitoring of BP instances and the registration of execution data in execution logs. Finally, in the Evaluation phase execution log data is evaluated to provide insight into the real execution of the BPs using, for example, process mining techniques. The boom in

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the use of BPM to support the BP lifecycle introduces both a fresh approach to business management and new challenges for the undertaking of management efforts. One of these challenges is that without proper guidance for applying BPM, the results are barely predictable, with the drawbacks that this entails.

According to the Gartner Group [4] “organizations carry out BPM projects in order to improve one or more business processes”. This places BP improvement as the number one motivation for BPM. In the same survey, the top five business goals identified include: improving customer satisfaction, improving the quality of BPs, reducing costs, improving BP agility, and supporting continuous process improvement. Measurement activities are implicit in the lifecycle, but to guide the integration of execution measurement through the whole lifecycle we must define measurement activities explicitly. This will help obtain insight into the real execution of BPs, knowledge that is needed for BP improvement.

The implementation of BPs by means of different systems in the organization also affects the way business people can perform the defined activities and how they perceive the software support provided. The traditional vertical vision of Information Technologies (IT) for implementing BPs, based on sections or areas of the organization, made the modification of BPs a challenging activity that required the integration of various heterogeneous information systems. These changes are not easy to introduce, in general, due to the implicit implementation of the BPs in the systems supporting them. Among other disadvantages, this often leads to more time being spent than initially planned. In addition, it may result into high costs and unfulfilled expectations of the business area regarding the functionality offered by the implemented BPs [5,6]. Service Oriented Computing (SOC) [7] provides the basis for defining services that can implement parts of BPs (activities, sub-processes) or even a BP as a whole, by introducing an intermediate layer of services between BP definition and their implementation by means of different technologies. This approach helps bridge the so-called business-systems gap caused by different views and expectations between the business and the IT side when introducing changes into BPs. The service layer enables us to separate the specification of BPs in terms of models from the technologies implementing them, thus improving their modifiability by decoupling the model from the implementation in the technology selected [5,6]. The approach provides the basis for integrating changes with minimum impact, both at the BPs level and at the system level, allowing for the organizational agility needed to respond to new demands or corrective measures [5,6].

In this article we present an approach for the improvement of BPs which extends the traditional BP lifecycle [1] with measurement and improvement activities. We have called this BP Continuous Improvement Process (BPCIP). Our proposal includes a model that integrates execution measures for BPs with services implementing them in a comprehensive way; we have called this model BP Execution Measurement Model (BPEMM). In previous work we presented an initial definition of the BPCIP [8], which we have extended significantly by redefining the complete BPCIP lifecycle based on the feedback from the conference and by completing the set of execution measures to be integrated into the BPEMM.

Both the BPCIP and the BPEMM are part of a larger framework called MINERVA [9,10], which we defined with the aim of providing an integrated approach to support the continuous improvement effort in an organization based on the realization of BPs by services with a model driven approach. Our purpose was also to enable BP execution measurement, as far as both BPs and services are concerned. The framework is organized in three dimensions: conceptual, methodological and tool support. Previous contributions described the MINERVA framework as a whole [9,10], the conceptual [11] and the tool [12] dimensions, as well as part of the methodological dimension: the BPSOM methodology and the

model-driven approach [13,14]. We will not deal with these aspects in detail here. Contributions of this paper concern the support for measurement and improvement of BPs that are part of the methodological dimension of MINERVA. What this article contributes therefore, is as follows:

- The redefined BPCIP lifecycle, based on the BP lifecycle [1] and extended with measurement and improvement activities, as well as the elements to carry out the defined activities, such as roles and input and output artifacts.
- The complete set of integrated execution measures defined in the execution measurement model BPEMM, along with the addition of a “cube” presentation for the tridimensional taxonomy we have defined to organize the measures.
- A proof-of-concept prototype of the ProM BPEMM plug-in, to support the visualization of the results of the execution measurement of measures defined within the BPEMM, as well as to demonstrate the feasibility of our definitions.
- The validation of our approach by means of a case study undertaken in the Hospital General de Ciudad Real (HGCR), with the help of business experts.

1.1. Background

“Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it.” H. James Harrington (Harrington, 1991) [15].

Continuous process improvement refers to a status in which the organization is continuously analyzing the way it carries out its business. Its goal is to find improvement opportunities for the performance of the organization's BPs [16,17]. Measurement of BP execution provides the basis for analyzing the real behaviour in the organization. It helps to detect deviations from planned behaviour, as well as to discover improvement opportunities for the BPs. Once improvement opportunities are detected, organizations need to define changes in the BPs that will lead to a new improved version of these for better achieving the business goal set by the organization. Execution measurement then becomes the enabler towards understanding and controlling the real occurrences of BPs in the organization, establishing an ongoing BP improvement culture [16]. To improve processes continuously, several aspects have to be taken into account. A key one refers to the creation of an organizational improvement context, which comprises a number of elements including business and software teams committed to the improvement initiative and a systematic approach for conducting improvement efforts, the explicit specification of BP models and the software implementing them, a definition of measures collected during BP execution, or techniques and tools to enable the evaluation of the collected execution logs. One key statement of process management is that quality of products and services is largely determined by the quality of the processes used to develop, deliver and support them. An effective process is capable of bringing people, tools and methods together into an integrated whole which produces the expected outcomes [16].

An improvement approach has to support the identification of process deficiencies and provide guidance for introducing improvements in a systematic way. To carry this out, measures of the BP, activities, performance, resources, cost and results have to be defined, implemented, collected and analyzed on a regular basis [16]. Organizations in different domains such as software, manufacturing, marketing, banking, and finance share similar problems. These could include, for instance, overworked staff, thanks to poor estimating and planning, or excessive rework. There

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