The Journal of Systems and Software 147 (2019) 86–103

Contents lists available at ScienceDirect

The Journal of Systems and Software

journal homepage: www.elsevier.com/locate/jss

Business process model refactoring applying IBUPROFEN. An industrial evaluation

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ARTICLE INFO

Article history:
Received 16 November 2017
Revised 3 September 2018
Accepted 4 October 2018
Available online 6 October 2018

Keywords:
Business process model
Refactoring
Understandability
Modifiability
Case study

ABSTRACT

Business process models are recognized as being important assets for companies, since appropriate management of them provides companies with a competitive advantage. Quality assurance of business process models has become a critical issue, especially when companies carry out reverse engineering techniques to retrieve their business process models. Thus, companies have to deal with several quality faults, such as unmeaningful elements, fine-grained granularity or incompleteness, which seriously affect understandability and modifiability of business process models. The most widely-used method to reduce these faults is refactoring. Although several refactoring operators exist in the literature, there are no refactoring techniques specially developed for business process models obtained by process mining and other reverse engineering techniques. Therefore, this paper presents the use of IBUPROFEN, a business process model refactoring technique for those models obtained by reverse engineering. IBUPROFEN is applied in an in-depth case study with a real-life information system belonging to a European bank company. The goal of this industrial evaluation is to prove that the refactoring operators improve the understandability and modifiability of the business process model after being refactored. In addition, the scalability of the technique is assessed to demonstrate the feasibility of its application.

1. Introduction

Business process models define the sequence of coordinated activities that an organization has carried out in the quest to achieve its business goal (Weske, 2012). They are considered to be one of the most important assets for organizations, since an appropriate management of them helps companies to adapt their business goals and structures to environmental changes quickly, while maintaining or even improving their competitiveness. Besides, to supply their management, business process models are mostly represented according to standard notation such as BPMN (Business Process Modelling Notation) (OMG, 2011). BPMN is considered the most advantageous notation since it facilitates the communication among several stakeholders across the system development life cycle, detects errors and omissions early in system development life cycle and so on. Because of the benefits of business process management, organizations are currently demanding mechanisms to ensure optimal quality levels of their business process models, aiming to achieve optimal business process management. Quality assurance of business process models usually focuses on understandability and modifiability. These high level representation quality features have been considered to be the most influential as regards business process management (Sánchez-González et al., 2010). According to the international standard for the quality of software products ISO/IEC 25010 (2011), understandability represents the degree to which users recognize whether the product is appropriate for their needs. Whilst, Modifiability is the degree to which a business process model is effectively and efficiently modified without introducing defects or degrading performance

When the organization does not explicitly have its business process models, reverse engineering is a solution to retrieve the models from existing information systems (Pérez-Castillo et al., 2011). Reverse engineering is the process of analysing a system to create representation of the system at a higher level of abstraction. Thus, business process models are high level representations of the company performing. Although reverse engineering is less error-prone and time-consuming than manual modelling from scratch, it implies a semantic loss (Canfora et al., 2011) due to the increase in abstraction.

Business process model refactoring is one of the most relevant solutions to the need of increasing the quality degree of business

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https://doi.org/10.1016/j.jss.2018.10.012
0164-1212/

process models (Dijkman et al., 2012; Weber et al., 2011; Misbhauddin and Alshayeb, 2017). These techniques change the internal structure of business process models without altering or modifying their external behaviour, thereby improving their understandability and modifiability. Refactoring operators replace some business process model fragments by equivalent ones. In this context, 'equivalent' means that the semantic of the business process model, regarding a certain business domain, remains inalterable. Despite literature exposes several refactoring operators that have been proposed for their application in business process models, there are, however, no refactoring techniques specially developed for those models that have been obtained through reverse engineering, with their own peculiarities (e.g., missing elements, mining of unmeaningful elements, etc.). Most business process model refactoring techniques consist of recognizing refactoring opportunities and then applying different refactoring operators, without paying attention to the opportunities happened because of the application of reverse engineering.

This paper addresses all the mentioned challenges by applying IBUPROFEN[1] (Improvement and BUsiness Process Refactoring OF Embedded Noise), a business process model refactoring technique and a supporting tool. This means that IBUPROFEN has been specially designed to be used with business process models retrieved by reverse engineering from existing information systems. IBUPROFEN considers a set of operators, divided into three categories focused on improving the relevance of elements, completeness, and fine-grained granularity. The majority of refactoring operators are taken from previous works concerning business process model refactoring (Weber et al., 2011; La Rosa et al., 2011). Actually, the set of refactoring operators of IBUPROFEN could be extended to cope with other problems associated with business process models obtained by reverse engineering. Although IBUPROFEN is based on previous, existing refactoring operators, the main contributions of the framework are:

- The selection of certain refactoring operators that make more sense to be applied for business process models obtained from reverse engineering from IS, i.e., those operators that are able to fix some of the issues associated with reverse engineering.
- The application of such refactoring operators when certain refactoring opportunities are detected. This means that although IBUPROFEN reuses existing refactoring operators, it applies these operators under different circumstances. In this case, when some bad smells in business process models related to reverse engineering are identified.

Other important contribution of this research lies in the fact that this paper presents an empirical evaluation in order to ensure the feasibility and applicability to the industry of IBUPROFEN. This empirical validation has been conducted through a case study with a real-life information system belonging to a European bank company. The case study was designed and conducted following the formal protocol proposed by Runeson and Höst (2009) for carrying out case studies in the software engineering field. The goal of this industrial evaluation is twofold:

- This evaluation firstly sets up IBUPROFEN, in an effort to prove that the refactoring operators improve the understandability and modifiability of the business process model after being refactored.
- The scalability of IBUPROFEN is also assessed according to a linear regression model. The objective in this case is to demonstrate that IBUPROFEN can be employed with larger industrial systems by applying a linear time regarding the size of the business process models.

The remainder of this paper is organized as follows: Section 2 presents work related to the paper. Section 3 provides the identification of the problems which are present in business process models that are mined from existing information systems. Section 4 introduces the proposed approach for refactoring business process models retrieved by reverse engineering. Section 5 presents a case study using real-life systems to assess the effectiveness and efficiency of the proposed approach. Finally, Section 6 sets out the conclusions and directions for future work.

2. Related work

Business process management has become a valuable activity for managing organizations from an operational perspective. Several techniques have emerged for supporting business process recovery (Normantas and Vasilecas, 2013). All these recovery techniques have in common to be based on reverse engineering, which signifies that information is abstracted and semantic is very often lost (Canfora et al., 2011). As a result, common quality faults are recurrent in outgoing business process models such as redundancies, ambiguities, inconsistencies, lack of completeness, as well as non-adherence to conventions or standards (Mens et al., 2007). As a result, various efforts have been made to fix such faults and improve the quality of business process models.

For that, this work has two kinds of related work: business process recovery and recovered business process problems solutions. Next subsections detail each part and give some example of related works in each area.

2.1. Business process model recovery

Several techniques have emerged for supporting business process recovery (Normantas and Vasilecas, 2013). For example, *Zou* et al. (2006) present a workflow recovery by means of a static analysis of information system's source code. In that work some heuristic rules are applied with the aim to discover the embedded business knowledge. These authors introduced the 'a callable unit – a business task' pattern, which has been followed by other proposals. This reverse engineering pattern considers each callable unit (pieces of code that can be invoked, e.g., Java methods, C procedures, etc.) as candidate business task. Paradauskas and Laurikaitis (2006) also intend to retrieve business knowledge but through the static analysis of the data stored in databases. Pérez-Castillo et al. (2011) focus on retrieved business process from legacy source code by using a set of business patterns formalized by model transformations. Their proposal, therefore, follows model-driven architecture principles (i.e., considering all software artefacts as models, and providing formal transformations to move models between different abstraction levels), making easier their extensibility. Normantas and Vasilecas (2012) combine patterns matching and program slicing to extract details about implementation of business rules. They define a set of patterns for extraction of different kinds of business facts from resources of enterprise content management system, including database schema, source code, and resource definitions. As in Pérez-Castillo et al. (2011), they uses the Knowledge Discovery Meta-model (KDM) to represent the extracted knowledge. Besides static analysis-based solutions there are also dynamic analysis-based solutions such as Di Francescomarino et al. (2009) approach where graphical user interfaces of web application are considered to discover business process. *Cai* et al. (2009), for their part, combine requirement reacquisition based on use cases with dynamic and static analysis tech-

[1] Despite the fact that IBUPROFEN is the name of a well-known painkiller, that name is not a trade/registered mark since it corresponds to iso-butyl-propanoic-phenolic acid, which is an open access term devoted to define the chemical formula. We chose that name due to it is easily remembered and it is an abbreviation of a longer name: Improvement and BUsiness Process Refactoring OF Embedded Noise.