Journal of The Korea Society of Computer and Information
Vol. 23 No. 11, pp. 103-109, November 2018
www.ksci.re.kr
https://doi.org/10.9708/jksci.2018.23.11.103

The study of a full cycle semi-automated business process re-engineering: A comprehensive framework

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Abstract

This paper presents an idea and framework to automate a full cycle business process management and re-engineering by integrating traditional business process management systems, process mining, data mining, machine learning, and simulation. We build our framework on the cloud-based platform such that various data sources can be incorporated. We design our systems to be extensible so that not only beneficial for practitioners of BPM, but also for researchers. Our framework can be used as a test bed for researchers without the complication of system integration. The automation of redesigning phase and selecting a baseline process model for deployment are the two main contributions of this study. In the redesigning phase, we deal with both the analysis of the existing process model and what-if analysis on how to improve the process at the same time, Additionally, improving a business process can be applied in a case by case basis that needs a lot of trial and error and huge data. In selecting the baseline process model, we need to compare many probable routes of business execution and calculate the most efficient one in respect to production cost and execution time. We also discuss the challenges and limitation of the framework, including the systems adoptability, technical difficulties and human factors.

▸Keyword: Business process re-engineering, business process management systems, process mining, cloud computing, distributed computing

I. Introduction

Business Process Management (BPM) lifecycle begins with process identification follows by process modeling, process execution and monitoring, and, finally, process redesign phase [1]. During process identification, modeling and redesign phase, domain and business experts are highly involved. They decide carefully what part of activities in the company (or industries) are identified and modeled as business process. In the redesign step, the experts decide whether current processes are streamlined and value-added to the company, consequently, they cut off (or merge) activities that are non value-adding and, possibly, introducing new activity based on changes in company behavior, if any. Whereas, during execution and monitoring of a business process, humans involvement can be deemed minimal as Business Process Engine (BPE) takes care of the logic.

Over the years, the interest on Business Process

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• Received: 2018. 10. 23, Revised: 2018. 11. 01, Accepted: 2018. 11. 01.
• This work was supported by 2018 Nurimaru R&BD Project Research Grant.

Re-engineering (BPR) is getting lower and lower because of misconception and over-radicalization in the company that apply it [2]. In the author point of view, however, BPR completes the BPM lifecycle in the sense that during process redesign phase we would need BPR to improve our business process. Six sigma [3] gives standards on how to do process redesign and rely heavily on experts, often a certified green or black belt expert.

With the advanced of computerization in many sectors and the growth of digital data, prompted more sophisticated algorithms and techniques to analyze data, including data generated during the execution of business process. Van der Aalst [4] pioneered a technique to discover a process model from a historical event logs from software information systems and analyze it, coined the term process mining. A way to look thoroughly on what actually happened during process execution. This way, it revolutionizes how we look on process modeling and redesign. In his book, Aalst mentioned that process mining is bridging the gap between process modeling and analysis, and machine learning and data mining. Dumas et al. [2], in his book, presented an idea which combines the traditional BPM lifecycle phases with process mining by adding the aspects of process discovery and process analysis phases.

Up until this paper is written, we found that integrating both worlds (e.g., BPM and process mining) are yet done, in the sense that BPM and process mining are done separately. The business process management systems (BPMS) concerns only on the BPM aspects, with process analysis and model discovery are done with separate systems. In this study, we present a comprehensive framework to join the BPR and process mining to complete a BPM lifecycle incorporating distributed computing.

This paper is organized as follows. Section II presents related works, while section III and IV explores in detail about the BPR platforms and discusses the prospective of the propose framework, respectively. Finally, section V draws conclusion.

II. Related works

1. BPM overview

A business process [1] is defined as a collection of activities that are performed in coordination in an organizational and technical environment. Claiming insurance, manufacturing a product and container handling operation in ports can be examples of business processes. Each activity in a business process can be performed manually, aided by a information systems or automatically executed. Submitting a claim can be done manually, while positioning a container in a yard block can be both aided (e.g., a human operating a yard crane receives a location in the yard block from terminal operating systems) or automatically done (e.g., an automated yard crane does the job) by a support from software information systems.

As briefly explained in the introduction section, BPM lifecycle is improved as the technology advanced. In [1], he mentioned a classical BPM lifecycle, which starts at the identifying business process(es) of an organization, modeling, executing, monitoring, and redesign it. In the identifying and modeling phases of a business process, a group of experts, consists the management of the company and process analysts, interview employees, checking documentations and observing how works having done in the company. These phases can be considered exhaustive since it takes time and the resulting model is sometime not exactly a depiction (e.g., more simplified or complicated) of the real situation. The execution and monitoring phases are handled by BPMS. Since business process changes over time, a redesign phase is necessary for a company to evolve. This phase is quite similar to the identification and modeling since the experts group will also identifying the changes and how to model and implement that changes in the improved process model. In [2], he revolutionized the BPM lifecycle by adding process discovery and process analysis of process mining to enhance process modeling and redesign phases, respectively, into [1], such that a full BPM lifecycle automation can be achieved. However, up until paper is written, it is not clear whether this conceptual breakthrough has been realized in the real world application.

Redesign part of a BPR is the most challenging part of a BPM lifecycle. Although the interest over BPM declines over the years, BPR has been studied in relation with ontology [5], knowledge management [6], Monte Carlo simulation and process value analysis [7]. among others. BPR has also been implemented in many areas, such as manufacturing [8-9], aviation industry [10], construction [6], healthcare [11], and municipal [12].

When computer was invented, it was used mainly for counting. Currently, with high performance and all-connected network, the capability of computers (including the mobile computers) are higher than ever. This advancement can be felt in every sector in our daily life, including in the BPM research area. Before, works are done and recorded manually, now we can schedule, implement, execute and monitor business process over a network-connected computer from around the world. The software architecture behind BPMS is also improved dramatically. By employing cloud infrastructure, the BPMS can run seamlessly.

2. Process mining overview

Process mining [4,13] was firstly positioned as a collaboration of data mining, machine learning, and process modeling and analysis. The basic idea of process mining is to find out and investigate of what actually happens during execution. This way, a process model, in contrast to process modeling in BPM lifecycle, sometimes differ from a modeler thought. Process deviation happens because of different factors, such as human performance, broken machines, old versus new technology, human experience, or any combination thereof, can be captured in an event logs. These factors, however, are not easy to quantify. In [14], Depaire et al. mentioned that some of the deviations are desirable, while others can be considered errors or frauds. Process mining starts from an historical execution of activity of a software information systems in the form of event logs. Then, a discovered process model from an event logs can be analyzed and, later, be used as an input for process improvements.

Van der Aalst [4] defined a hierarchical structure of events logs, wherein it composes of cases that consists of events. An event composes of an event label, timestamp, originator, event type, and other attributes. Similar to event, a case can also have attributes. Process model is discovered by observing the sequential relations between (sometimes also among) events in a case. Since its inception, there are many process discovery algorithms dealing with many aspects. For example, alpha-family algorithms [15-17] defined a sequence relation between events in a case, heuristics algorithms [18-19] defined a dependency relation between events relative to its frequency, fuzzy algorithms [20] defined a fuzzy-like abstraction and node/edge/concurrency filtering measurements, inductive mining [21] guaranteed a sound process model, other algorithm can discover a business process management notation (BPMN) model [22-23] or tree structure [24], others employ clustering [25], genetic algorithms [26-27], and linear programming [28] to discover a process model. Once a process model is discovered, a test, which known as conformance checking [29-31], can be conducted to see whether a discovered model complies to a given event logs.

In his latest book, Van der Aalst [13], he stated that several process mining tools both open source and commercial are not fully supported every process mining perspective. ProM [32] is well-known tools used in process mining. It is an extensible framework wherein researchers around the world can develop their algorithm and integrate it in ProM. Although it shows a good performance, practically, it is not easy to use for general users. Several other tools, i.e., Celonis [33] and Disco [34], provides a more user friendly to practical user. Both Disco and ProM are only supports process analysis, while process improvement are done by analysis of the experts. While Celonis is closely related to SAP, it is not clear whether it fully supports BPM lifecycle, including BPR.

III. Comprehensive BPR Framework

This section describes in detail the upgraded BPM life cycle and the technology that supports it.

1. The enhanced BPM life cycle

Fig. 1 shows the enhanced business process lifecycle which integrates BPM and process mining. Our framework starts two-ways. First, under assumption that a process does not yet identified, then we can start on the process identification and modeling path. Second, if a company already has historical execution of a previous activities (or process), then we can start on the process identification and discovery. Afterwards, both models (e.g., the modeled and discovered process) are transformed into an executable business process to be executed with BPE. Here, starts the boundary of the streaming block. Concurrently, a process monitoring, analysis and evaluation can be conducted in situ during execution. Next, a process evaluation and redesign are conducted by taking a snapshot of current running

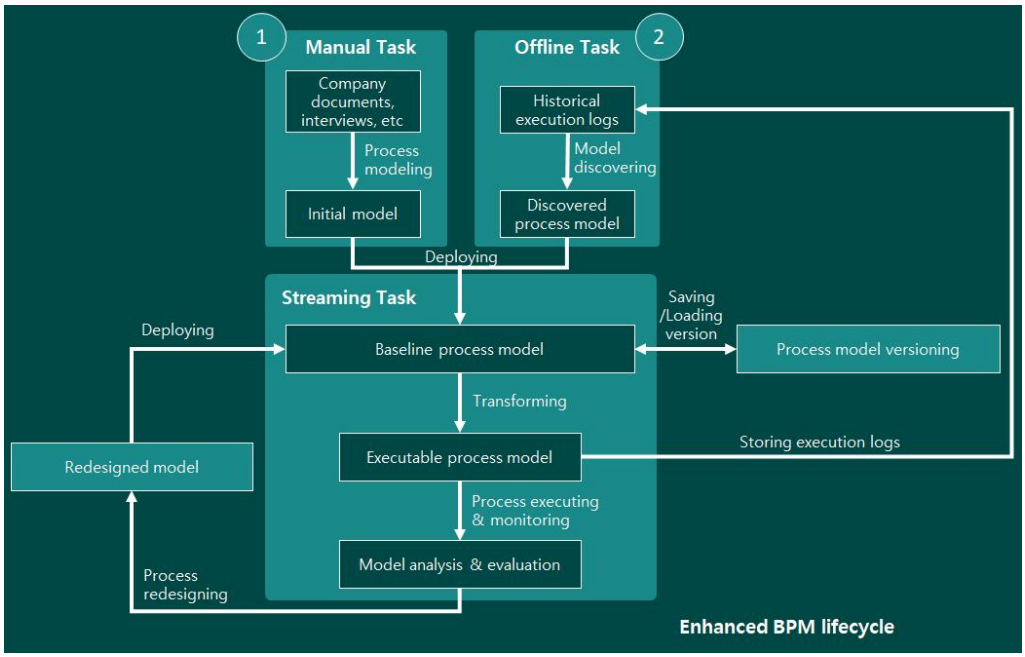

Fig. 1. Enhanced BPM lifecycle

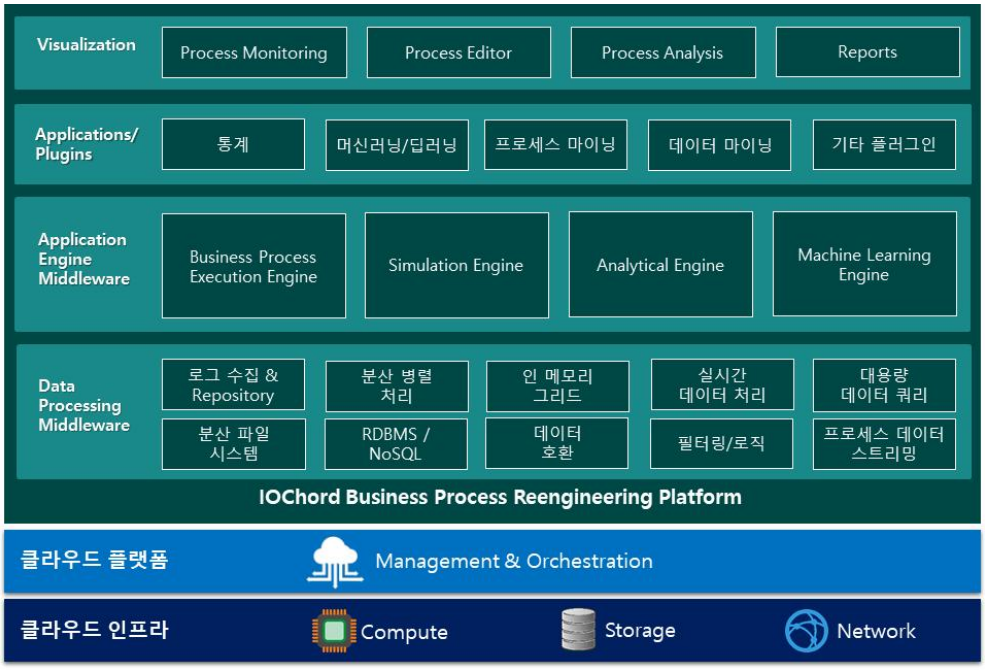

Fig. 2. BPR framework

process. In this part, snapshot is taken and the model is modified offline following six sigma standards and evaluation parameters during execution. Thereafter, the modified model then converted to an executable business process and deployed in the BPE, while also maintaining a process model versioning mechanism for tracking the changes in the business process. Hence, completes the life cycle of BPM.

2. The BPR frameworks

Our BPR platform consists of 4 layers, namely data processing middleware, application engine middleware, applications/plugins and, finally, the visualization layer, as shown in Fig. 2. Our platform sit on the top of cloud platform and cloud infrastructure. Unique factor compare to other BPMS is twofold. First, our data processing middleware connects various sources of data forms, i.e.,

distributed file systems, RDBMS/NoSQL, and stream data, among others. Second, our application engine layer integrates not only business process execution engine, it also contains simulation engine, analytical engine for process mining and data mining analytics, and machine learning engine. Applications layer is an extensible plugins where customized algorithm/program/application can be embedded to the systems. It will broadly extends the capability of the overall framework. Lastly, the visualization layer shows process monitoring during execution, business process model editor and simulation model editor, process analysis from applications of data mining/process mining/machine learning algorithms, reports contains reporting needed for simulation result, process analytics and monitoring.

IV. Discussion

There are many software giants that provides BPMS as a service, for example Bizagi [35] and Nintex [36], to name a few. On the other hand, tools like Celonis supports a cloud-based installation. However, as stated in the Introduction section, the integrated platform for automated BPR are not yet realized. Mainly, the separation of BPMS and process mining tools, which are the core of this platforms. Hence, we consider this as a business opportunity.

Besides the opportunity, we also face with technical challenges and systems adoptability once the product is realized. Particularly on the behavior changes on the implementation of the platform. Are business analysts no longer needed? What if the new redesigned process is performed worse than before? What if the automation is cutting people jobs? These questions may hinder the success of systems adoptability. These questions are also implicitly containing technical challenges that we must address.

We realized that redesigning a process model on a live systems is very challenging. That is why we consider a semi-automated BPR wherein our platform suggests recommendation on how a better business process can be achieved by learning on previous execution data, doing simulation and employing machine learning and data mining. Here, business analysts can give a consent before deploying it to the live systems. Additionally, we also maintain a versioning systems of the business process such that if the redesigned business process model performs worse then we can revert to the previous version, while continue to improve it.

V. Conclusion

This paper presents an improvement framework for BPM lifecycle, which supports a semi-automated BPR, by developing a BPR platform that integrating several body of knowledges sit on top of cloud infrastructure and platform. We also discuss in detail the opportunity and challenges related to this platform, including business opportunity, several technical challenges, and systems adoptability. Up until this paper is written, this study is the first to attempt such work.

Given the current data explosion, it would be beneficial for the industry to benefit from the implementation of our framework. We can start from data to obtain a process model, deploy, execute, analysis and redesign automatically, which some big industries are well-defined, while other small industries are not clearly aware how their company works. Doing analysis on what-if simulation that can be expensive if directly implemented in the company. For scholars, on the other hand, our extensible framework can be a test bed for breakthrough algorithms without them worrying about the complicated integration parts.

The limitation of the study including the technical difficulties for redesigning process model using a deep learning technique. It would be quite challenging since it will be time consuming and needs huge data for training. Other points, the systems integration of this framework would be like fitting in the puzzle wherein not every part of the framework perfectly fit with each other.

Going forwards, we think of extending this framework in a domain-area basis. This way, we can extending our framework and adding necessary algorithms specific in that domain, and, finally, our algorithms can identify and learn what factors effect the most on which domain.

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