Applying the Process Mining Project Methodology for Insurance Risks Reduction

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A R T I C L E   I N F O

A B S T R A C T

Risk is a destructive phenomenon, which is an integral part of any business. Process mining is a form of a business process analysis based on the recorded process data by information systems, whose its aim is to discover process, control, data, organizational and social structures from event logs. A process mining project methodology (PMPM) is considered as especially useful in the process mining project, which a comprehensive methodology that can be used as an efficient and effective approach for applying process mining in practice. This methodology made us sure that all important activities are performed and prevented of redundant work. This paper utilizes the PMPM for risk reduction to increase the organization agility against competitors and obtain the more market share. Evaluating the case study results with trace alignment method confirms expert confirmations. Trace alignment shows interesting patterns and provide better insight on process executions.

1. Introduction

Today, in the rapidly changing environment, uncertainties increase and approximately appear in all aspects of our life because they are a ubiquitous feature of life [1 and 2]. Ray et al. [3] said these uncertainties are what we define as risks and common definition of risks can refer to a possibility of loss, injury, or destruction [4]. Also, Shaw [5] said that Risk can be seen as the potential of loss or harm to an entity, (where) such an entity can be a person, a group, an organization, a system, or a resource. Many important elements in configuring risk involve place, time, space, and scale [6].

The estimation of possibility that a risk can occur and its effects (bad or good) are important [3] because a risk may drop performance, influence task execution, increase support costs and cause huge economic loss and social impact [7]. For example, a risk could cause obstruction

to project progress and can have negative results on the deliverables. If risks occur, at least, they have a positive or a negative effect on a project objective, such as time, cost, scope, or quality [8]. Totally, the risks cannot be eliminated; some of them can be controlled well by taking appropriate preventive action. Today, a risk management (RM) approach is a general procedure for resolving risks that originated in Germany [4 and 7]. RM is a collection of methods or techniques that its aim is to minimize or reduce the effects of risk and in recent 20 years, RM has become a comprehensive boundary science and important branch of modern management science [7 and 9].

RM is a means of avoiding danger and, simultaneously, offering an opportunity. The good risk management can make a difference between wealth and poverty, between success and failure, and even between life and death. Therefore, RM is worthy of close attention [5]. Process Mining (PM) is a relatively young research discipline that can be used for risk management [10]. As a result, using the comprehensive methodology is essential for implementing the PM projects. Process mining is a form of business process analysis based on recorded process data by information systems. The logs of these information systems contain information about historic events that took place during the process. Process mining techniques support organizations in retrieving structured process information using these logged events to discover, monitor and improve their processes [11].

Also process mining has proven to be a valuable approach that provides new and objective insights into the way business processes are actually conducted within organizations [12]. Caron et al. [13] propose a comprehensive Rule-Based compliance checking approach with process mining. The results of their research show PM could complement the management's existing set of tools and techniques for risk evaluation, response and monitoring. Their approach discovers configured rule patterns. These patterns enable us to identify the events that might adversely affect the achievement of the objectives and the estimation of both the risk's probability and severity, known as respectively risk identification and assessment. Moreover, the approach makes the discovery of correlations between different types of risk. Also, comprehensive rule-based compliance checking is well suited for the design and implementation of detective retrospective management controls, which is a risk response strategy. Their proposed approach is suitable for monitoring the evolution of both the risk's impact and its possibility of occurrence.

The corporate fraud represents a huge cost to our economy which one of them is internal transaction fraud. Jans et al. [14] utilized PM for reducing the internal fraud. PM diagnoses the processes with event log mining and provides opportunity for fraud detection and fraud prevention [14]. Also, they present the extended IFR2 framework as a complement to the internal control framework of the COSO (Committee of Sponsoring Organizations of the Tread way Commission). This framework is for both academics and organizations to investigate how to reduce internal fraud risk by using PM [15]. Health care service providers' fraudulent and abusive behavior has become a serious problem these days which Yang and Hwang proposed a process-mining framework that utilizes the concept of clinical pathways to facilitate the automatic and systematic construction of an adaptable and extensible detection model [16].

Until some studies developed a methodology or framework for a specific purpose, for example to check or to reduce fraud risk. Other studies developed a methodology for a specific context, e.g. healthcare environments. These studies use process diagnostic method (PDM) or business process analysis in healthcare (BPA-H) environment methodologies.

None of studies did not utilize a comprehensive methodology for risk discovery in process mining scope. In this paper, after comparing the available methods for mining, authors use a process mining project methodology (PMPM) for risk detection for the first time.

PMPM can be used as an efficient and effective approach in order to apply process mining and seems to be a valuable methodology for conducting process mining projects in practice; therefore, the methodology needs more empirical evidence to be presented as a valuable methodology for business process mining projects [11]. Therefore, this paper utilizes the PMPM and implements it on Insurance dataset for uncovering risks in business processes. This approach is suitable to improve business processes in all kinds of sectors and functional areas and be independent of time, budget and the tools used for working with the data [11]. In the first section of this paper, the authors introduce the concepts of risk and risk management. Section 2 introduces process mining and Section 3 explains the PMPM. Section 4 includes using of the PMPM on insurance dataset as case study. Section 5 presents a discussion about using the PMPM on insurance corporation dataset, and Section 6 prepares conclusions.

2. Process Mining

Process mining (PM) is a relatively new research scope that its idea evolved in 1990s [10 and 17]. It is between computational intelligence and data mining on the one hand, and process modeling and analysis on the other hand [10 and 18]. It is the art of extracting non-trivial and useful information from event log that achieved executing processes, due to PM is the method of distilling a structured process description from a set of real executions [19]. The aim of PM is to discover, monitor and improve real processes by extracting knowledge from event log readily available in today's (information) systems, such as enterprise resource planning (ERP), workflow management (WFM) systems, customer relationship management (CRM), etc. [10 and 11]. An event log consists of cases and cases consist of events. The events for a case are represented in the form of a trace and each trace describes a sequential list of events corresponding to a particular case [20].

PM is a process management technique that can be used to support several activities of the process management spectrum [11]. PM is closely related to business activity monitoring (BAM), business operations management (BOM), business process intelligence (BPI), and data/workflow (WF) mining [21]. Cook and Wolf used PM in the context of software engineering and firstly, Agrawal used PM in the context of workflow managements based on the workflow graphs [17 and 22]. Process mining techniques help organizations for discovering and analyzing their business processes based on raw event data or logged events automatically [18]. This action can often be done quicker, cheaper and in a more reliable way than traditional analysis due to traditionally processes analysis is time consuming, expensive and human force needs [11].

Process mining establishes a link between the event logs and process models which event logs can be used to conduct three types of process mining [11 and 10]. Due to three main types of PM, namely discovery, conformance and enhancement can be identified [11]. The first type of PM is discovery which uses an event log and procures a model without using any a-priori information. The second type of PM is conformance which compares existing process models with the event log of the same process. The third type of PM is enhancement which its idea is to extend or improve an existing process model using information about the actual process recorded in some event log [10 and 11].

Performing process mining projects in organizations requires several extra activities next to the actual application of the process mining techniques. Heijden [11] shows six different methodologies in the area of data and process mining (TABLE 1). As these methodologies could be helpful by providing inspiration for developing a process mining project methodology selecting the best one for PM is very important [11].

According to C.W. Gunther in 'Process Mining Camp 2012' conference, a lack of a process mining methodology for business is a good reason for the development of PMPM or proposed methodology. PMPM is unlike KDD, CRISP-DM, PDM, BPA-H and L*. The five first methodologies all lack in being a general approach for all business process mining projects [11]. KDD and CRISP-DM which are in data mining scope can't be used for process mining (TABLE1) because data mining and techniques can (and usually will) differ from process mining data and techniques [11]. PDM and BPA-H do not take the business and BPA-H and L* designed for specific process. BPA-H is designed for unstructured healthcare processes. While L* describes the typical life-cycle for mining structures processes [11]. Whereas,

- PMPM includes certain activities that are necessary for process mining, but not included in the data mining methodologies,
- PMPM contains a phase that identifies the organizational process and formulates business objectives included, therefore PMPM is a business driven.
- All activities as described in PMPM can and should be performed in any business process mining project [11] and this method does not relate to specific process. Therefore, authors select the PMPM as the general methodology for risk discovery.

3. Process Mining Project Methodology

A process mining project methodology (PMPM) as a comprehensive methodology describes how to accomplish process mining in practice. PMPM has six phases (FIGURE 1) that in this methodology all phases and main activities of business process mining projects are described and that can be used as an efficient and effective approach for applying process mining in practice. The phases of PMPM methodology define as bellow:

1. Scoping phase means developing understanding to identify how process mining can be applied to the process and to formulate the objectives that drive the process mining project. This phase contains three parts namely identify the process, determine objectives and determine tools/techniques [11].

2. Data understanding means understanding the data that is needed for these objectives and investigating if and how this data is available. This phase contains three parts namely locate data, explore data and verify data [11].

TABLE 1. Six Different Methodologies

Row	Methodology Name	Description	Scope	Driven by	Process Specific
1	Knowledge discovery of databases (KDD)	This process is a common framework that aims to understand the variety of activities in the KDD field and how these activities are related. Researchers view the KDD process as a set of various activities in order to make sense of data. The core of KDD is the application of data mining methods for pattern discovery.	Data mining	Business	No
2	CRoss-Industry Standard Process for Data Mining (CRISP-DM)	This process is a widely used methodology developed to support the professionals that apply data mining and to demonstrate prospective customers that data mining was sufficiently mature to be adopted as a key part of their business processes.	Data mining	Business	No
3	Process diagnostics method (PDM)	This methodology highlights three different perspectives of process mining and aims at giving a broad overview of the organization's process (es) within a short period of time.	Data mining	Data	No
4	Business process analysis in healthcare (BPA-H)environments:	This methodology is built on PDM. This methodology for the application of process mining techniques in a healthcare setting aims to identify regular behavior, process variants, and exceptional medical cases.	Data mining	Data	Yes
5	L* life-cycle model for mining Lasagna processes (L*)	The five-stage model that describes the life-cycle of a typical process mining project aiming to improve a structured process.	Data mining	Business	Yes
6	Process mining project methodology (PMPM)	A comprehensive methodology that describes how to accomplish process mining in practice.	Data mining	Business	No

3. Event log creation means which how the data must be gathered and prepared to be appropriate as input for process mining techniques. This phase contains three parts namely select data, extract data and prepare data [11].

4. Process mining means which process mining techniques has been applied to answer the business questions such as improve the organizational process. The main activities in this phase are familiarizing with the event log, ensuring that the event log is structured enough to apply the required process mining techniques and actual analysis of the data by applying the process mining techniques. Therefore, this phase contains three parts namely familiarize log, ensure structuredness and answer questions [11].

5. Evaluation means evaluating the accuracy and value of the output of the process mining techniques. This evaluation is done by a verification, validation and accreditation of the analyzed results. Furthermore, it can be decided to elaborate the process mining project. Therefore, this phase contains four parts namely verify, validate, accreditate and determine elaboration [11].

6. Deployment means reporting the results to the organization so that it is possible to deploy the gathered knowledge in the process environment. This phase contains two parts namely Identify possible improvements and present results [11]. [11] Shows all phases of PMPM as Figure 1.
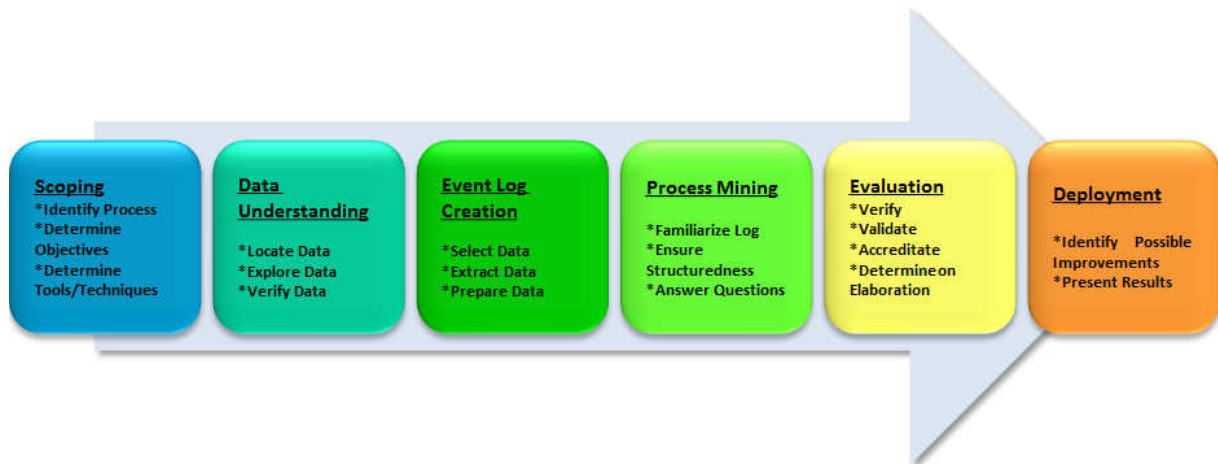

FIGURE1. Summary of the Process Mining Project Methodology (PMPM)

4. Case Study

For illustrating the application of the PMPM in RM, the dataset of a case company was acquired. Day Insurance Corporation was chosen for mining because of one of the provided services by this corporation is Life and Investment Insurance service and this activity is one of the most risky activities. In this case study, the authors utilize the PMPM for mining the risk of insurance business activities.

4.1. Scoping

In scoping phase, developing the understanding to identify how process mining can be applied to the process and to formulate the objectives that drive the process mining project has been done [11]. Therefore, in this phase the registration and issuance of life and investment policy activity of Day Insurance Corporation' activities set have been chosen. The business process selected for risk reduction is services, so data from the case company's services cycle is the input of our study. The starting point of registration and issuance of life and investment policy activity is that a policy proposal form should be filled by a marketer or insured. After that, based on proposal form, the policy draft is produced. If policy draft is confirmed then it is converted to policy document which will have a financial charge. Therefore, the registration and issuance of policy steps are 1-registration and confirmation of policy draft and 2-creation of the policy document.

4.2. Data understanding

Data understanding phase understand the data that is needed for PM objectives and investigating if and how this data is available [11]. Also many different information systems, like ERP, WFM, CRM and B2B systems, are characterized by the omnipresence of logs. Typically, information about the usage of the system by its users records in these information systems. These logs contain information about the instances, also called cases, processed in the system, the activities executed for each instance, at what time the activities were executed and by whom [15]. Input data for this case study belongs to Day Insurance Corporation that contains 2357 events and 2059 cases which recorded from 10 November 2012 to 10 December 2012. Company experts verify the data accuracy because they are gathered during the actual implementation of business processes.

4.3. Event log creation

Event log creation phase describes how the data must be gathered and prepared to be appropriate as input for process mining techniques [11]. Under review data was gathered by information system according opinion experts. In this case study, the XESame software has been used and creates the event log. After selecting the event attributes, three steps for generating the event log passed. The generated event log has 2 attributes for each event which is generated by 36 users.

4.4. Process mining

In process mining phase, selecting the appropriate process mining techniques for answering the business questions has been done [11]. For mining the hidden risks in business processes, heuristic algorithm had been selected for creating the process model. Heuristic algorithm has the capability of the loop mining and Loop is an open problem when mining and modeling processes [19 and 22]. Various loops have a great impact on the process performance [23]. Therefore, mining the loop is a very important problem in each process. Authors consider loop in business activities as risk since loops in any processes cause that we

can't terminate the process successfully on time because we lose the time and money. Accordingly, Karadsheh [8] said: If risks occur, at least, they have a positive or a negative effect on a project objective, such as time, cost, scope, or quality. Therefore loops in process model consider as risk.

Heuristics Miner mine traces that could be incomplete and may contain noise. The algorithm computes edge frequency (a number between 0 and 1) to indicate the confidence in an edge. Also it provides a number of heuristic rules that rely on the frequency of edges to infer ordering relations [24]. Heuristic algorithm used for mining higher quality model in shorter time and its aim is discovery of a "good" process model, often targeting particular challenges (e.g., the mining of loops, or duplicate tasks) [12 and 25] because not all process discovery algorithms can handle event loops [19]. Figure 2 shows the acquired process model using heuristic algorithms. DP and AR mean the registration and confirmation of the policy draft activity and creation of the policy document activity sequentially. The precision value of model is 0.9903 that high precision addresses overly general model [11].
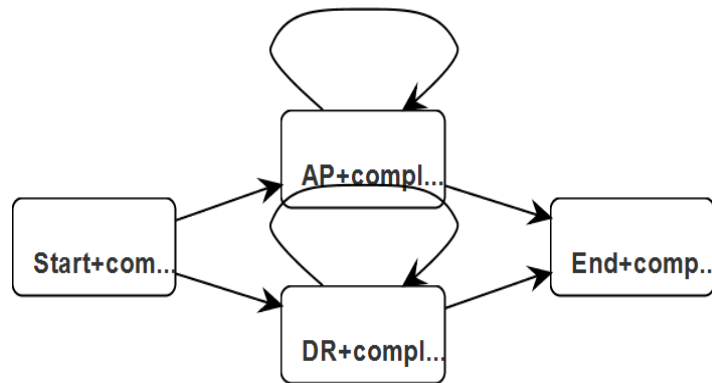

FIGURE2. Process Model

Figure 2 shows the process model which has two loops on activities. The loop on registration and confirmation of policy draft activity shows this activity has risk but the risk of it is light because the draft accepts the changes. Also the existence of loops on the creation of the policy document's activity has risk because this activity can't accept changes. Information manipulation of issued policy is risk because of the existence of the loop on activities that can't change, shows there are risk. Identified risks on two selected activities are confirmed by insurance experts.

4.5. Evaluation

Evaluation phase evaluate the accuracy and value of the output of the process mining techniques [11]. In this case study, insurance experts confirm the identified risks but the trace alignment method is used for ensuring the accuracy of identified risks. Trace alignment can be used in a preprocessing phase (for investigating or filtering the event log) and in later phases where detailed questions need to be answered. This method complements existing process mining techniques focusing on discovery and conformance checking. The trace

alignment goal is to align traces in a way that event logs can be explored easily and find optimal alignments. Alignment is allowed between a pair of traces, a trace and an alignment and between alignments. The selection of traces for alignment is based on their similarity because this method has an iterative nature. Traces that are most similar to each other are aligned first. Once similar traces have been aligned, the resulting clusters of traces are aligned against each other. A guide tree is built to assist this process. Also trace alignment uncovers common execution patterns and deviations in the log yielding better insights for analysis [26].

Identified risks in process mining phase are confirmed by insurance experts and trace alignment method is used for assessing the obtained answers for insuring the accuracy. Assessing the answers is very important because expert mistake in the confirmation of the case as none risk can bring damage to the organization. Trace alignment on the case study dataset must show the risky activities are similar. As a result, Trace alignment with two clusters are used for evaluating "is the risky event trace put in same cluster or not?" Trace alignment put the similar traces as the length of the alignment and gaps which are shown with "-" sign [26].

Trace alignment on insurance dataset with two clusters shows that traces without loop are put into one cluster and traces with loop are put into another. Cluster 1 contains traces that are related to activities that are performed once and do not create loop. These traces travel safe path and are considered without risk traces although the traces are different from each other as executing path. For example, registration and confirmation of policy draft activity travels different path from creation the policy document activity but these two activities' traces put in one cluster because both of them are without risk.

Cluster 2 contains traces that related activities perform more than once and create loop. This loop can be the factor of risk. Also event traces in cluster 2 not similar as execution path because this traces are related to registration and confirmation of policy draft activity and the creation of the policy document activity. All of the traces in this cluster has loop and some of the traces contains "-" sign because the length of the alignment of traces was not equal. Therefore, by using "-" sign for equal length, similar traces as the length of the alignment and gaps are put in cluster 2. Figure 3 shows the trace alignment for cluster2. Chars "a" and "b" show the registration and confirmation of policy draft activity and creation the policy document activity sequentially.

A guide tree is built to assist trace alignment with visualization of alignments for different subsets of the traces [26]. Traces with no 1019600 and 1020129 put in cluster 2 because they are similar. These traces have one parent (FIGURE 4).

4.6. Deployment

Deployment phase reports the results to the organization so that it is possible to deploy the gathered knowledge in the process environment [11]. In this phase, results have been sent for managers and they confirm the results and decide to utilize PMPM on other organization sections for identifying risks, managing them and improving the business processes.
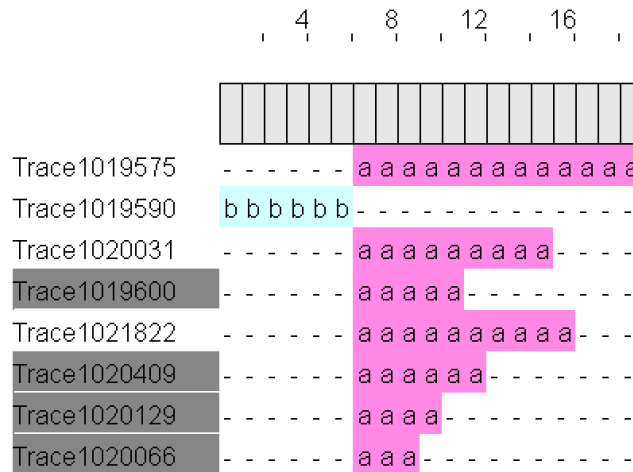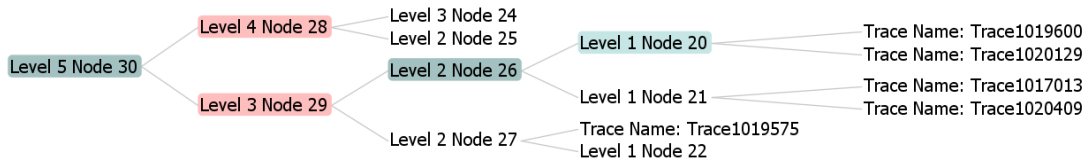
Figure 3. Trace Alignment for Cluster2

Figure 4. Guide Tree for Alignment of Cluster2 Traces

5. Discussion

PMPM is a comprehensive methodology that described all phases and main activities of business process mining projects and that can be used as an efficient and effective approach for applying process mining in practice. PMPM is developed with the help of the Systems Engineering Approach [11]. Using PMPM on insurance dataset for risk reduction illustrates two types of risk (loop) are in business processes of insurance. First type is light risk that happens on registration and confirmation of policy draft activity because the draft accepts changes. This type of risk can be managed with using expert users for register the customer information. This type of risk is operational risk that if we can control it then the reputation risk and financial risk are controlled. On the one hand, operational risk causes reputation risk, and reputation risk can be creator factor of financial risk on the other hand.

Second types of risk are on creation the policy document's activity because changing this activity is impossible. Information manipulation of issued policy is fraud and the cost of this type of risk is very high. Fraud can cause the organization bankruptcy and financial risk occurs. Identified risks confirm by insurance experts and then for evaluating the accuracy of results trace alignment method used. The acquired results from trace alignment show two types of risk exist in insurance business process.

The traces without risk put in cluster 1. These traces travel safe path although they passed different execution path. For example registration and confirmation of policy draft activity travels different path from creation the policy document activity but these two activities'

traces put in one cluster because both of them are without risk. The risky traces put in cluster 2. Event traces in cluster 2 not similar as execution path because these traces are related to registration and confirmation of policy draft activity and creation the policy document activity. All of the traces in this cluster has loop and some of the traces contains "-" sign because the length of the alignment of traces did not equal. Therefore by using "-" sign for equal length, similar traces as the length of the alignment and gaps put in cluster 2.

Caron et al. [13] propose a comprehensive Rule-Based compliance checking approach that uses PDM methodology with highlighting a functional process, control-flow process, organizational process and data process perspectives of process mining. Jans et al. [14 and 15] utilized PDM methodology with considering process, organizational and case perspectives for reducing the fraud. Yang and Hwang [16] proposed a process-mining framework that utilizes the BPA-H method. Available studies developed a methodology for a specific purpose or for a specific context. As their used method lacks a general approach for all business process mining projects, authors use the general and comprehensive methodology that was business driven and no process-specific for the first time [11]. Also the precision of 0.9903 confirms that the acquired model by general methodology is general.

With considering the research results, existence of case studies that present the application of general methodologies in all aspect is very important. Therefore, this research helps the researchers that select the good methodology for business process mining and obtain best results in their work area. Also as the improvable point in this scope is risk discovery and control it in business processes.

6. Conclusion

A process mining project methodology (PMPM) was considered especially useful in conducting the case study since it made sure that all important activities were performed and prevented redundant work. The aim of this case study was to use the PMPM on business processes and risk discovery. Nowadays most businesses accept the risk and hidden risk in business processes causes that the organizations cannot obtain maximum benefits. Therefore, using the PMPM on business processes is essential since it uses a comprehensive methodology which closes the organizations to their target. Using the PMPM for the business process causes organization managers find failure processes sooner and try to revise or improve them. The organization agility increases if business processes improve. Increasing the agility causes return on investment increased and business obtain more market share. Utilization of the PMPM on insurance dataset helps managers to discover risks easier and select appropriate strategy for controlling them. The results of a case study shows two types of risk found. The first type is operational risks that happen when there is a lack of user's skill. The second type of risk is fraud that has important impact on organization financial resource. Also evaluating the obtained results with trace alignment shows the risky activities, which are put in one cluster because they are similar. They spend time, cost and human resource; however by the assigned resource cannot perform business processes successfully.

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