Business Process Evaluation of Outpatient Services Using Process Mining

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***Abstract*—A business needs an evaluation to increase its services and adaptability to the environment changes. Business process evaluation is one of the several ways for business development. This paper reports an assessment of outpatient service process at RSUD Sukoharjo for BPJS Health insurance's patient using process mining to get an objective *process model*. We implement the Inductive Miner infrequent approach and analyze the process model with conformance checking and performance analysis. Stakeholders can utilize the results of the evaluation to understand the real service condition and plan an action to improve their services. We can conclude that there is a bottleneck in the waiting time of the registration process with an average of 1.5-2 hours, a polyclinic treatment process with an average of 1-2 hours and pharmacy process with an average of 0.5-1 hours.**

***Index Terms*—Business Process; Evaluation; Process Mining.**

I. Introduction

Business development is one key attribute to assess an organization's maturity [1]. As a business organization, Regional Public Hospital (RSUD) needs to develop their business process by making an objective evaluation of its service implementation. This assessment aims to find out any problems that occur in the service application and to plan for better service and quality [2]. Community complains about the discontent against the services provided, both by Public and Private Hospitals [3]. They complain about their inconvenience in a long queue. Despite already having a transparent procedure and regulation made by the Government, there are still many complaints about the services. Data service records in the hospital's information system should be optimized to evaluate outpatient services process.

Process mining that uses real execution data is an approach that can help hospitals to do the evaluation objectively [4]. It discovers, monitors and develops the real processes from available data stored in the information system [5]. Process mining standard and its implementation approach have been used widely, such as in banking, insurance, customer relationship management, and healthcare [4][6]. In this study, we use ProM tool, an open source project developed by the Process Mining Group, Eindhoven University of Technology, to implement the process mining techniques. ProM is a framework that allows its user to implement various process mining techniques through available plug-ins [7][8].

Previous researchers on process mining techniques in healthcare area have been performed by Rojas et al. (2015) and Murti et al. [9][10]. Other research has applied process mining techniques on the extraction of ERP business processes to identify the bottleneck by comparing Alpha++ algorithm to Heuristics Miner and drawing a conclusion based on their result [11]. Process mining has also been used to search the patterns of employment relationships between medical personnel in serving diabetes patients and its complication on inpatient services [12].

This paper describes the implementation of process mining to evaluate the outpatient service process of RSUD Sukoharjo for BPJS Health insurance patient only.

The remainder of this paper is organized as follows: The Literature Review section provides an overview of process mining and related knowledge such as event log, Petri net, and inductive miner-infrequent. The methodology section describes steps to employ this study and discussion section discuss our analysis and findings using Petri net and ProM and finally concludes the paper, with a summary and usefulness of this work.

II. Literature Review

A. Process Mining

Process mining works by finding, monitoring and developing the real processes [13]. The objective of process mining is to extract the information related to the process of an organization or system from event data that has been available in the information system [5][7]. The three most important types of process mining are [7]:

a. Discovery, discover a process model from an event log.
b. Conformance, compare an existing process model and its event log to find whether the reality conforms to the model and vice versa.
c. Enhancement, making improvements or additions to the process model by using the information in the event log.

B. Event Log

An event log is defined as information about a single process [5]. In general, it contains information about the case, event, timestamp, resource and other case's attribute. Each event in an event log represents an activity that is done in the system which is closely related to a case [7][13]. In process mining, event log can be used to do some checking against the model's conformance, as well as doing development of process model [5][14].

C. Petri Net

Petri Net is a bipartite graph consisting of a place and transition that connected in a line/arc [5]. Petri Net is a triplet $N = (P, T, F)$ where P is a limited set of place where T is a finite set of transition. Then $P \cap T = \emptyset$ and $F \subseteq (P \times T) \cup (T$

x *P)* is a set of a directed arch or flow relation [5].

D. Inductive Miner-infrequent

Inductive Miner-infrequent is a process mining approach developed with the goal to find a model that is 80% sound [15]. To implement this method, we use an Inductive Miner package in ProM tool. The output of Inductive Miner can be either a Petri Net or a Process Tree [16].

III. METHODOLOGY

The first step of this research is retrieving real processes of the hospital's information system in the form of a CSV file. There are approximately 58,569 records, containing data of March 2017, April 2017 and the first week of May (1-7th, May) 2017. It includes a patient's medical record number, type of service, a timestamp of the service. To ensure that the data is valid, we observe RSUD Sukoharjo's outpatient service process in four days. This observation gives information on both manual and automated service processes. We record each process and time spent on it including waiting time and service time. The second step is preprocessing the data by excluding the surgery case and outpatient who received inpatient services. We also perform identification and exclusion for an event that is automatically added to the system with the registration activity. After the preprocessing is done, we convert the CSV data info an XES format before processing with ProM 6.6. We implement the Inductive Miner-infrequent approach with Petri Net as its result [16]. Meanwhile, we analyze the process model with a replay concept by using event log and a process model as its input. We use conformance checking and performance analysis to analyze the process model [5][17]. We perform conformance checking to find how well the process model confirms the event log and performance analysis to find the bottleneck in the process.

IV. DISCUSSION

We analyze the event log by using a patient's medical record number as a case ID, type of service as an event ID, and execution time of the service as a timestamp. We classified the outpatient service into four types of process. Firstly, Registration and Consultation (including registration process and consultation with the doctors in polyclinics). Secondly Polyclinic's Treatment (including all the treatment in the polyclinic's beside medical consultation). Then, Supporting Check-up (including all the services provided by the installation of electro-medic, laboratory, radiology, and medical rehabilitation), as well as Pharmacy (getting the medicine in the hospital's pharmacy). These classification aims to get an overview of BPJS outpatient service processes by the administrative procedure that has been established (Figure 1) [18].

Existing Process of BPJS Health Outpatient Service shows the administrative process that has been established. We use the Inductive Miner-infrequent approach with 0.20 noise threshold to get a Petri Net process model of the event log [14]. Table 1. Event Log Summary Information shows information about the service processes extracted from event log while Figure 2. The Discovered Process Model shows the process model based on the event log.

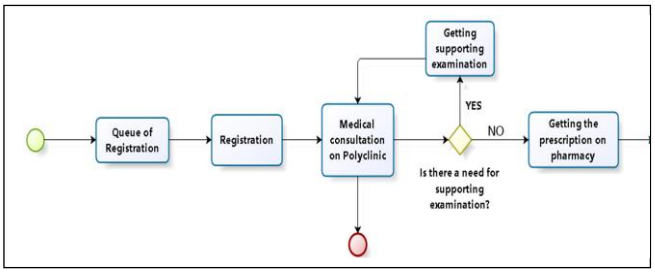


Figure 1: Existing Process of BPJS Health Outpatient Service.

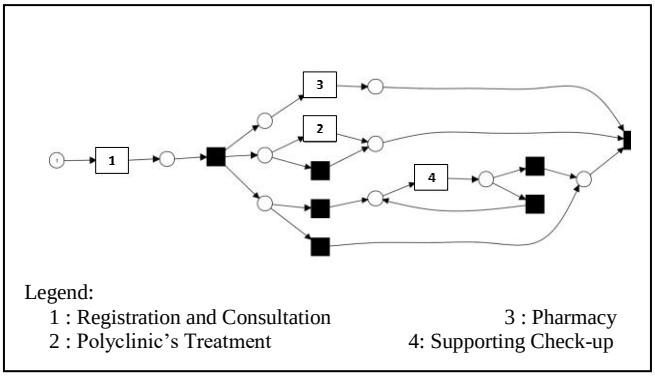


Figure 2: The Discovered Process Model.

Table 1
Event Log Summary Information

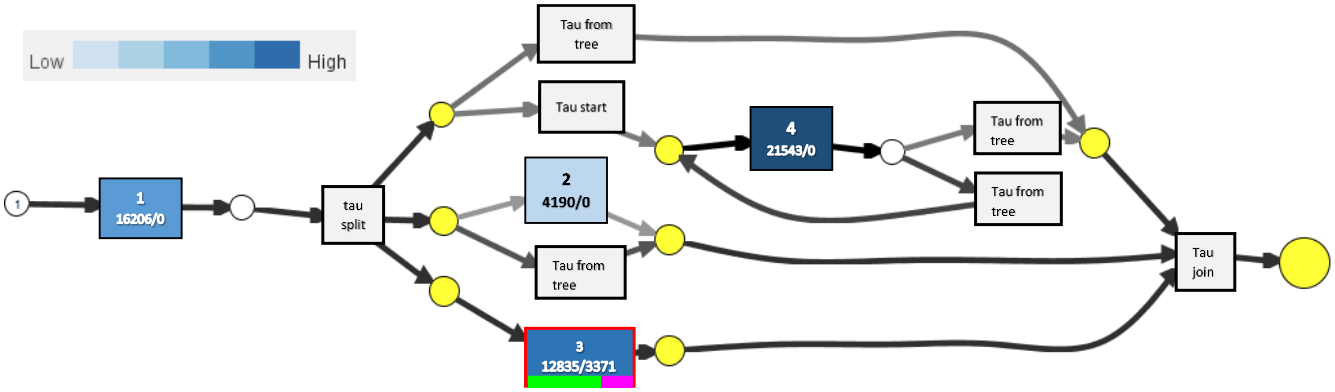
Subject	Information
Time	March-7th May 2017
Cases Total	16,206
Events Total	58,568
Common Process Behavior	(1) Registration and Consultation- Pharmacy, (2) Registration and Consultation- Policlinic's Treatment-Pharmacy, (3) Registration and Consultation- Supporting Check-up-Pharmacy

From the event log, as shown in Figure 2 and Table 1, the first process is a patient's registration and consultation with the doctors. After getting a medical consultation, there are three kinds of processes that can be done by the patient: getting the polyclinic's treatment, getting supporting checkups, or going to the hospital's pharmacy to get their prescription. The comparison between the existing process model and the event log shows some differences. First, the event log does not include the other automated process, queue of registration. It is a queue line of patients who will bring their document to register in the RSUD Sukoharjo's outpatient service. This difference occurs because the registration queue's data process is recorded in a separate system called queue system instead of the outpatient information system. Second, the activity of a medical consultation with doctors in the polyclinics is considered the same as the registration process because it was inserted in conjunction with the registration process into the system. When a patient registers themselves, the system automatically inputs two processes: the registration process itself and medical consultation with the doctors in the polyclinics. Therefore, the event log considers these two different processes as one because of their timestamp.

We analyze the discovered process model by using the conformance checking and performance analysis. Conformance checking provides information and analysis about how well the discovered process model conforms to the event log [17] while performance analysis gives an

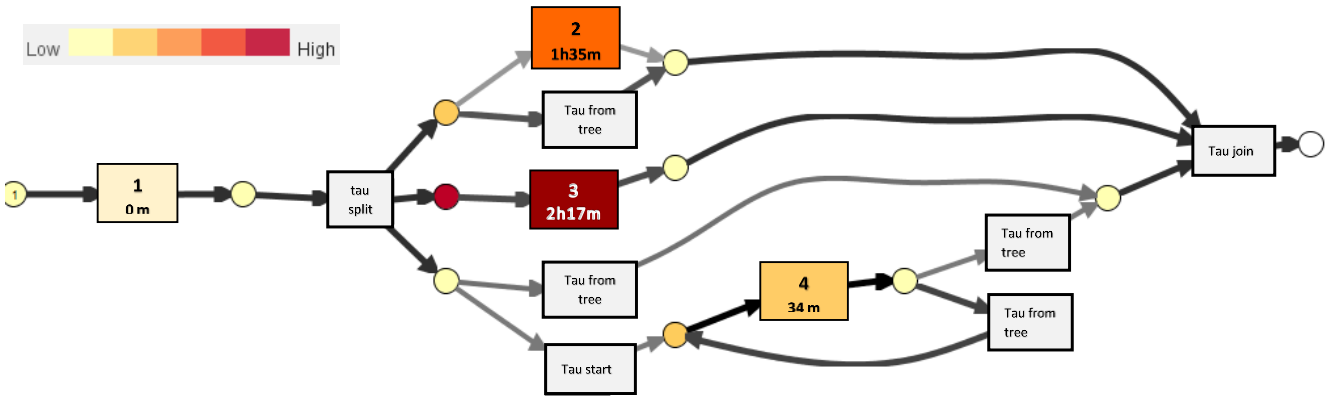
analysis of the risk of the bottleneck [16][19]. Figure 3. Conformance Checking of Event Log shows the result of conformance checking while Figure 4. Performance Analysis of Event Log shows the result of performance analysis. Both Figure 3 and Figure 4 show process model discovered from the event log described in Figure 2 and Table 1.

Conformance checking provides information about how well a process model describes the process flow listed in the event log [20]. We use trace fitness value to determine whether the discovered process model has a good quality. Fitness value will give its perfect scale, 1 when all behaviors in event log fit with the model. The frequency of matches between the event log and process model is depicted through the difference in color in the process model. Dark color transitions mean that it has a higher frequency of matches compared to bright colors. In addition to that, the size of the place describes the frequency of events occurring in that place. Greater size indicates there is a higher number of event. Through Figure 3. Conformance Checking of Event Log, we know that the Supporting Check-up process is the highest. The discovered process model has a good quality with its fitness value is 0.93 with maximum scale 1 [19].



Legend:
1 : Registration and Consultation
2 : Polyclinic's Treatment
3 : Pharmacy
4: Supporting Check-up

Figure 3: Conformance Checking of Event Log



Legend:
1 : Registration and Consultation
2 : Polyclinic's Treatment
3 : Pharmacy
4: Supporting Check-up

Figure 4: Performance Analysis of Event Log

Performance analysis shows that 16,206 cases in the event log have been modeled in a Petri Net process model. The analysis calculated how much time is spent in each transition process and an average of overall processing time. A comparison between the average time and each transition process' time determines the color transition. As a result, performance analysis gives darker colors for the process that takes a long time to run and brighter colors for a process that does not require a long time. Therefore, we can identify bottlenecks by using the information from the performance analysis. Nevertheless, it should be understood that there is a difference between the public understanding of the service time standards and the minimum process standards of the time service in the hospital [21]. Regarding hospital's process standards, the service process is doing well since the actual execution time does not exceed the service time standard. However, the community is questioning and complaining about the waiting time of service process that has not been specifically described in the service standard [3].

From the result of performance analysis and observation of the service process, the bottlenecks are:

1) Registration queue. The waiting time in the registration process causes the longest queue with an average of 1.5-2 hours. Lines of the patient queue that have already occurred in this process has an impact on the next processes.

2) Polyclinic's treatment. The waiting time, with an average of 1-2 hours, is one of the causes in the long queue. The existing process model shows that this process is unified with the medical consultation. In other words, patients who line up at polyclinic A may get treatment as well as medical

consultation. Therefore, we can conclude that a bottleneck occurs when patients are standing in line waiting for polyclinics service, including medical consultation.

3) Pharmacy. The performance analysis shows that a patient needs to wait for about 2 hours 17 minutes before they get their prescription. However, from the previous discussion about the process, we can conclude that the average waiting time of pharmacy process is about 30 minutes-1 hours. Further research needs to be done in order to get more detailed analysis because it only needs 1-2 minutes for a patient to receive their prescription.

V. CONCLUSION

Based on the analysis, we can conclude that the discovered process model enables to describe the process of administration services. There are three primary processes that most likely cause a bottleneck included Registration waiting time, Polyclinic service's waiting time, and Pharmacy's waiting time. There are several opportunities to develop more detailed research on the process of Supporting Check-up and Pharmacy to shorten the waiting time. Then, hospital management should establish a standard of waiting time for each process to reduce the bottleneck's risks and evaluate the outpatient service processes for a nonBPJS patient. Analyze the detailed process of outpatient service in RSUD Sukoharjo.

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