Procurement Process Analysis Using Process Mining in Cement Manufacturing Company (Case Study PT. Semen Indonesia Persero, Tbk)

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Abstract—**Procurement process holds crucial role in companies' business process, particularly manufacturing company. PT Semen Indonesia as one of manufacturing Companies in Indonesia relies on procurement process in order to fulfill their business. However, existing e-procurement does not cover all the procurement process which creates process variants have made whole procurement process run into bottleneck. Deeper analysis required to dig insights on the process variants to derive the cause of problem. Hence, this research aims to explore Process Mining to gain more insights from the process using data log derived from the system. BPM lifecycle used as an approach to reach the objective of the research. However, not all phases in BPM lifecycle are imposed, yet Process Identification, Process Discovery and Process Analysis. The result showed that top three activities that take time most are Upload to E Procurement, Purchasing Configuration, and Technical Evaluation which require improvements.**

Keywords—**Procurement, Process Variants, Bottleneck, Process Mining, BPM Lifecycle**

I. INTRODUCTION

INFORMATION Technology growth set an important role in the sustainability and success of an organization or company. Some companies implement technology information to support their business process in daily basis, including their procurement processes. Business processes mean a chain of activities carried are design in a technical organization, where these activities will create a business goal [1] . The business process of procurement at the company became a routine activity to fulfill a product demand as well as creating value to its customer. In doing so, good procurement process requires good planning and integration to all processes within an organization. Therefore, an integrated system is needed to make the process runs effectively. Using an integrated systems become a key to survive in the competition between companies to improving their company effectivity [2] since it helps companies achieve the effectiveness by using integrated systems. Enterprise Resource Planning (ERP), is one of the ways that can be used in implementing integrated information systems or technologies. According to some experts, ERP can improve the performance of companies. The implementation of ERP in the procurement process also expected to fulfill the company's business strategy.

PT Semen Indonesia (Persero) Tbk, is a cement industry which has been implementing an integrated ERP information

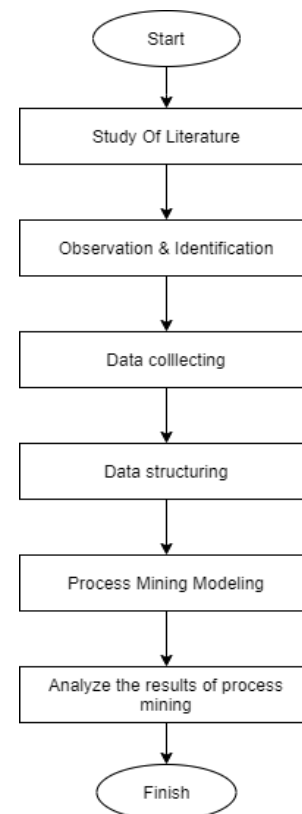Figure 1. Example of event log.

Figure 2. Step of research.

system to support their business process, one of them is in the procurement process. Unit of procurement in PT Semen Indonesia (Persero) Tbk, implementing E-procurement and SAP system to arrange all of the procurement process, start from purchase requisition until purchase order published. Implementation the ERP system into business processes helps company to automate procurement process which
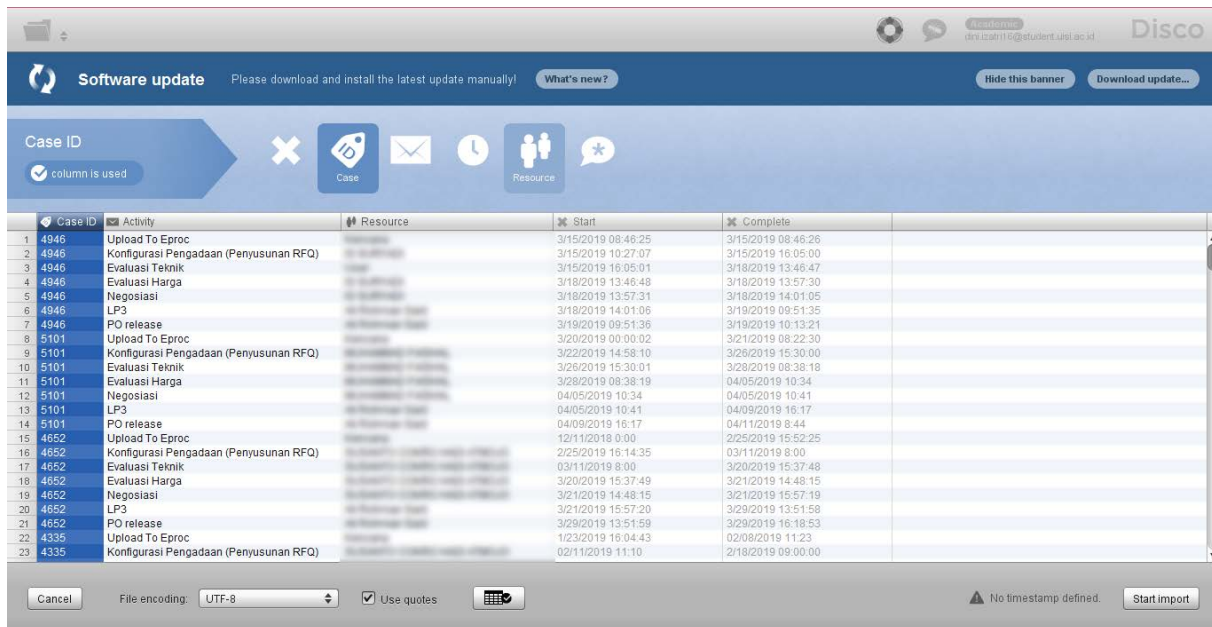
Figure 3. Import event log to Disco Software. Some information are blurred due to resctriction from the company.
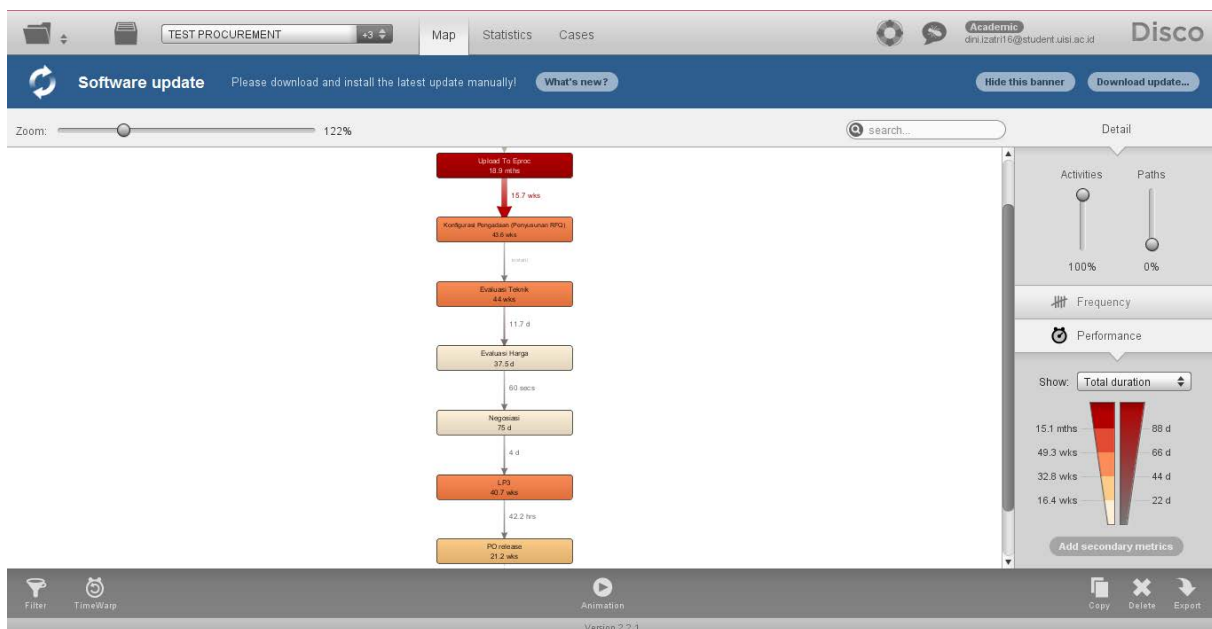

Figure 4. Process model e-procurement showed by Disco software.

consists of two complex activities: Planning and Procure. Each has multiple steps such as Purchase Requisition, TOR and Cost estimation, Vendor Selection, Aanwijzing, Request for quotation, Negotiation, and Dealing. Those activities are supported by e-procurement system. However, existing e-procurement does not cover all the procurement process. It needs to be integrated with SAP system. In addition, many procurement types such as construction, consultation, assets, consumption, and others result on multiple process variants. These process variants have made whole procurement process run into bottleneck cases like unfinished negotiation, never ending TOR revision, etc. Deeper analysis required to dig insights on the process variants to derive the cause of problem and understand what is really going on within the procurement process.

One method can we use to analyze the procurement process is using process mining. Process Mining is a study that focused on machine learning and data mining that handling the modeling process and analysis. This process is having a purpose to find, supervise, and develop the original process by exploring event logs in the system. Using the event log, process mining can be done and got the analysis of the result of the business process that applied [3]. Hence, this research tried to explore Process Mining in order to gain more insights from the process since it could model, visualize and statistically analyse the process from the data log derived from the system.

Event logs are required to do a process mining, event logs is a historical transaction record that contains information about activities that run on the system[4] . In the event log consists of events, time, activity, and resources. (Figure 1) Process mining analysis using event logs aims to find information about a process that records an activity that refers to a case and it will also refer to the person who runs the process [5].

Process mining has three types of activities [6]:
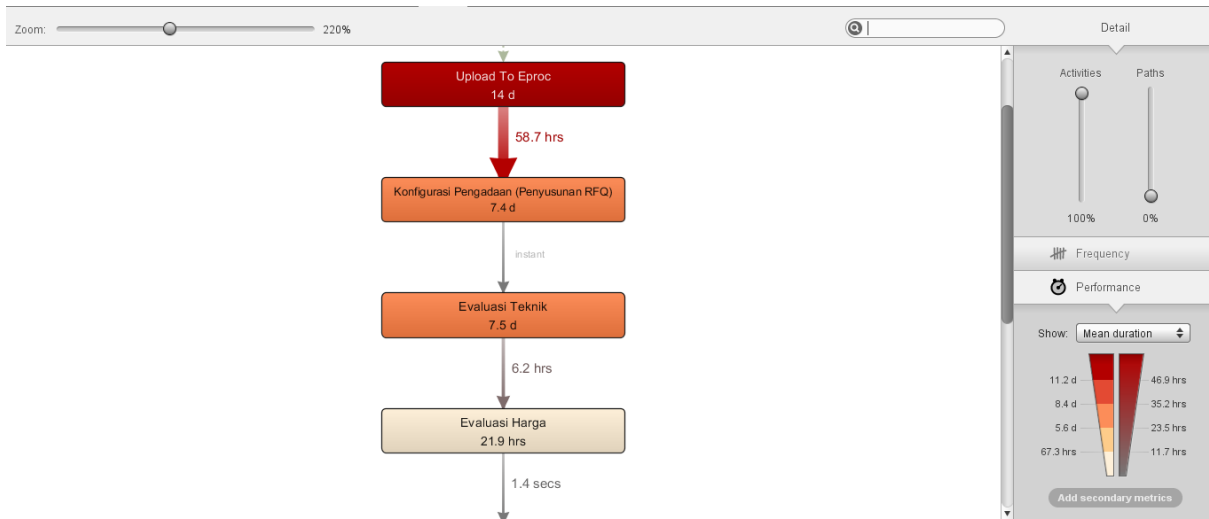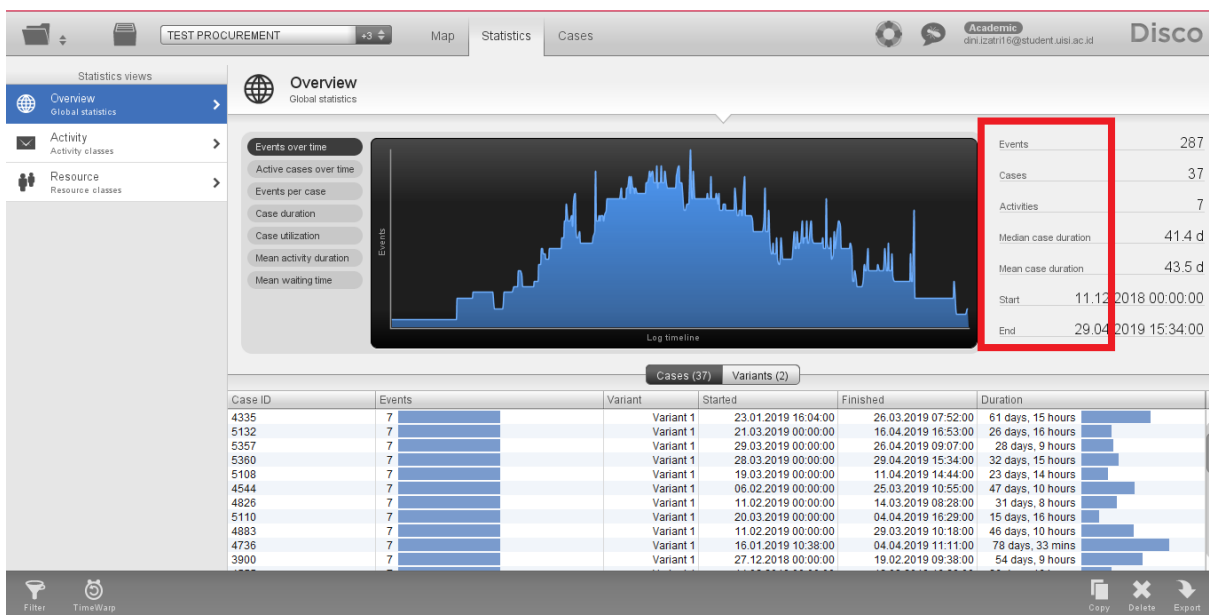1. Discovery

Figure 5. Process mapping with time average.

Figure 6. Statistic information.

   a) Event   : shows the total number of activities in the procurement process.
   b) Cases   : shows the total number of processes in the eventlog data.
   c) Activities   : specifies the total number of different activities in the even tlog data.
   d) Median case duration   : shows the median for all case durations in the event log data.
   e) Mean case duration   : shows the average of all case durations in the event log data.
   f) Start and End   : shows the priod time covered by the event log data.

In this activity do the discovery and search for process models of activities that have been recorded in the event log.

2. Conformance Analysis

This activity is used to compare the event log that has been analyzed with the process model that has been obtained.

3. Enhancement

In this activity, the process model will be reformed aimed at improving the quality of existing processes.

To execute the process mining activities, a software called Disco is used to analyse the current procurement process derived from the event log. The software can show time-based analysis for each activity. This software was developed by technology companies in Netherlands, namely Fluxicon [7] who also states that Disco can examine each case in detail. The software will display an overview of business processes, with display information such as frequencies, employees, and all activity related to the business process. All in all, the results of the analysis will help company to determine whether the procurement process has a new activity appears or even a bottleneck.

II.   METHODOLOGY

A. Research Method

The research method was shown on Figure 2.

B. Study of Literatures

The study of literature is the first step in the analysis of business processes. In this step will collect and review the literature according to research including related procurement documents from the company such as standard operating procedures and reports.
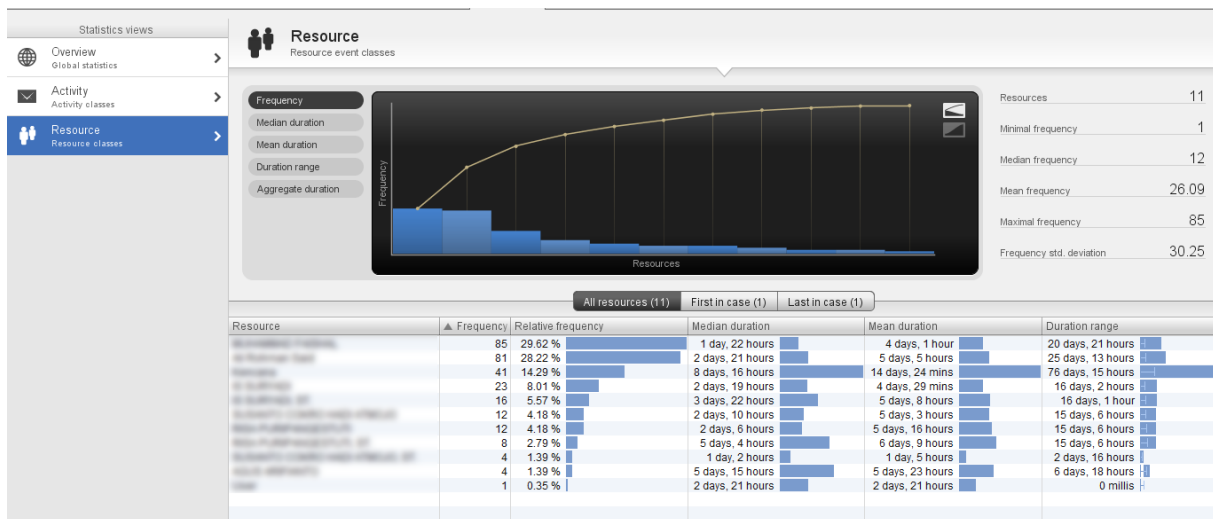
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Figure 7. Overview Resources. Some information are blurred due to resctriction from the company.
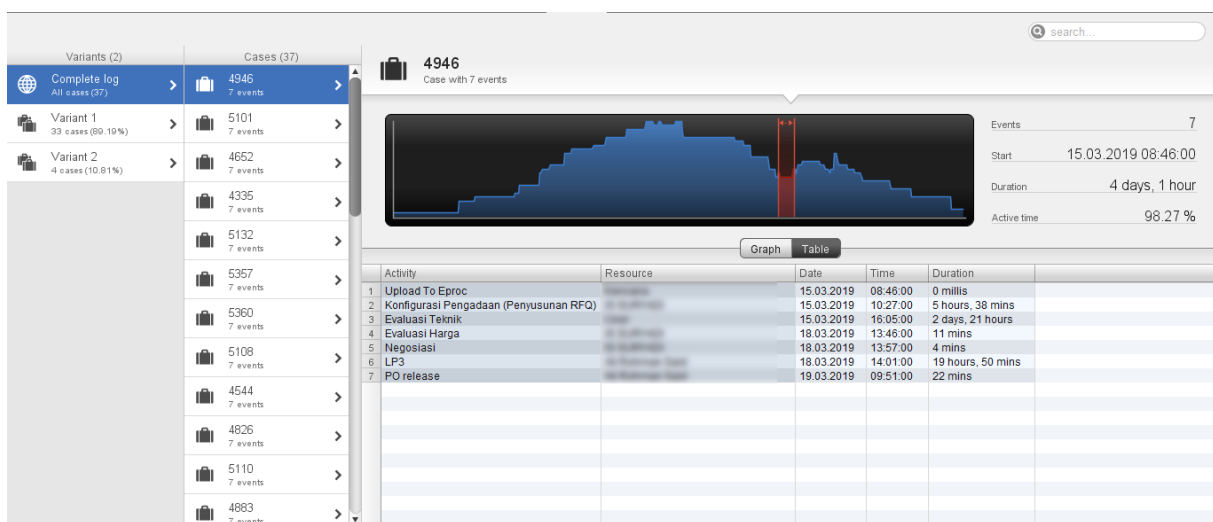

Figure 8. Overview Cases. Some information are blurred due to resctriction from the company.

This step aims to understand the concepts and methods in processing the process mining, the implemented systems, the initial data needed and also the current practices within the company.

C. Process Identification

The process identification carried out to find how the flow of business processes in the unit of procurement PT Semen Indonesia (Persero) Tbk. The identification process is done by conducting an interview with the interviewees. This identification aims to find how the detailed business process particularly in the procurement process. The identification process adopts Identification from BPM Lifecycle to gather the activities within procurement process [8]. The interviewee chosen are Business Process Owner: Manager of Procurement and some Staff for each activity within the procurement process.

D. Data Retrieval

Based on the results of interviews and process identification, the data needed to evaluate will be obtained. This data is an event log in the e-procurement system. While collecting the data, at least there are three main attributes that must considered, i.e. activity, case, and timestamp. The event log then cleansed and structured to get the same format

and discard some that unused or redundant, since not all data will be used in process mining.

E. Conduct the Process Mining

Structured event log then imported and processed using Disco process mining software, the software provides information about any activities that occur in the procurement process. The result produces a real business process model (see Figure. 4) that is run and recorded on the E-Procurement system.

F. Analyze the Results Of Process Mining

After the business process model and its result are obtained using the Disco process mining, next, an analysis is conducted to find out whether there are differences between standard SOP and the real process using E-Procurement. An evaluation to the average time and length of time needed to execute the procurement activity are also conducted. This evaluation also considered as process audit to determine whether previous process are well run [9] .

Three ranks of heading may be used section, subsection, and sub-subsection. Use the heading styles: 1. Section; 1.1 Subsection; and 1.1.1 Sub-subsection. Put a space line before each heading (see Table 1). Bullet and numbering within body text are not allowed. All sentence should be typed as descriptive paragraph format.

III.   RESULTS

A. *Procurement Process*

PT Semen Indonesia (Persero) Tbk has divided into two phases on their procurement system [1] : First is planning phase that starts from purchase requisition until it is being verified. Second is procurement phase, which starts from selecting vendors, tenders, and until purchase order released.

B. *Results Of Procurement Business Process*

This procurement process starts from the planning process, which is initiated by sending a procurement request or Purchase Requisition (PR) by user, PR that comes is in the form of a document containing Term of References (TOR), and Engineer Cost Estimate (ECE), at the TOR document contains an explanation of the scope of work and the technical specifications, and the duration of the work (if requested is the installation of equipment, installation of applications, etc.), at the ECE document contains the details of users budget. After PR sent by user get in, next the procurement division will do a verification data, this verification means to evaluate the TOR and ECE documents, if its appropriate, will continue an approval verification from the procurement division.

After the PR document is approved by the procurement division, then the requisition enter the procurement process, this process consists of the following stages:

1) *Vendor Selection*

This phase, the procurement division invites vendors who participate in the project. There are 3 types of vendor selection that is direct appointment, direct election and auction. At this stage, it can take up to 1 week.

2) *Aanwijzing*

Aanwijzing is the step where the user explains the technical of the project. This process aims to avoid mistakes or errors while working on the project. This step is usually done when the work is non-routine or large-scale projects. The time required for aanwijzing is 1 hour or more.

3) *Request For Quotation*

Request For Quotation (RFQ) is a request submitted by the procurement division for goods / services to get the best offer according to the specifications and budget that has been submitted. RFQ can minimize risks such as prices, stock of goods, and others. RFQ can also shorten the time in the procurement process because with this RFQ the User and Procurement only describe the desired needs according to the existing budget or ECE.

4) *Technical Evaluation*

In this process the vendor who already sent the offer will be evaluated, it can be related to the quality provided by the vendor, or also the price offered by the vendor.

5) *Negotiation process*

Negotiations are carried out to reach a price agreement in accordance with the market price and also in accordance with the existing ECE. Negotiations are carried out by the procurement division and the goods and service providers that have passed the evaluation.

6) *LP3/ Winner's Approval Sheet*

The making of LP3 (Winner's Approval Sheet) is a process after negotiations, the winner has been found from the Vendor selection step. Then Procurement division makes LP3 to approve the Vendor who has become the winner.

7) *Publishing SPK/Work Order Letter*

SPK (Work Order Letter) is a letter shown to the Vendor to start the work that has been agreed. Publishing of SPK is done after the results of the negotiation are obtained and negotiation agreement has been issued.

C. *Results of process mining using Disco*

In this process, information related to procurement process are discovered and gathered. Disco process mining software read the data obtained from the E-Procurement event log and will form a process model. The first step, structured event log data are imported into Disco. Here are the results of the structured event log data import from software to Disco. (Figure 3)

As a result, imported event log data are processed and then process model is generated. Figure 4 shows a description of the process model contained in the E-Procurement of PT. Semen Indonesia (Persero) Tbk,.

In Figure 5, the performance time is set to an average duration with a path of 0% (the purpose of the activity details 100% / 0% indicates that you want to display the process model with the activity as a whole or only the important ones, then the 100% / 0% path means that it displays the entire procurement process path based on the event log.).

Result shows that three most time-consuming process are: 1) upload to e-procurement process which takes 14 days, 2) the procurement configuration which process takes 7,4 days, and 3) technical evaluation process which takes 7.5 days.

After being analyzed, the performance analysis are then consulted and discussed with the BPO. Tt turns out that the upload to e-procurement process has the longest time due to the large amount of data accumulation that will be uploaded into e-procurement, then in the process of procurement configuration and technical evaluation also takes 7 days since it requires Anwijzing. Anwijzing is the process of inviting vendors to perform and present their offer which can not be done in a single day. The procurement division must contact the vendors to arrange the meeting for Aanwijzing.

In the technical evaluation process, the technical proposal that has been sent by the vendor to the procurement department of PT Semen Indonesia will be given and evaluated by the user (Unit who created PR). User will evaluate its specifications required, and sometimes takes longer time than usual. The condition cause the average technical evaluation process takes an average of 7 days.

Then, the procurement configuration process. The process requires preparation particularly at RFQ, which takes an average of 7 days. As explained before, RFQ is the process where the procurement division send initial request to the vendor (Prior to Purchase Order) then will wait for a reply from the vendor again.

a. Results of Disco Statistic

This section discovers statistical information obtained from Disco. In the statistical information there are Events, Cases, Activities, Attributes, Median case duration, and Mean case duration which are overall data obtained from E-Procurement.

From the results of the analysis obtained the number of events in the procurement process using e-procurement as many as 287 events, with a total of 37 cases, and as many as 7 activities in the span of 11-12-2018 to 29-04-2019. (Figure 6)

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Figure 7 shows an overview display of the resources, the data can also be known which resources are most often handled the procurement process in the e-procurement system.

b. Results Of Disco Cases

It is very important to check each case accordance with existing standards. Each case will display the activities and the resource who handled it.

Figure 8 depict example of cases and jobs executed in time wise. In the figure, there is an example of the 4946 work which has 7 events, or it can be said the process that has executed from Upload PR to E-procurement, Configuration procurement or RFQ preparation stage, Technical evaluation, Price Evaluation , Negotiations, LP3, and PO Release. Then from the results of the analysis could be derived that the 4946 work turned out to take 4 days and 1 hour in total starting from the process of uploading e-procurement to the issuance of PO.

IV.   DISCUSSION AND SUMMARY

Unit of procurement supply goods or services needed in overall business activities at PT Semen Indonesia. The identification process defines activites of company's business process and set criteria for prioritizing it. In general, the procurement process at PT. Semen Indonesia, needs a total time about 37 days. At the vendor selection step, the procurement division invites vendors who participate in the project that will be carried out. Aanwijzing process is where the user explains the technicality of the work or project. Request For Quotation is a request submitted by the procurement division for goods / services to get the best offer according to the specifications and budget that has been submitted. After that, Negotiations are carried out to reach a price agreement that is in accordance with the prevailing market price and also in accordance with the existing ECE. Negotiations are carried out by the procurement division and the goods and service vendors that have passed the evaluation. The making of LP3 (Winner's Approval Sheet) is a process after negotiations in which the winner has been selected. Then, Procurement division makes LP3 to approve the Vendor who has become the winner. SPK (Work Order Letter) is a letter addressed to the Vendor to start work that has been previously agreed.

In this paper, the discovery process used information gathered from the structured event log which derived from E-procurement system. The process used Disco process mining software to interpret the data obtained then form a process model. The analysis process is carried out to identify whether each process has a problem. Then the event log data results that have been imported will appear as we can see in Figure 3, the picture shows the process model contained in the E-Procurement of PT. Semen Indonesia (Persero) Tbk ,.

The result showed that top three activities that take time most are Upload to E Procurement, Purchasing Configuration, and Technical Evaluation which has average time to 14 days, 7,4 days and 7,5 days respectively. Upload to E Procurement activity still conducted manually from hardcopy of documents to be uploaded to the system. In addition, prior to uploading document to E Procurement, configuration sometimes needs Aanwijzing that has no exact time. The condition caused by Aanwijzing requires physical meeting between company and propective vendors to discuss technical requirements. This condition also worsen by unsynchronized system between E Procurement and SAP as data from vendor need to uploaded manually to E Procurement while master data and transaction data are stored in SAP system. All in all, Process analysis using process wining with Disco provide insights on how the procurement process look like and which activities within the process that identified as a bottleneck. The insights could be considered by the company to improve the process and gain more efficient process in the future. From the results of the analysis, it is found that several problems such as the existing process in the E-Procurement system is different from the standard process defined in SOP as some activities are carried out manually. Also, Disco discovered some processes or work that is not continued or stuck in the E-procurement. The condition indicates that the work was stopped due to several factors, such as the project being canceled or not pass evaluation stage but never being updated in the system.

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