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Analysis of Customer Fulfilment with Process Mining: A Case Study in a Telecommunication Company

Mahendrawathi ER\textsuperscript{a}, Hanim Maria Astuti\textsuperscript{a}, Ayu Nastiti\textsuperscript{a}

\textsuperscript{a}Institut Teknologi Sepuluh Nopember, Sukolilo, Surabaya, 60111, Indonesia

Abstract

This paper presents results of process mining implementation in a characteristically unstructured customer fulfilment process in a real Telecommunication Company. The aim of process mining implementation is firstly to discover the typical customer fulfilment business process. It is also aimed at assessing the current rate of completed customer fulfilment, the typical component required for the process and the lead time for different types of customer requests. The steps to achieve the goals are to prepare, extract the data and construct the event log from the company’s in house built Customer Relationship Management systems. The event log is then processed using Disco and PROM tools. The complete event log when model with Disco results in a Spaghetti-like process model with 673 different variants. In order to identify typical process, the log is filtered to include only business variants with 1\% case occurrence of the total case. This enables the identification of 18 typical business variants, which differ based on the order requested, sequence of activities and occurrence of Return Work Order. Based on the typical variants, the components required to fulfill a certain order are identified. Another important findings are the fact that the completion rate is very low (only 8\%). This may due to the fact that the issues faced by the field officer in processing the order and the resolution are either recorded manually or in a different systems. Finally, findings from this study can be used by the company to improve their current business process. It also stressed out the importance of resolving data integration issues in implementation of process mining in real cases.

Keywords: Process Mining, Unstructured Process, Customer Order Fulfilment

1. Introduction

Telecommunication industry is one of the most competitive industries in today’s business environment. Like many service industry, companies competing in Telecommunication industry must put great attention on customers. In addition, Telecommunication industry is one of the most data intensive industries and therefore the implementation of Enterprise Systems such as Enterprise Resource Planning (ERP) or
Customer Relationship Management (CRM) to support the business process is essentials in providing service to the customer.

PT. ABC Indonesia is a leading Telecommunication Company in Indonesia. The company provides a wide range of telecommunication services to the customers. The company has implemented in-house developed CRM systems to support various business processes including customer order fulfilment. The customer order fulfilment process starts with new or existing customers contacting the company’s call center to order for services related with network and home telephone installation. The company will process the requests until the service is installed and ready to use. However, the fulfilment of customer requests can vary significantly from one request to another depending on the condition of the customers. This type of process is relatively unstructured, since the company responds will very much depend on the customer requests and condition.

Ideally, the customers want their service to be installed immediately. The company must provide a service level agreement to satisfy the customer’s request. The company’s ability to meet the request swiftly will depend on the capacity of workforce and the availability of component needed to provide the service. The company has not been able to set a standard procedure nor service level agreement for customer fulfilment mostly because they do not have detail insights on how the current business process is actually conducted. But, the history of customer requests is recorded in the company’s database and thus can be utilized to address the issues.

Process mining is a technique that develops business process model from the company’s information systems event logs [1]. It can be used to discover the business process, identify compliance of business process practiced in reality to the standard procedure, and/or identify business process enhancement [2]. Process mining has been implemented in various sectors including healthcare, insurance, government, and manufacturing [3-7]. However, more research needs to be done to understand the potential of process mining to solve real problems and to compare the performance of algorithms used in process mining [8, 9].

This paper presents the works on implementation of process mining to analyze the customer fulfilment process. The contribution of the paper is twofold. First, it demonstrates the use of process mining to discover typical business process from a less-structured process of a real company. Secondly, it provides insights to the case company on how the customer fulfilment business process is actually conducted. The findings are expected to provide foundation for the company to develop standard procedures, set service level agreement and propose potential planning process to better meet the customer requests.

2. Process Mining

The wide-range use of information systems is expected to bring benefits for an enterprise to integrate the disperse information across the enterprise, streamline its daily business processes, fasten the delivery time to market and increase customers’ satisfaction. However, information systems are not always working smoothly as expected. To some extent, information system might execute business processes which are against the desired outcome defined by an enterprise. An evaluation on the real execution of business processes performed by an information system is necessary. This necessity has prompted the rise of process mining research.

Process Mining is getting more attention in the literature to date as a methodology to model process based on the data recorded in an information system [1]. Process mining is typically used to discover process model, determine compliance to the standard model and identify potential for process enhancement. A process mining tool called PROM [10] has been developed by a group of researchers which aims to help practitioners as well as academicians to implement process mining technique based on various algorithms such as genetic algorithm, heuristic miner, et cetera. This tool enables to model business process and analyze the model in a great detail.
The implementation of process mining depends on the availability to obtain or construct high quality event log [11]. Event log contains activities performed by specific person in a specific time. Therefore, event logs are also called the representation of a business process. Event log can be obtained directly from the systems or extracted from the information systems’ databases [11]. In process mining, this event log is required to be converted into a MXML [12] or XES format [13] before being processed using PROM tool. The conversion can be done using supporting tools such as DISCO or NITRO provided by Fluxicon [14].

There are two extreme of business processes as suggested by [2]: Lasagna and Spaghetti. Lasagna processes are relatively structured and the cases flowing through such processes are handled in a controlled manner. In this type of process, most cases can be handled in a pre-determined manner. Since all activities are repeatable and have a well-defined input and output, most of the activities can be automated. Spaghetti process on the other spectrum is less structured and therefore it is difficult to determine exactly the pre- and post-conditions for activities. Spaghetti process, according to Aalst [2], “…are driven by experience, intuition, trial-and-error, rules-of-thumb, and vague qualitative information”.

Researchers have implemented process mining to model process of real cases in various types of organization. Process mining implementation was conducted by [3] in order to discover knowledge from hospital’s business processes for the purpose of hospital’s careflows improvement. Another scholar [5] implemented process mining to perform internal fraud mitigation in a SAP based procurement while [4] used process mining to evaluate document management system in financial services organization. Our previous works [6, 7, 15] also implemented process mining to model the real execution of business processes including incoming materials, production planning and material movement in a manufacturing company.

3. Customer Relationship Management

The advance development of technology in today’s globalization era has urged enterprises to shift their focus from company-centric to customer-centric. While in the past, the focus of an enterprise was mostly on “market driven by companies”, nowadays, the focus has also changed into customers-driven market. All enterprises’ efforts are directed to achieve customer satisfaction. As customers are the heart of any enterprise in doing business, to get closer with customers is essential. This idea marked the beginning of various studies in Customer Relationship Management.

According to [16], CRM is “the strategic use of information, processes, technology and people to manage the customers’ relationship with company in all customer life cycle”. The ultimate goal of CRM based on the CRM hierarchy of Maslow [16] is the increase in customer loyalty. The practice of CRM requires the involvement of many functions across an enterprise. Several activities are performed by four main functions in a company namely Marketing, Sales, Product Support and Customer Service. Marketing is the function that responsible for branding, messaging and other communication strategies with customers. Sales function is dealing with selling and closing an agreement. Product support or customer support focuses on answering customers’ questions and resolving customers’ problems with companies’ products or services. The last, customer service function provides additional services to customers such as consulting and integration. Usually, this function has a direct interaction with customers. This study focuses on evaluating the business processes of sales function, more specifically customer fulfilment process.
4. Methodology

The first step in conducting process mining is to define the goal of the project. The aim of process mining implementation is firstly to discover the typical customer fulfillment business process. It is also aimed at assessing the current rate of completed customer fulfillment, the typical component required for the process and the order fulfillment time. Interviews with representatives from the case companies are held to obtain understanding of the customer fulfillment business process. Then, the data is mapped, prepared and extracted. Based on the data extracted the event log is constructed. The event log is processed using Disco and PROM tools.

Two stages of analysis are conducted. In the first stage the complete log is analyzed to obtain the completion rate of the cases. In the second stage of analysis, the complete log is filtered to obtain the most frequent business variants. Business variants analysis are conducted to understand the common service requested and components required to fulfill the request. Finally, bottleneck analysis are done to obtain length of time required to satisfy different types of customer orders.

5. Data Extraction and Preparation

5.1. Case Description

PT. ABC Indonesia is a Telecommunication company that implements in-house developed Enterprise Systems called ISISKA to manage its customer relationship management process. ISISKA manages information related to customers, networks, products, services and customer bills in eight (8) modules that conduct different functions in CRM process. PT. ABC determines five main phases in fulfilling customer orders: 1) Date Entry, 2) Date Feasible, 3) Date Validate, 4) Backroom and 5) Completion. In date entry phase customer requests are received and registered in the system by inputting customer identity including name, address as well as the service requests. In the second phase, the request is determined to be feasible in a sense that it can be satisfied. In the third phase the request is considered valid and then activated.

The next phase is backroom when the request is being handled and the status of the service is “Put into service”. In backroom phase, the services are classified into four types that relate to the components of the telephone and network service required to fulfill the request including: 1) Switch or central telephone, 2) main distribution frame (MDF), 3) line or local line that connects MDF to distribution point and 4) installation which include the installation from distribution point to the customer home. Each type of services has two main status in backroom: Print Work Order (WO) and Return Work Order (WO). Print WO status means a work order is released to obtain the necessary component and conduct the requested actions to satisfy the customer request. Return WO means that the field officer returned the work order assigned to him due to various reasons. The status marks the progress of a certain request fulfilment. The activities in this process does not have a strict sequence, which means there are many possible variants based on a combination of components required by the service and their status in the backroom. The final phase is completion where the process ends with the delivery of service bill to the customer.

5.2. Event Log Construction

To have an event log, the first step is to prepare and extract data from database. This step consists of identification of the activity, tables and attributes related to customer fulfillment business process and mapping to the DEMANDE table in ISISKA database. Mapping of activities and attributes in the table is shown in Table 1. Results from the data preparation are used to extract the data from ISISKA Database.

Table 1. Mapping of attributes for each activity
The event log is then constructed by structuring the activity data extracted from the previous stage. Event log at least has three main attributes to identify an activity: 1) identifier or ID, 2) activity name and 3) time attribute that is known as timestamps. The case in this process mining implementation is the customer request or demand. The activities are extracted from DEMANDE table, which has one unique identifier, NDEM or Demand Number. This number is set as Case ID for the event log and the corresponding activities and timestamp are obtained from the same table. After event log with three attributes are obtained, it is converted into MXML format with Disco tool.

5.3 Process Mining with Heuristic Miner

First, the entire log is processed. However, as will be described in detail later, it resulted in a “spaghetti like” process with so many business process variant (673 business variant). Using Disco tool, we are able to identify business variant with less than 1% frequency out of the total cases. These business variant may appear because of a very specific customer request or situation. As the main goal of the study is to understand the ‘typical’ process and components for customer fulfilment, the event log is filtered by determining business variant with at least 50 case occurrence (frequency over 1%). Using this setting, the number of business process variants reduced significantly to 18, which can be considered as a good representation of typical customer requests.

The filtered event log is then processed using Heuristic Miner Plugin in PROM tool for further analysis. As explained in [17], Heuristic Miner Algorithm uses several parameters including: dependency threshold, positive observations and relative-to-best-threshold. In this study, the parameters are set as follow: dependency threshold is 1, positive observations is 0.9 and relative-to-best-threshold is 0.05.

6. Results

In this part, we present two parts of process models as the result of the use of process mining. First model was obtained from the complete event log and the next model was executed from the filtered event log. The complete event log consists of 5809 cases and 673 business process variant. Each variant represents a certain combination and sequence of activities. The complete log result in a Spaghetti-like model which is quite unstructured in nature to depict the customer fulfilment process. The activities depend on the type of the customer requests and the component used to satisfy the request. In order to
find typical processes, further filtering needs to be done. Nevertheless, result from the complete log can be used to analyze the customer fulfillment rate. Filtered log consists of 3304 cases, 18 business process variant. The variant included in the filtered log contain at least 50 cases.

7. Analysis

This part presents three analyses that were conducted in the study. First analysis is performance analysis which aimed to determine the customer fulfillment completion rate. The second analysis is to find out the typical business process occurred in the case study. The last analysis is aimed to analyze bottleneck.

Performance analysis was conducted because it is important for the company to understand the current service level that they have provided for their customers. In order to determine the completed fulfillment rate the complete log is analyzed with Disco Tool by determining whether the case have completed i.e. end with payment. The result shows that only 418 out of 5503 can be declared as complete according to the standard set by the company. This means that only 8% out of the total case is complete. This number is very low and need further investigation.

The next analysis is to find the typical business process. It can be obtained by analyzing the filtered log using Disco Tool. Each business variant represent the sequence of activities conducted for a case. The first interesting finding is the fact that for all the cases the operation complete activity is not recorded. Secondly, the sequence of activities are consistent from Date Entry → Date Feasible → Date Validate. Variation occurs after this sequence depending on the component required for the service.

In order to understand the fulfillment time for the typical service, a bottleneck analysis in PROM is conducted. First, the process model is obtained by running the Heuristic Miner Plugin in PROM. The process model is shown in figure 1. This model is considered to be a good representation of the filtered log because the fitness is 0.94. Based on the Bottleneck Analysis, it can be seen that the bottleneck appears between date validate and backroom activities. In order to analyze the lead time for each types of customer order, the business variants are further grouped based on the component required for the service: 1) cases requiring only one of the component (switch, installation, line or MDF), 2) cases requiring a combination of installation and line, 3) cases requiring installation, line and switch, and 4) cases requiring a combination of installation, line and MDF. The time required for these group of cases are summarized in table 2.

![Fig. 1. Bottleneck Analysis of Filtered Log with PROM](image-url)
It can be seen from Table 2 that in most of the business variant there are high gaps between the minimum and maximum fulfilment time, which shows that the process are highly uncontrolled.

Table 2. Time from first to last activity in customer fulfilment

| Groups of Business Process Variants | Number of cases | Components or materials used | Lead Time | Minimum (days) | Maximum (days) | Average (days) | Standard Deviation |
|------------------------------------|----------------|-----------------------------|-----------|---------------|---------------|--------------|-------------------|
| 1                                  | 783            | Switch                      |           | 1             | 306           | 52           | 66.31             |
| 2                                  | 565            | Installation                |           | 1             | 323           | 99           | 91.37             |
| 3                                  | 131            | Line                        |           | 1             | 277           | 62           | 73.66             |
| 4                                  | 239            | MDF                         |           | 1             | 334           | 42           | 69.71             |
| 5                                  | 179            | Line, Installation          |           | 1             | 303           | 90           | 85.77             |
| 6                                  | 77             | Switch, Line, Installation  |           | 1             | 244           | 26           | 45.17             |
| 7                                  | 1330           | MDF, Line, Installation     |           | 1             | 306           | 63           | 78.45             |

8. Discussion

8.1. Typical Processes

The main goal of process mining implementation is to discover typical process from a highly unstructured business process where 673 business variants are originally discovered. A huge number of variants means it is difficult to determine the typical process needed to satisfy customer requests. With proper filtering of the business variants focusing on only on the most frequent ones, 18 typical processes with frequency of case occurrence more than 1% out of the total cases (minimal 50 cases in each variant), are obtained.

Based on this typical variants, it can be identified the sources of variation between the variants. First, the fulfilment of customer request may include combination of one to three different types of services and there are no standard sequence for the field officer in processing the activities. This is further complicated by the presence of Return WO activities, which appear after the field officers start to do a certain activity and encounter some issues.

For example, business process variants 9 and 11 both require works on Line and Installation. In both business variants the sequence of activities are: Date Entry → Date Feasible → Date Validate → Print WO Installation → Print WO Line. However, unlike variant 9 where no further activities are recorded, in variant 11 the sequence continues with Return WO Line and then Return WO Installation. Similarly, variants 13 – 18 all entail work on installation, line and MDF but with different occurrence of Return WO and sequence of the activities.

Several findings can be obtained from Table 3. First, with respect to work involving a single component, Switch is the most frequently needed service with 24% of the total cases. This is followed by order requiring only Installation (17% of the total cases). Installation always appear to be needed when customer requests require combination of two or three services. It is also found that 40% of the total cases Installation work also require work on Line and MDF.

These findings can help the company understand the “standard” request from the customers. From there, they can identify standard time required to service for the request and create service level agreement. Furthermore, the company can use the information to plan for their capacity. For example, knowing that 40% of the cases require work on Installation, the company can give higher priority for the field officer with the necessary capability and components required to serve Installation requests.
8.2. Low Completed Customer Request and Long Lead Time

Results described also highlight several striking diagnostics on the customer fulfilment process in PT. ABC. First, the number of cases recorded as complete is only 8%. The typical business variants described in section 7.1 do not end with operation complete activity, but the length of time required from the first to the last activities are quite long. As shown in table 3, the entire variants show wide range of minimum and maximum lead time which results in very high standard deviation. The fastest average lead time (from the first to the last activity) is 26 days for business variant that involve Installation, Line and Switch. The average lead time for the rest of business variants are over 42 days. Counter intuitively, while work related to Installation, Line and Switch took relative fast, the work on only Installation, Installation and Line or Installation, Line and MDF all took longer than 60 days. These findings need further investigation in order to understand the work involved in each type of service and the standard time needed to fulfil the service.

In order to understand the cause of a very low completion rate of customer requests further interview are held with representatives from the case company. While they are startled with the results, they provide several possible cause. The first cause is that the field officers encounter some issues while processing the work order and force them to return the WO with a “Not OK” status. Unfortunately, the continuation and resolution of the Returned WO are recorded in a different systems which make it difficult to be traced. There are also some cases when the requests are cancelled by the customers. The last possible cause is that the field officer or staff record the activities manually and not in the Enterprise Systems. Nevertheless, these findings highlight that the Customer Fulfilment Process in the case company are far from standardized. There is a need for a more standard procedure for the entire staff conducting the operations. This will result in a more consistent service delivery for the customers.

9. Concluding Remarks

This paper highlights how process mining can be used to discover typical process in a characteristically unstructured customer fulfilment process. The findings presented in this paper contribute insights for management of the case company and further implementation of process mining in real case. Manager in PT. ABC can use the findings as a foundation to improve their business process. First the fact that the completion rate of the customer requests are found to be very low deserves further investigation. Findings regarding typical processes can be used to set standard sets of services which will be useful for prediction and planning of capacity. The long lead time from the start of the process until the last activity must be investigated further to understand root cause of the problem. This paper also highlights one of the main issue that could hinder the potential use of process mining in real case i.e. data integration. Process mining depends very much on the availability of accurate and high quality event log as the input. When the data used to construct the event log are stored in different databases and systems, then it is not a very easy task to obtain and link these data. This stressed the importance of mapping the overall activities at higher level before extracting the event log. It also highlights the importance of taking a more holistic view of Business Process Management in implementation of Enterprise Systems.

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