SUPPORTING INFOTOPICS IN FINDING USER CASES TO APPLY A BUSINESS PROCESS MINING SOLUTION

Student
Ferial el bou Messoaudi
f.elboumessaoudi@student.utwente.nl
BSc Industrial Engineering and Management
Faculty of Behavioural, Management and Social Sciences

University of Twente
Drienerlolaan 5
7522 NB Enschede
The Netherlands

Infotopics
Gerard Hollinkstraat 1
7575 BB Oldenzaal
The Netherlands

Supervisors
Dr. R. Guizzardi (UT)
Dr. I. Seyran Topan (UT)
J. Deetman (Infotopics)

UNIVERSITY OF TWENTE.

Preface

Dear reader,

Before you lies the thesis 'Supporting Infotopics in finding user cases to apply a business Process Mining solution'. It has been written to complete my bachelor Industrial Engineering and Management at the university of Twente.

This thesis was done at the company Infotopics. First and foremost, I would like to thank Joost Deetman, my supervisor at Infotopics, for providing me with the opportunity to work on my thesis at Infotopics. I began this thesis during the COVID-19 pandemic, and he still gave me the opportunity to begin it. I would like to thank Joost for giving advice and feedback; it really helped me get a clear picture of what Infotopics wanted. Aside from that, I would like to thank Evelyn Tempel and Alexander Belderink to give additional knowledge to the subject. This aided in the refinement of my research.

Second, I would like to thank Renata Guizzardi, my first supervisor from the university of Twente. She was a huge help to me during this thesis and helped me stay positive. Despite her hectic schedule, she always made time to assist me and provide feedback.

In addition, I appreciate the feedback from my second supervisor, Ipek Seyran Topan. She provided feedback from a different perspective, which helped me in improving my thesis.

Furthermore, I appreciate the time that interviewees took to help me with my research. There would be no data if they did not participate. I would like to thank in particular the two interviewees who provided me with the data for the Process Mining model and the BPMN models. Thank you for providing the data and assisting me in reaching this conclusion.

Finally, I want to express my gratitude to my family and friends for their unwavering support. They provided me with advice and ideas throughout my thesis.

I hope you enjoy reading it!

Ferial el bou Messaoudi
14 May 2021

Management summary

This research is done at Infotopics. Infotopics is a company that assists their clients in extracting more information from their data. Tableau is one of programs that Infotopics provides to help clients visualize their data of the client through dashboards. Process Mining is one of the Tableau extensions offered by Infotopics. Process Mining visualizes the business process in a business process model and provides insight to outliers and bottlenecks.

The problem Infotopics faces is that the Process Mining extension is not yet adapted to the clients' demands. Infotopics has no clear idea for which business problem Process Mining can offer support. In addition, Infotopics wants to know how clients can benefit the most from using Process Mining. The clients of the municipalities form the scope of this research. As a result, only research is conducted in business processes of municipalities. The general goal of this research project is understanding what kind of business problems can be solved with Infotopics Process Mining extension. Moreover, this project also aims at understanding the added value of using Process Mining for the client.

With the information about the problem that Infotopics faces, the following research question is defined.

How can Infotopics use the extension Process Mining for the domain municipalities' clients in order to improve their business process?

To collect the data for this research, five interviews were first conducted with municipalities that use Process Mining. The results of the interviews indicate various business processes that can be implemented in Process Mining. Subsequently, a framework is created to classify the business processes, based on the two factors 'value' and 'complexity'. This framework examines which business processes, if improved, add value and which business processes are overly complex. During the second round of interviews with 7 municipalities, a business process with the most added value and which is not overly complex was searched for. According to the findings of the interviews, there is not one or two specific business processes that most municipalities find added value in the event of improvement. During the interviews, it was noted that data is the most important aspects of Process Mining. Process Mining is impossible without correct and structured data. As a result, the research chose to focus on business processes where data could be easily extracted. TOPdesk is an application that is widely used by municipalities and beyond. Business processes in TOPdesk are selected as the targeted business process.

The next step was to use Process Mining to implement the targeted business process and make a Business Process Model Notation (BPMN) model. Unfortunately, no data is available about business processes in TOPdesk. As a result, another business process is implemented in Process Mining. This business process is implemented and analyzed in Process Mining. The findings demonstrate how Process Mining can help municipalities to improve their business process. Aside from that, challenges of using Process Mining are also discovered.

Following that, a Business Process Model Notation (BPMN) model of a business process is created. The Process Mining model analysis is used to look for insights that Process Mining

could provide for this BPMN model. The outcomes represent potential insights that Process Mining could provide to improve this business process.

After comparing the two results of the Process Mining implementation and the BPMN model, five business problems arise. Process Mining can give the following insight:

Municipalities do not answer to the customer within a legal term.

- Process Mining provides insights into which cases take longer than the legal term.

Business processes in municipalities do not comply with the four eyes principle.

- Process Mining can reveal whether or not the case has taken this path, and thus whether or not the four eyes principle is guaranteed.

The case does not run through the preferred path of the business process.

- Process Mining reveals which cases go through these activities and Process Mining easily reveals whether or not this preferred path is taken.

The business process is taking too long.

- Process Mining reveals how long each activity takes on average and which takes the most time.

Employees are taking an excessive amount of time to complete a case or activity.

- Process Mining reveals which employers deviates the most from the average.

These insights can help municipalities to improve their business processes. Needless to say, Process Mining only gives information about how the business processes are being executed. It is up the municipalities to search for solutions to improve the business processes.

List of figures

List of tables

TABLE OF CONTENT

CHAPTER 1 – INTRODUCTION

1.1. Background Information

Processes are everywhere, from preparing one's breakfast until developing a budget for a big company. Companies are full of processes, some huge, some small and some more complex than others. Every process is different, but to guarantee the quality of their products and services, companies must ensure that each business process is as efficient as possible. Targeting this, Business Process Management (BPM), *'can be defined as the set of all management activities related to business processes'* (Mendling, 2008). To make certain decisions regarding BPM the companies' management has to have a clear view of how their business process is working. In this context, Business Process Mining emerged, allowing the use of data analysis techniques to support BPM. Process Mining gives the companies' management, tools to get insights about the real functioning of the companies' business processes and to make certain decisions based on business process log data.

Infotopics is a company that helps their clients get more information out of their data. Infotopics supports clients in accessing and understanding their data, so that the clients can make better decisions. Infotopics was established in 2003 with the goal of delivering business intelligence where the ICT component is as small as possible. *'After all, it is about insight into the data and not about technology.'* (Infotopics, 2020)

The company is based in Oldenzaal and has currently around 50 employees. Infotopics uses different programs to help their clients visualize their data. For example, Tableau, Alteryx and Exasol.

This work focuses on a particular software, i.e., Tableau. Tableau products visualize clients' data via dashboards. Tableau *'visually expresses data by translating drag-and-drop actions into data queries through an intuitive interface'*. (Tableau, 2020) Infotopics makes extensions for Tableau, and one of these extensions is a Process Mining extension. Infotopics Process Mining extension supports the visualization of a business process of the client along with the information of the client's process logs. Below in figure 1 is an example of how a business process model looks like. This model visualization gives insight into the

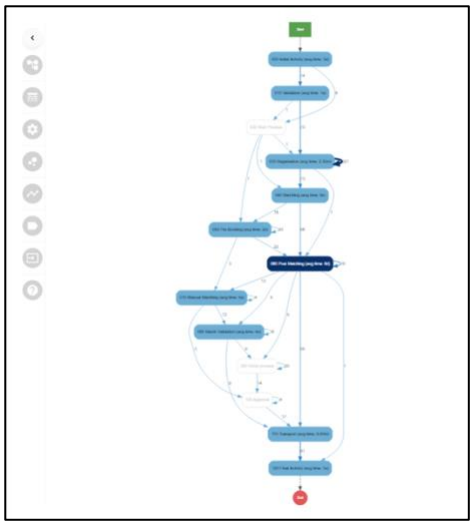


Figure 1 - Example process flow chart (Apps for Tableau, 2020)

client's sub processes, outliers and bottlenecks. Process Mining has different features in the extension. One of these features is the happy path, i.e., the user can select the preferred business process path. The steps that are not in this preferred path are easily spotted as outliers or deviations. In other words, the analysis of the aforementioned outliers and deviations may instigate an investigation of the causes for people to conduct business process in distinct ways, eventually indicating opportunities for business process reengineering.
(Apps for Tableau, 2020) (Infotopics, 2020)

Motivation for research

The extension Process Mining visualizes the business processes of the user in a clear map. Process Mining uses the data, the users process logs, to make this business process model. The business process model shows how the business process really works, instead of how the user thinks the business process works.

Infotopics sees potential in Process Mining techniques and wants to investigate if there is a market for using them. In fact, the other Infotopics' extensions are selling more often than the Process Mining one. The problem Infotopics faces is that the Process Mining extension is not yet adapted to the clients' demands. Hence, such extension is offered to clients only sporadically. In other words, Infotopics does not currently has a business model to market such extension. One of the problems is that Infotopics has no clear idea **for which business processes** Process Mining can support. Besides that, Infotopics wants to know **how clients can profit the most** with the use of Process Mining.

1.2. Problem statement

This section lists the problem cluster, which can be used to locate the core problem. The core problem is then defined. The norm and reality are described along with the scope of the core problem.

Problem cluster

Figure 2 is a scheme of the problem cluster of Infotopics. The problem cluster gives a view of the problems Infotopics faces. '*A problem cluster is used to map all problems along with their connections*'. (Heerkens, Heerkens, & van Winden, 2017)

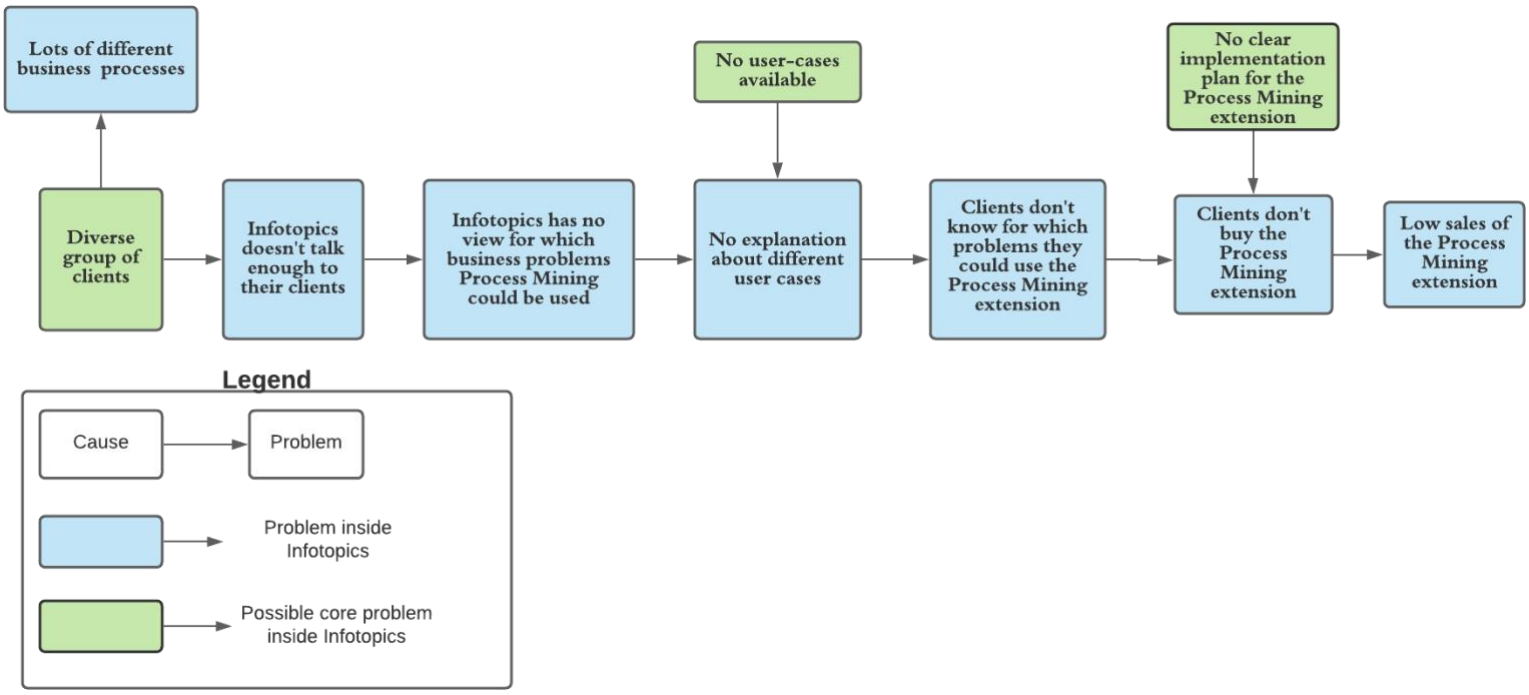


Figure 2 Problem cluster Infotopics

The problem cluster gives three problems that do not have causes, these problems could be the core problems and are thus analyzed in the next section.

Core problem

The problem cluster gives three core problems:

1. Diverse group of clients
2. No user cases available
3. No clear implementation plan for Process Mining

The first one is part of the business, because Infotopics depends on a variety of clients and does not want to refuse clients. The other two problems can be solved. Therefore, the core problem is:

There are no user cases and implementation plan for the extension Process Mining of Infotopics.

Norm and reality

The reality is that Infotopics has ***no user cases*** and ***implementation plan*** for the Process Mining extension. Consequently, clients have little idea for which business problems Process Mining is suitable for and how such approach may solve the business problem.

The norm may be described as ***having a relevant user case that a lot of the clients can identify with***. In other words, this user case plays a relevant role in a business process of a lot clients, resulting in potential changes for such clients, and thus motivating them to adopt Process Mining. Besides motivating clients to adopt Process Mining, Infotopics also needs a clear ***implementation plan for this user case.***

The difference between the norm and reality is the availability of a user case and implementation plan for this user case.

To solve the core problem this main research questions is defined:

How can Infotopics use the extension Process Mining for the domain municipalities' clients in order to improve their business process?

Scope

Infotopics has a lot of different clients from a lot of different businesses. It is difficult to find a business problem that could be the same for a lot of clients. That is why, in this research the focus is on the clients out of the domain municipalities. These clients have a lot of processes in common, for example in every municipality there are processes that help with insurance, taxes and clients. A lot of these business processes also use the same system. This makes it easier to search for a problem in a business process that more clients face.

1.3. The problem-solving approach

Now that the core problem has been defined, a problem approach is created to solve this core problem. Figure 3 shows the structure of the problem approach. Below figure 3 is the explanation of the problem approach.

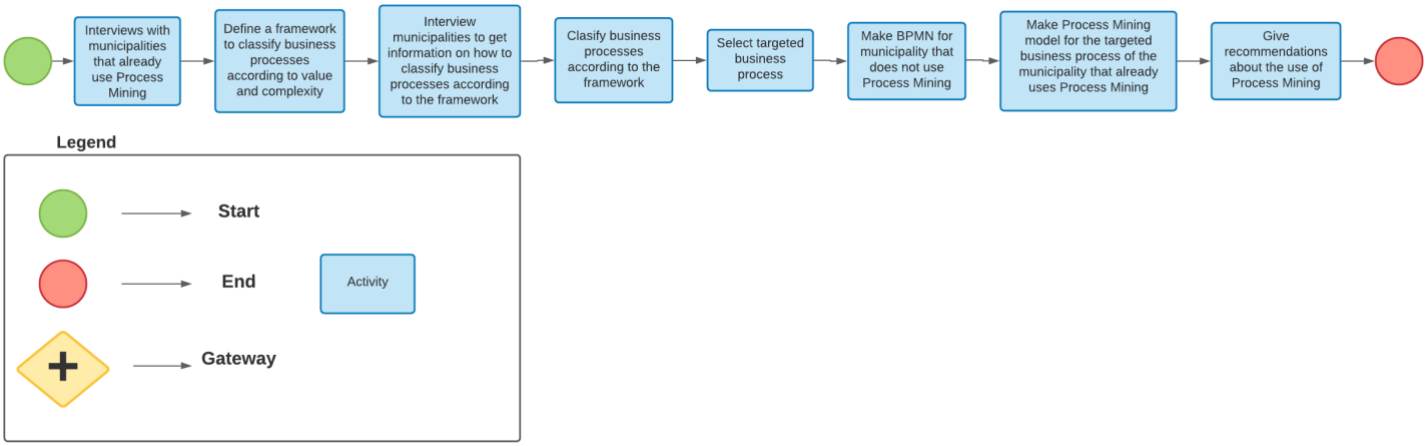


Figure 3 Structure of the problem approach

Finding the problem to target

Several steps are required to solve the core problem. Infotopics wants to find a user case that plays a role in a lot of the municipalities. The first step is to see for which problems in their business process clients can use Process Mining. This was done by doing 5 *different interviews with municipalities that already use Process Mining*. In these interviews, clients who use Process Mining are asked for which problems they are using it and how the clients are using it. The goal of these interviews is to gain more insight into the business problems for which the client uses Process Mining and how this is done.

The next step is to value each business process with the factors **business value** vs. **complexity.** This is a prioritization framework where each business process is prioritized over each other. This means that every business process is characterized with high business value or low business value, and high complexity or low complexity. The characteristics of the business process are given in a prioritization matrix. Together with Infotopics it is discussed how you can evaluate the business process based of these two factors. In consultation with Infotopics, *the framework is defined to classify business processes according to value and complexity.* The business process with the highest business value and the lowest complexity is the problem the research focuses on.

A second interview is done with the municipalities that use Process Mining. In addition to doing interviews with clients who are already using Process Mining, there are also interviews with clients who are thinking about using Process Mining but are not currently doing so. The goals of these interviews are: i) to gain a better understanding of the business problems that the clients are facing; ii) to understand whether it is possible to use Process Mining to solve these problems; and iii) figure out how the clients are currently solving these business

problems. *These interviews are done to get information on how to classify the business process according to the framework.*

With the information gained from the interviews, *the business processes are classified according to the framework.*

Implementation of the business process of the client
As a result of the last step, *the business process to target is chosen*. The next step is to create an implementation plan for this business process and to evaluate the use of Process Mining on a business process.

The next step is to *make a Process Mining model for the targeted business process of the municipality that already uses Process Mining*. An implementation plan is drawn up to set up this business process in the extension Process Mining. Information is obtained from the interviews with the clients and experts of the company. With this information a step-by-step plan is made for the implementation of the business process in Process Mining. The insights obtained from the Process Mining extension are explained.

A business process of a municipality that is not using Process Mining is analysed. This business process is mapped out in a business process model, so *a BPMN is made for a municipality that does not use Process Mining*. This gives an idea of how the business process currently works. With the insights gained through the use of Process Mining model, it is possible to look at opportunities that Process Mining can offer for improving the business process.

The research then gives *recommendations about what to do with the information that the mined business process model gives.* This recommendation provides information about how to reflect and improve the business process on the basis of the mined business process.

1.4. The problem description

Research aim

The general goal of this research project is understanding what kind of business problems can be solved with Infotopics Process Mining extension. Moreover, this project also aims at understanding the added value of using Process Mining for the client.

This general goal results in the following specific goals for this research:

- Understanding the pros and cons of using Process Mining to support BPM for the clients. This will give a picture of the scenarios in which using Process Mining provides the clients with advantages.
- Investigating which and how business processes of the clients currently solved differently can potentially gain with the use of Process Mining.

Relevance

The relevance of this research for Infotopics is that it enlarges the view of the business processes that the extension Process Mining could be used for. The research will give user cases of business process where Process Mining could be used for. This will be relevant, because Infotopics can show these user case to clients.
Aside from that that, a real case study is interesting for both Infotopics and for science. This research will present a real user case; in addition to Infotopics, other clients may benefit from it.
This research is also relevant for the municipalities themselves. The term 'common ground' is increasingly used in municipalities. Common ground was created because municipalities found it difficult to innovate quickly and to deal efficiently with data. Common ground focuses on reforming the information provision of the municipalities and dealing with data more efficiently. The research yields user cases for Process Mining. Process Mining is aimed at visualizing the data, so that municipalities can deal with data more efficient. Because there is a great demand for this common ground**. This research can assist municipalities in gaining a better understanding of how to manage their data more efficiently and comply with the common ground.** (Ground)

Limitations

This research is conducted in 10 weeks, therefore there is limited time available. With this limited time available there is only time for research on one user case. Besides that, there is also only time to look at one domain of clients. Because of this there is also a second limitation. The second limitation is that because the research only looks at one domain the user case is not generalizable. In some cases, this user case could be applicable to other variety of clients. On the other hand, there will be a lot of clients that do not have the problem of the user case. The limitation of this research therefore is that the user case in this research can not be generalizable.

1.5. Research questions

The main research question is defined as:

How can Infotopics use the extension Process Mining for the domain municipalities' clients in order to improve their business process?

The following sub research questions are defined to help answering the main research question:

1. *Which business process of the domain municipalities' clients should we target?*
    - *1.1. Which business processes of the domain municipalities' clients can Process Mining support?*
    - *1.2. Which business process has the biggest business value and the lowest complexity for domain municipalities' clients?*

2. *How can business Process Mining help the domain municipalities' clients deal with the targeted business process?*
    - *2.1. How can the business process be implemented in Process Mining?*
    - *2.2. How can the analysis resulting from the business Process Mining lead the clients to reflect and improve the business process?*

3. *Which opportunities does Process Mining give to improve the targeted business process?*
    - *3.1. How can the targeted business process be represented in a business process model?*
    - *3.2. In which ways do the mined business process deviates from the modeled business process?*
    - *3.3. How can Process Mining lead the clients to reflect and improve the business process?*

Success criteria

In table 1 are the success criteria defined for each research question. The chapters are indicated in which the research questions are answered.

Table 1 Success criteria per research question

RQ	Success criteria
$RQ_{1.1}$	SC1.1 – Have a list of business processes that are *(Chapter 3)*
	SC1.1.1 – Able to be solved by Process Mining. SC1.1.2 – Significant for clients of Infotopics.
$RQ_{1.2}$	SC1.2 – Have a matrix where *(Chapter 3)*
	SC1.2.1 – Every problem is scaled the factors value and complexity. SC1.2.2 – Every problem is scaled in comparison to each other. SC1.2.3 – There is one problem with the highest value and lowest complexity.
$RQ_{2.1}$	SC2.1 – Have an implementation plan were *(Chapter 4)*
	SC2.1.1 – It is stated clearly how the business process can be implanted in Process Mining. SC2.1.2 – Every step of the implementation is described.
$RQ_{2.2}$	SC2.2 – Have a list of opportunities where it is clear how clients can reflect and improve their business process. *(Chapter 4)*
$RQ_{3.1}$	SC3.1 – Have a business process model where every step of the business process is displayed. *(Chapter 5)*
$RQ_{3.2}$	SC3.2 – Have an analysis of the minded business process where the difference w.r.t the modeled business process is clear. *(Chapter 5)*
$RQ_{3.3}$	SC3.3 – Have recommendations where it is clear how clients can reflect and improve their business process. *(Chapter 5)*

Validity and Reliability

'Reliability is concerned with the stability of the research results; similar research conducted at a later date using the same method ought to yield the same result'. (Heerkens et al., 2017)

The problem-solving approach is explained extensive, this means that every step of the research is in depth explained. Therefore, the research could be conducted in the same way at a later date by somebody else. The way this research is conducted will not change over time, only the results could probably change over time. This because the clients that are researched are now at the beginning of using Process Mining. Later in time these clients could be more experienced in Process Mining. Therefore, the results of the interviews later in time could differentiate from this research. Overall, with an explicit problem-solving approach, research questions and interview question the reliability of the research is secured.

'*Validity is concerned with the contents. Have you measure what you intended to measure?*' (Heerkens et al., 2017)

The validity of this research will be complied with this project plan. In this project plan every step of the research is described. To see if the measures are as is described in the project plan, there are success criterions set for each research question. These success criterions will show is if the criterions are as the research intended. With this tool the validity of the research will be measured and secured.

CHAPTER 2 – THEORETICAL FRAMEWORK

Various key concepts of this research are discussed in this chapter. Every concept is discussed in terms of different theories and definitions. The research starts with conducting interviews, and the theory of conducting an interview is described. The business processes must then be scaled based on the factor's 'value' and 'complexity'. These two concepts are explained, and theories on how to scale based on these concepts are described. Following that, the idea of BPM is illustrated, as are the various languages of BPM. Because the language BPMN is used in this research, it is specified in greater detail. The last concept that is portrayed in this chapter is Process Mining. The concept of Process Mining, the required data, and the methods for using Process Mining are all described in this section.

2.1. Business Process Modelling

Companies provide a product for the market; this product is the outcome of different activities in the business process of the product. It is essential for the companies that all the activities in the process work and efficient as possible. Companies aim to know how their business process looks like and how the activities are operating. *'BPM is an integral part of business process management, which addresses the design, maintenance, analysis, and improvement of business processes in enterprises.'* (Gerth, 2013)
Traditionally, the business process model is performed by the knowledge of the personnel. The performance of the personal is regulated by the organizational regulations and procedures. (Weske, 2012) The challenge of BPM is the number of processes it can optimize due to the complexity and resource restrictions of the business processes. (Fischer, Hofmann, Imgrund, Janiesch, & Winkelmann, 2021)

(Weske, 2012) describes business processes models as a model that specifies the activities, with their relationships, that are performed within a single organization. Modelling a business process can be done in different model languages. Below are different languages explained. BPMN is discussed in a later chapter.

Petri nets
One of the best know techniques is Petri nets, this language models the business process in a formal and abstract way. This means that the model is not ambiguous and that only the functional and the process perspectives are covered. In figure 4 an example of a petri net is shown. Petri nets is expressed in transitions, places and arcs connecting places and transitions. In Petri nets the transitions (the squares in the figure 4) coincide with the activities in a business model, while the places (the circles in the figure 4) correspond with the execution of the activity in a business process. The black dot is the representation of the token, tokens represent the state of the business process.

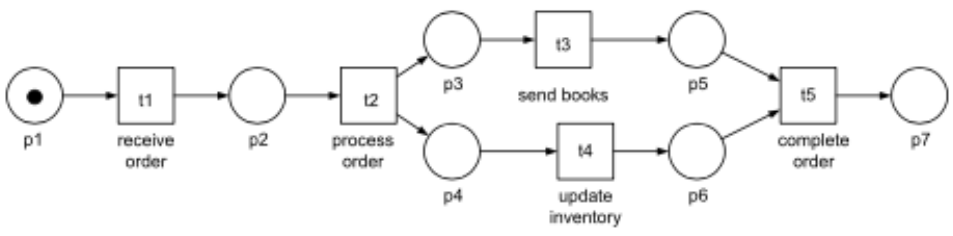


Figure 4 Example Petri Nets (Weske, 2012)

Event-driven process chains

This notation focuses on representing the domain concepts and processes. The main building blocks of this notation are functions, events, connectors and control flow edges. An example of an event-driven process chain is given below in figure 5. Events represent an activity that is happening is a business process, without providing a decision. Functions coincide with a representation of units of work, this means that functions take input and convert it to output. At last, the connectors represent the process logic.

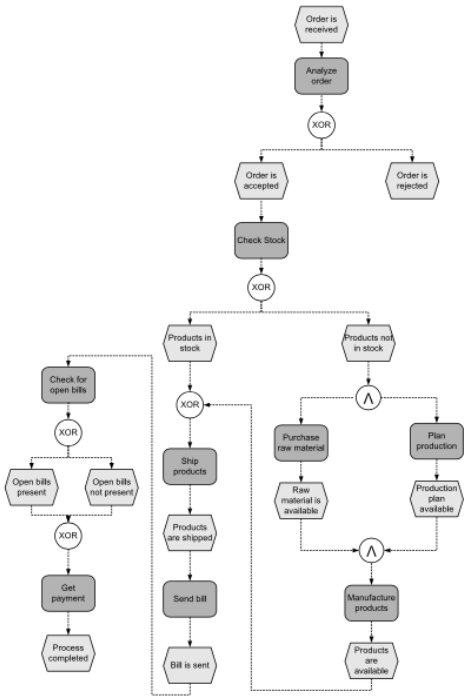


Figure 5 Example Event-driven process chain (Weske, 2012)

Workflow nets

Workflow nets are created to improve Petri nets with notations and concepts that simplify the representation of business processes. *'Workflow nets can be defined as Petri nets with specific structural restrictions.'* (Weske, 2012)

YAWL (Yet Another Workflow Language)

Before the development of the YAWL language, there was a lack of languages that supported all control flow patterns. The YAWL language is based on a variant of the workflow nets. The business process model enhances arcs, transitions, splits and joints. Below in figure 6 an example of a YAWL specification.

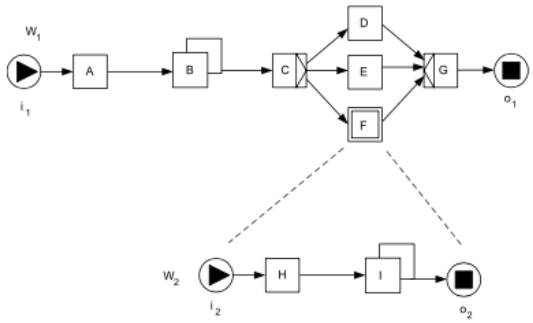


Figure 6 Example of YAWL (Weske, 2012)

Graph-based workflow language

A more commercial workflow is introduced by the graph-based workflow language, it includes the explicit representation of data between activities and dead path elimination. In figure 7 is an example of a credit request process in graph-based workflow language. Activities are characterized as node. The solid arcs represent the control flow. The data flow is represented by the dotted arcs.

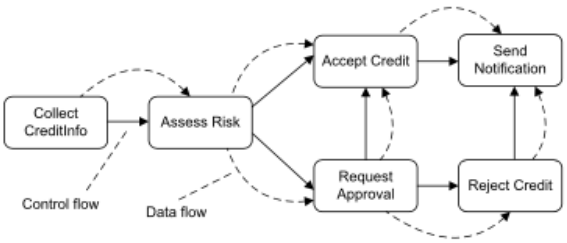


Figure 7 Example graph-based workflow (Weske, 2012)

BPMN (Business Process Model and Notation)

Over time, a broad variety of process modeling languages has been proposed, triggering a call for standardization efforts in this area. The BPMN is an example of a response to this demand for standardization. (Recker, 2010)

The goal of BPMN is to be easily understandable by all users. Hence, BPMN creates a bridge between the business process design and process implementation. The basic modelling elements of BPMN are easy to comprehend, due to this process designers don't need extensive training to use this language. As process designers become more used to BPMN, extensive elements can be added. The elements are divided into four categories, in figure 8 below it shows how these elements look like in the BPMN:

1) **Flow objects** – these elements are the building blocks of the business process.
   i) **Events** – these objects represent anything relevant that happens.
   ii) **Activities** – these are the units of work executed during business processes.
   iii) **Gateways** – these objects represent join and split performance of the flow of control.
2) **Artefacts** – these elements show added information about the business process.
   i) **Data object** – these artefacts represent the documentation of data used in the business process.
   ii) **Group** – these shows groups of elements of a business process.
   iii) **Annotation** – these serve as a textual form of specific aspects.
3) **Connecting objects** – these elements are connecting the other elements.
   i) **Sequence flow** – these are to specify the ordering of the flow.
   ii) **Message flow** – these are to specify the flow of messages between pools.
   iii) **Association** – these are used to link artefacts to elements in business process diagrams.
4) **Swim lanes**

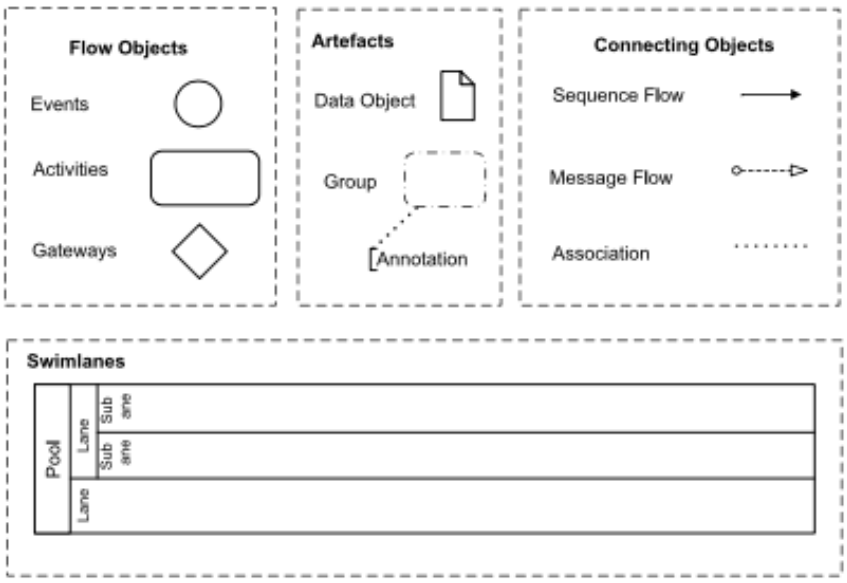


Figure 8 BPMN: elements (Weske, 2012)

In figure 9 is example of a BPMN business model of an ordering process. This BPMN shows all the main elements.
(Weske, 2012)

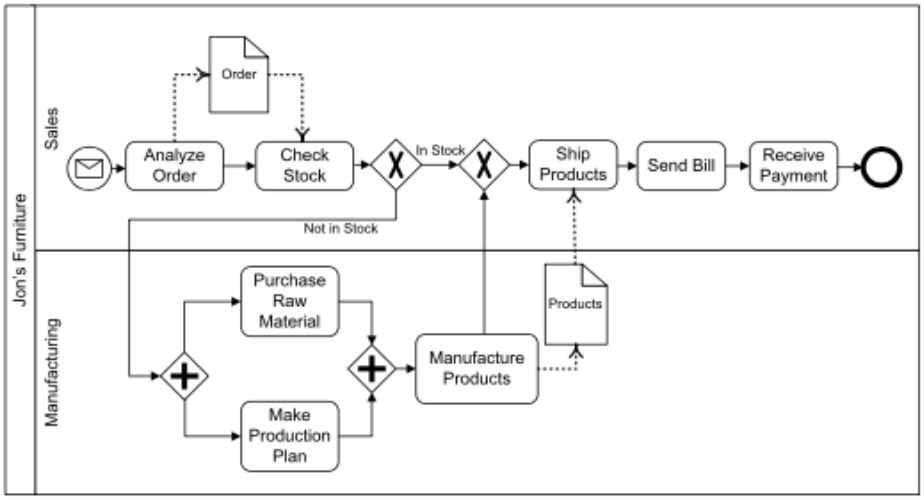


Figure 9 Example BPM (Weske, 2012)

Business Process Mining

'Unlike the traditional Business Process Management techniques that use handmake models, Process Mining is based on facts.' (v. d. W. M. P. Aalst, 2012) On the contrary to Business Process Modeling, Business Process Mining discovers real processes based on given event logs. This means that the models are built on data, specific process logs, and not on experience of the company. The business process with Process Mining will also be represented in a business process model. This model makes it easy to monitor the process, because you can easily see every step of the process and the information of every process step. The information given in the business process model can be used to improve the real process. Information that could be extracted from the business model are for example which steps are taking too long and steps that you didn't expect were in the process. With this information you can adjust and improve the process.

Ordered data is needed for Process Mining, ordered events needs to be related to a case and an activity for a good view of the business model. A case is described as one time through the process. Process Mining is built up on all these cases. All the cases summed up together is all the time somebody goes to the process. In a process there are different steps, these are called events. Therefore, a case consists of events, each event had attributes. These attributes are the characteristics of the event, for example time, cost and resource. With this information the process can be monitored, you can see how long each step takes and how much it costs. Below in figure 10 is an example of information about a case, event and its attributes.
(W. v. d. Aalst, 2016)

Case id	Event id	Properties				
		Timestamp	Activity	Resource	Cost	...
1	35654423	30-12-2010:11.02	register request	Pete	50	...
	35654424	31-12-2010:10.06	examine thoroughly	Sue	400	...
	35654425	05-01-2011:15.12	check ticket	Mike	100	...
	35654426	06-01-2011:11.18	decide	Sara	200	...
	35654427	07-01-2011:14.24	reject request	Pete	200	...

Figure 10 Example of event logs (W. v. d. Aalst, 2016)

As we look at the most important Process Mining challenges given by (v. d. W. M. P. Aalst, 2012) it can be seen that many of the challenges have to do with data, such as data has different characteristics, event data can be incomplete, the data can be changing while being analyzed and the data can contain outliers. As a conclusion, the main challenge of Process Mining is finding the right data. Companies may extract a large quantity of data, but most of the time it unstructured. As a result, companies don't know how to look to extract the added value from data. (W. v. d. Aalst, 2016)

Process Mining can be used in different ways:

1. ***Discovery***

With Process Mining you can discover how your process looks likes without any prior knowledge.

2. ***Conformance***

There is also the possibility with Process Mining to check if the reality conforms with how the company thinks the process should go. With the business model it is easy to see if certain steps in the process are going as it should be.

3. ***Enhancement***

Besides conforming and discovering, Process Mining can also be used to improve the existing model. This can be done with information of the actual process, this is about changing or extending the process.
(W. v. d. Aalst, 2016)

Two examples are given to show that where Process Mining can be used for and the effect Process Mining can have.

- *Uber*

The rapid growth of Uber has led to inconsistency in how they handled their issues in customer support. This resulted in additional process waste, increased the cost and let to poor customers experiences.
Uber wanted to have the ability to identify all the processes and discover unnecessary variation. The aim was to provide all the customers a high-quality service all the time. Process Mining allowed them to discover process waste, such as inefficient contact handling. The implementation of Process Mining gave them insight to quickly identify over 20 Million gains in efficiency.

- *BMW*

The automotive industry is currently tremendously changing. In order to be prepared for this, Process Mining is for BMW an important tool. The initial process to use Process Mining for was for BMW the introduction of new paint shop in one of their plants. The introductions of this new technology didn't go without friction. Therefore, a good IT landscape was needed and placed at the plant. After evaluating the data, some big possibilities came forward:

- *'Visualizing the production process as they really happen and not as they've once been planned.'* (Reinkemeyer, 2020)
- Bottlenecks can quickly be identified.
- *'Analyzing the quality and relevance of process KPIs.'* (Reinkemeyer, 2020)

BMW gets the most of their process improvement if they improve the process along the whole value chain.
(Reinkemeyer, 2020)

2.2. Support to BPM decision making

Customer value

The term 'value' has different meanings in various work fields. (Sales et al., 2018) describes three different meanings value can stand for. The first implication is *ethical value*, this notion of value can be used in the study of Ethics. Moreover, value can stand for *exchange value*. This meaning of value captures how much customers are willing to pay for a good or service. At last, a common meaning for value is that of *use value*. Use value emerges form how well its capabilities match the goals/needs of a customer in a particular context.

Existing literature on customer value gives a various number of different definitions. (Leroi-Werelds, Streukens, Brady, & Swinnen, 2014) defined customer value as *'a tradeoff between the offering's benefits and costs perceived by the customer'.* Moreover, *'customer value as an interactive relativistic preference experience'* is defined by (Holbrook, 1996) as customer value. Customer value is characterized by (Woodruff, 1997) as *'a customer's perceived preference for and evaluation of those product attributes, attributes performances, and consequences arising from use that facilitate achieving the customer's goals and purposes in use situations'.*

(Gustafsson, Grönroos, & Helle, 2010) described another interesting form of customer value. Mutual value creation, one for the customer's value-creating and one for the supplier's value-creation. The supplier is committed to serving her customer by supporting the customer's practices in a way that benefits her business, requiring the customer's commitment to align her practices with the corresponding practices of the supplier to get the intended value-creating process.

'To find out and put the right value on a thing is both easy and hard' (Andersson, Guarino, Johannesson, & Livieri, 2016) In a sense, anyone can decide freely the value of a thing. This is easy, but it is difficult that a valuation barely holds for every situation and at all times. The valuation process can be very complicated, and naturally subjective and dependent on the context. (Andersson et al., 2016)

A framework is purposed by (Sharma, Krishnan, & Grewal, 2001) for value creation. This framework consists of three sub-processes, namely:

1. **Technology delivery process**
   This process creates value through the transfer from R&D to the product development. Another aspect of the technology delivery process is efficiency. Hence, when a company manages efficiency in all development work, value will increase.
2. **Product delivery process**
   The product delivery process involves delivering value through product development and delivery tasks to ensure that the product meets customer requirements and comply with internal commitments regarding quality, delivery, cost and speed to market.
3. **Customer delivery process**
   The customer delivery process creates value through effective supply chain management (including product sales, fulfillment and service).

(Sharma et al., 2001)

Complexity

The concept of complexity has become one of the most important concepts in the modern science. It implies the complexity or scale of the system. Processes are dynamic, due to this and their complexity it is difficult to establish their reliability and stability. The simplest measure of complexity can be considered as the length or size of the process. A high complexity of processes can lead to poor comprehension, defects, errors and exceptions, resulting that processes take longer to develop, test and maintain. Hence, it is crucial to avoid excessive complexity. (Ibl & Boruchova, 2017)

Complicated systems have the advantage of being able to support all process variations and to satisfy the challenging requirements of consumers of users while providing a competitive advantage on the market. On the other hand, higher procurement costs, higher maintenance costs and improvement are all penalties. As a results, it's critical that the information system is complex enough to effectively cover the widest range of business requirements, while still avoiding complexity outside these requirements. (Ibl & Boruchová, 2017)

(Cardoso, 2007) identifies four main complexity perspectives:

1. **Activity complexity**

This prospect on complexity simply counts the number of activities in a process.

2. **Control-Flow complexity (CFC)**

Loops, splits, joins and ending and starting points all have an effect on the process's control flow behavior.

3. **Data-Flow complexity**

The complexity of a process's data structures, the number of parameters of activities, and the mapping between the activities' data all increase the data-flow complexity.

4. **Resource complexity**

During the execution of a process, activities include access to resources. A resource is any entity that is needed for the execution of an activity, such as a document or database.

(Lloyd, 2001) proposed three questions, when pursuing to quantify the complexity of a thing:

1. How hard is it to describe?
2. How hard is it to create?
3. What is its degree of organization?

2.3. Conducting interviews

In this research there will be interviews with the clients of Infotopics. Three main topics are important while conducting the interviews: the designing and planning, conducting the interviews and making sense of interview data.

Designing and planning
In this section the designing of the questions and interview will be discussed. It starts with deciding which type of interview is best for the research. After that the designing of the questions is essential and the duration of the interview. After finishing this, the focus will be one how many interviews will be conducted and how the interviewees are selected.

Conducting interviews
During the interview it is important that the interviewee understands every question. Two main points to focus on while conducting the interview is how to get the conversation going and how to get the interviewee fully engaged.

Making sense of the interview data
The analysis of the interview data is the last step in conducting an interview. The interview should be written in a complete transcript, this should also be checked by the interviewee. After that the search start to the best way to analyze the data, here are different methods for. When finding the best suited method, the last step is writing all the interview data down. (Rowley, 2012)

CHAPTER 3 – FINDING THE TARGETED PROCESS

This chapter identifies the business process that will be targeted in subsequent chapters. This business process corresponds to Infotopics' and the municipality's requirements. First, the method is discussed, including how the research will conducted and for what purposes. Following that, the results will be shown and explained, and the chapter's conclusion will be obtained using these results. The sub research questions that are answered in this chapter are:

1) *Which business process of the domain municipalities' clients should we target?* The targeted business process can be found at the end.
    a. *Which business process of the domain municipalities' clients can Process Mining support?* The results of the interviews describe the business processes that can be implemented in Process Mining.
    b. *Which business process has the biggest business value and the lowest complexity for the domain municipalities' clients?* The frameworks for the two factors are discussed, and interviews are conducted to order to identify the targeted business process.

3.1. Method

At the start of this research, it is important to get an idea of the business processes for which Process Mining is already used. Hence the first interviews were conducted with 5 of Infotopics' clients who already using Process Mining. Some are in a pilot version of Process Mining and some are already analyzing their results. The goals of the interviews are to gain insight in the business processes for which clients are using Process Mining, but also to discover the challenges and benefits of Process Mining. Below are the questions presented that are asked for the first interview. The interviews are semi-structured, which means that there is room for additional questions.

The first interview questions:

1. In which business process do you use Process Mining?
2. How does the business process work in which you are using Process Mining?
3. Did you have all the data available to use Process Mining in your business process?
4. To solve what kind of problems in your business process did you purchase Process Mining?
5. What steps did you take to solve these problems? How did you used the process flow chart in this?
6. How did you solve these kinds of problems before using Process Mining?
7. Can Process Mining be used in other business processes in …, and which one?
8. In which business processes would Process Mining be unsuccessful?

The questions are drawn up together with Infotopics. The first two questions are intended to get an idea of the business process for which the client uses Process Mining. An important topic in Process Mining as described in the theoretical framework is the availability of structured data. Hence, the third question is about whether the clients has the correct data and how the client obtained the correct data. An interesting topic to learn more about is the problems that the clients want to solve. This is done with questions 4, 5 and 6. The questions

provide information about what kind of problems the client encountered, how the problems were solved with Process Mining and how the clients solved these problems before using Process Mining. Finally, the questions 7 and 8 are about other interesting business processes for Process Mining and business processes that are not interesting for Process Mining and why.

The next step is to scale the business process where Process Mining is possible. A prioritization framework is used to choose a business process. This prioritization framework gives the business process with the highest priority. In this research, a value versus complexity prioritization framework will be used. *'Value vs. complexity is a prioritization framework that allows a product team to evaluate each initiative according to how much value the initiative will bring, and how difficult or complex it will be to implement.'* (Product plan, 2020) Each business process will be prioritized over each other. Figure 11 shows the value vs. complexity prioritization framework is given. The result of each outcome is given.

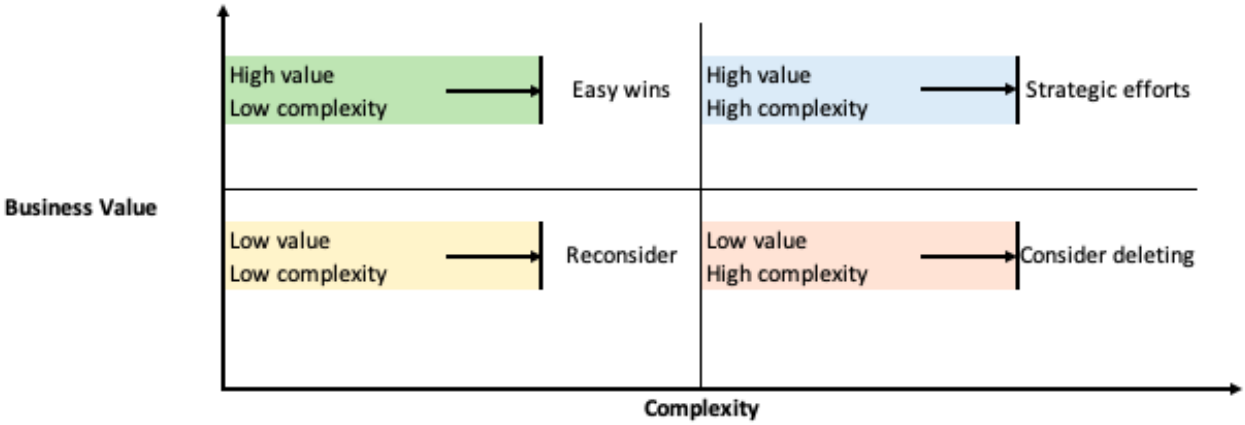


Figure 11 Value vs. complexity prioritization framework

Starting with the framework of value. As described in theoretical framework, mutual value is a way of looking at value, in this research it is important to meet the customer and supplier side. The supplier side is discussed together with Infotopics. Infotopics have insight into what they consider important in the chosen business process and what gives them added value. The main focus for Infotopics is that the business process that is chosen will be repeatable, which means that this process takes place in more municipalities. It would even be better if the chosen business process also takes place in other client's businesses. Then the user case would also apply to other businesses and that would be an added value for Infotopics.

As for the customer value, a framework is discussed in the theoretical framework. Added value for the municipality means one of three things: a) when analyzing the business process may make the whole work within the company (including other processes) more efficient (technology delivery process); b) the business process delivers a product that complies with internal commitment (product delivery process) or c) the business process of the client is an effective supply chain (customer delivery process). This framework gives a couple of factors that will give added value to the customer:

- A business process, when improved, takes less time to go through the business process.

- A business process, when improved, gives a better product for the customer of the client.
- A business process, when improved, gives less cost or more revenue.

The complexity of the business process is also considered. This factor will be important when implementing the business process in Process Mining. There are three questions to quantify complexity, as described in the theoretical framework. When looking at those three questions in context of a business process, three questions arise:

1) Does the business process involve multiple departments?
2) How many steps are involved in the business process?
3) How many employees are involved in the business process?

After conducting the first interviews, an important finding was that right and structured data is crucial for using Process Mining. Without right and structured data, it difficult to get good Process Mining model but also it is difficult to get the right information out of the model. Therefore, the question is added about the availability of data:

4) Is there data available for this business process?

To sum up, the business process to focus on is chosen will basis on the aforementioned framework and questions. To be able to respond to these questions, a second interview is done with the clients that are using Process Mining. During the interview, we identified by asking the before mentioned questions, what the business process is that gives more valuable to a given client.

Besides these interviews, a first interview is done with 2 municipalities that are not using Process Mining. The goals of these interviews are to get insight in the business processes that they find interesting to improve. The same framework is used to look at which business processes when improved, gives added value. The goal is to find out which business process is most interesting to improve or where the most urge is to improve.

3.2. Results

First round of interviews

In this section, the results of the two rounds of interviews are discussed. The most important information of each of the 5 first interviews is given below; some information is left out because of privacy reasons. Also, for privacy reasons, we suppress the client's real names and identify them by using different letters (X, Y, Z, Q and P)

Client X

Business processes in Process Mining

This client uses Process Mining in their end-to-end processes, for example their purchase-to-pay process. To get a better view of their process and to see how the process goes, they use Process Mining on the subprocesses.

The problem the company was facing

They need a tool for internal control, to see if the process as described in the quality manual is carried out the way it is described or not.

Data

It is important to trigger the business controls you want to see in your Process Mining application. Due to this it is possible that you need to make system modifications to trigger the right business controls

Advantages

Process Mining facilitates the mapping of your performance. Hence, it is less labor intensive and real time. Besides that, Process Mining provides insight in the process variances and with this you can intervene on an employer, your police or your system. Another advantage is that Process Mining gives more fact-based substantiation of what deviates from the ideal process.

Possible other processes

It is possible to use it on every process if you have the right data.

Client Y

Business processes in Process Mining

Process Mining is used in their client processes, for example the application of social security or the TOZO, a new process due to corona. At the moment it is mostly used internally to ensure the quality of the process. The goal is to use Process Mining as a tool to give the client a perfect product.

The problem the company was facing

The client wanted to get a view on how the clients are going through the system.

Data

The data was available through the Suite of Centrix tool.

Advantages

Looking at quality, Process mining ensures that you can quickly check if people are doing the right activities. Before that, the quality check was done with a sample. If only a sample of the cases are checked, then it is more likely that cases will be missed with steps that do not proceed as described. Process Mining shows all the cases and not just a sample of it.

Challenges

One of the challenges with data is the historical data. This type of data was not in their basic package and is costing a lot of storage capacity. At the moment, the data can only show the

process's current situation. Historical data makes it possible to compare with the process of last month.
When the client was using Process Mining another challenge occurred. The client noticed that the data that was given by Process Mining did not match reality, because the system that gathered such information was not setup correctly. It is therefore important to analyze the process with someone who knows such processes well, and not to immediately see the data as the truth.

Possible other processes

Processes that allow monitoring are interesting. These processes should be set up right, so that it is possible to get the right data out of the system.

Client Z

Business process in Process Mining

The process this client uses for Process Mining is the administrative process in the field of Finance. At the moment, the client is looking at the creditors side of this process.

The problem the company was facing

The client wanted a tool to easily search in their processes for issues in their performance and possible bottlenecks.

Data

The data was available for the process for which they are now using Process Mining. Other processes were not set up in a right workflow. Currently, the wish is to have a new system to ensure that processes are set up in a right workflow.

Advantages

Process Mining gives them opportunity to look at their performance. The client looked what would happen to the process if they changed or deleted a step in their process.
Previously the accountancy was done with random checks. Before, the accountant just received a lot of data and now, the accountant can easily view the process for a whole year.

Challenges

The challenge this client faces is that this Process Mining extension has a limit in the amount of data it can handle.

Possible other processes

There are other possible processes to choose at their department of Finance, but also their Helpdesk and TOPdesk are interesting processes with workflows. In contrast to these processes, there are still a lot of processes that are logged via Excel sheets, and in this case, there is no structured data to mine (i.e., Process Mining is not possible).

Client Q

Business process in Process mining

The clients' objection process was integrated in Process Mining, due to that this process is the most expensive one and has a lot of steps.

The problem the company was facing

It is an expensive process, decreasing the duration time of the process helped to reduce the costs. They needed a tool to see where to look in the process to save time.

Data

Their data was not complete, and the processing times stamps were not available. Since then, the software supplier changed the software, now the processing times can be measured.

Advantages

On the basis of Process Mining, they could visualize the lead times and process times. With this information, the client could look at which steps took the longest and focus on those steps. The information that you get from Process Mining is objective, so you can avoid discussions with employees about their performance.

Possible other processes

In principle, process mining can be applied to all processes registered in their workflow system. The remission process is next on their list for Process Mining, and capacity planning is also an interesting topic for Process mining

Client P

Business process in Process Mining

Process Mining is used in their employees' inflow and outflow. They are now looking at the re-entering of the employees and the process of hiring their temporary workers. Besides that, TOPdesk processes are also put in Process Mining. Only processes in the modification module are suitable for Process Mining.

The problem the company was facing

The client wanted to be more data driven and to improve their processes with process optimization.

Data

It is possible to extract the data out of TOPdesk, but the registration of the data is challenging.

Advantage

Process Mining gives them the opportunity to verify how their process is running and to see where it can be improved. Process Mining finds out where their weaknesses lie and where does a case get stuck. This will help them to reduce turnaround times and to eliminate constant errors of their process.

Challenges

The difficulty of TOPdesk is that the registration of the data is difficult. Some employees run through the process without registering how long each step takes, and therefore time stamps are no longer correct.

Possible other processes

Processes are interesting for Process Mining if the process runs through different departments of the company. Small basic processes that are self-evident are not interesting for Process Mining.

After analyzing the first interviews together with Infotopics, the most interesting information was that Process Mining is possible for every process as long as right and structured data is available. Finding the right data is often hard to do, but if the client has the data, it is still sometimes hard to implement the data in Process Mining. This happens because data is often not structured or registered in the wrong way. After implementing the data in Process Mining, the client has to be careful of using the information out of Process Mining, as it could be wrong registered data. Because the information can be wrong, wrong conclusion and possible wrong decisions can be made.

Second round of interviews

In the second round of interviews business processes are discussed further based on two topics, namely value and complexity. First, the municipalities that were interviewed in the first round were interviewed again. Now the interview focused on the business process with the most added value. This was asked through the value framework discussed above. Most of the clients that already use Process Mining choose the business process with the most added value to put in Process Mining. Therefore, the results of the first and second interview will give most of the time same business processes.
After asking which business process gave the most added value, the interview focused on asking about the complexity of the chosen business process. The complexity framework is discussed above. The questions above are asked to the client, a lot of the answers are an approximation of the number of steps and employees. The results of the interviews are below.

Table 2 Results second interview

Client	Business process	Data program	Is the business process running through different departments	Number of activities in the business process	Number of employees in the business process
X	Services	Suite of Centrix	Yes	20-25	4/5
Y	Customer journey*	Suite of Centrix	Yes	10	10
Z	Creditor process of Finance	Oracle Database	Yes	32	3600
Q	Objection process	Alteryx designer	Yes	25-30	75
P	Enlistment of employees	TOPdesk	Yes	n/a**	6

* The customer journey is built up of different small processes. The process starts with an application, then the request is processed. The processing of the request is also built up out of different processes, because applications are different.

** The client doesn't know how many steps are in the process exactly, that is one of the reasons why Process Mining is used.

In the second round of interviews also two municipalities are interviewed which are not using Process Mining. In these interviews the goal was to find out which business processes are interesting for them to improve and why.

Municipality A

Social domain has interesting processes to improve. The last couple of years is this domain thoroughly examined because there is a lot of expenditure involved. It is difficult to get a grip on management instruments to keep costs under control. Client A noticed some processes in the social domain, namely:

1. Youth services, this is one of the processes per person that is the most expensive
2. Applying for benefits. This process has a lot of steps, hence that the client finds it interesting to see how the application actually goes.

Suite of Centrix is used to store their data. The systems the client uses are very complex, because there is no competition there is no innovation. The client uses are the moment Tableau, the data they use for this comes from suite.

Municipality B

At the moment they are busy with writing down all their business processes and how their business processes should go. This municipality is not really process oriented. They look at if their process is customer friendly and if their process doesn't get any complains their process is at the moment fine. In the further, there will be more interest in improving business processes, but at the moment they are too busy to improve. Business processes that were interesting for them were:

1. Debt counseling, this is a process that a long time to go through the process.
2. Purchase, this process is done with different municipalities. This makes it a complex process and they want to know how to monitor the whole process.
3. Writing letters for employees. That takes a lot of time and annoyance, also this process can be automated. There are about 40 employees involved, which is precisely why it is very complex.
4. Environmental law. Make it faster and clearer what should or should not be done by environmental law.

This municipality doesn't look what a process costs, but if it complies with the legal deadlines. The most important thing is that decisions making is done properly.

3.3. Conclusion

In the conclusion each research question will be answered with the success criteria that is defined in the introduction.

Which business processes of the domain municipalities' clients can Process Mining support?

The success criteria for this research question are:

- ***Have a list of business processes that are able to be solved by Process Mining.***

During the research, 5 interviews were conducted with clients that are using Process Mining. With the information of the interviews, a list was made with business processes that are implemented in Process Mining. The list entails the business processes that the clients already used but also ones that they thought were interesting to implement. Almost every client said that Process Mining is possible on almost every business process in the municipalities, but only if the correct data is available. Also, the business process should have added value when improved. During the research, it was noticed that Process Mining does not solve a business process but gives insights to possible improvements in the business process. The list below shows the business process the clients talked about, but as mentioned, a lot of other processes are interesting to implement.

- The different business processes during the customer journey *(Client Y)*
- Objection process *(Client Q)*
- Enlistment of employees *(Client P)*
- Credit and debit processes in Finance *(Client Z)*
- Application of social security *(Client Y)*
- TOZO *(Client Y)*
- Processes of the helpdesk *(Client Z)*
- Processes in TOPdesk *(Client Z)*
- Remission process *(Client Q)*
- Purchase-to-pay process *(Client X)*

- ***Have a list of business processes that are significant for clients of Infotopics.***

After the list was made with different possible business processes that can be implemented in Process mining, it was interesting to search for which are significant for the clients. When a business process is significant, it means that it has added value when it is improved. During the second round of interviews, questions were asked about which business process gave added value to the municipality. The added value is described in the framework discussed in that chapter. The added value usually comes from *reduced duration time*, *better product for the customer* and *reduced cost or more revenue*. This resulted still in a lot of different business processes. This is not strange, because every municipality focuses on different business processes to improve. Almost all the clients worked in a different kind of department, therefore it is difficult to find similar business process that are interesting for a lot of municipalities. Also, only seven municipalities were interviewed, and in this small sample of clients, it is difficult to find business processes that are interesting for more municipalities.

Which business process has the biggest business value and the lowest complexity for domain municipalities' clients?

- ***Have a matrix where every problem is scaled with the factors value and complexity, every problem is scaled in comparison to each other and there is one problem with the highest value and lowest complexity.***

After the first interviews, the framework for valuing the added value and complexity of business processes was made. With this information, the second round of interviews was done. The results of the interviews make explicit a lot of the different business processes that municipalities want to improve. Therefore, it was too difficult to compare all the business process in a value versus complexity matrix. This makes it difficult to scale the business processes based on the results that are presented. In the perfect situation, there is only one business process or two, that most of the municipalities wishes to improve. In reality, this is not the case, and the choice is much more difficult than we anticipated. A municipality has at least 400 different business processes. As can be shown by the results, every municipality focusses on other business processes to improve, because every municipality has different problems inside their business. Besides that, the interviews are done with specific persons inside the municipality. This causes that these interviewees only look at their own processes in their domain, such as Finance. Hence, it is difficult to get the big picture of all the processes and which one has the biggest added value. With all this taken into account it is very difficult to find one business process based on the value framework that a lot of municipalities find interesting.

During the interviews, it was again noticed that good and structured data is the most important part of Process Mining. Because without structured data, it is not possible to implement the business process in Process Mining, and without correct data it is possible that the wrong conclusions are made from the Process Mining model. Only if you have the right data, it is possible to use Process Mining, and eventually it can be used on every process if the right data is available. Although we set up value and complexity as prioritization variables, in the end, we could only take these variables into account after we made sure that data was available for the process. Otherwise, how could we make the analysis of the result of Business Process Mining? The clients that are using Process Mining use TOPdesk, Suite or Alteryx to extract their data. The two programs that are used by most of the municipalities were Suite and TOPdesk. Below the two programs advantages and disadvantages are discussed.

TOPdesk

As discussed in the previous chapter, one of the main points for Infotopics was that the chosen business process should be repeatable. After the interviews, the questions were asked to all the interviewees if they use TOPdesk. Three other municipalities are also asked this question. 7 from the 9 interviewees who were asked use TOPdesk. Besides that, on their website also other municipalities use TOPdesk. Concluding that a lot of different municipalities use TOPdesk. Besides that, a lot of other business use TOPdesk, for example universities, health care and retail companies. This gives the advantage that if this would be chosen as our user case, the results of our assessment could also be used by businesses outside municipalities. Since Infotopics wants to broaden their client list, this would give a big advantage to Infotopics. For example, if Infotopics would make a standard plug-in for TOPdesk in their extension Process Mining, then a lot of different clients of Infotopics could use this. The processes that are in TOPdesk are internal processes, for example application of a VOG

(certificate of conduct) or the application for a company pass. The processes are set up manually in TOPdesk, therefore the processes are clear. So, another advantage is that the data from TOPdesk is therefore structured well.

The disadvantage is that Process Mining can only be used in one part of TOPdesk. TOPdesk has two modules; one is incident management, and one is change management. The incident management is for all incoming tickets, this is not a suitable process for Process Mining. These notifications are all very different and it is difficult to find measure variable. The only variables that are possible to measure, is the time of registration of notifications the time that it is finished. In this there are not a lot of opportunities for improvement. On the other hand, in the change management module, you can make an entire workflow. Thus, Process Mining is only suitable for this module of Process Mining. Some businesses use only the incident management, in these cases Process Mining is not suited and they will not purchase it.
As one of the clients used TOPdesk to put this data in Process Mining, another disadvantage occurred. The registration in TOPdesk is manually, this means that the employees have to start and stop their steps themselves. It can occur that employees registered all the steps in the end, then the duration of the steps is not correct. To change this, the work customs of the employees must change, which can be very hard.

Suite of centric
Suite is used in a lot of municipalities to store their data; social domain is where suite is mostly used. Suite has a wide range of solutions for different departments inside the Social domain. Besides the social domain, suite has a lot of standard solutions for example taxes, civil affairs and finance. Suite is interesting program because it has so much different solutions.

The disadvantage is that suite for social domain is only used by municipalities, there are no other business that have to deal with the social domain. This means that if Infotopics made a plug-in for processes in the social domain of suite in the Process mining extension, that no other client could use this plug-in. Besides that, municipalities use Suite only to store their documents and not the right data for Process Mining. It is not clear how many municipalities have the right set up for Process Mining.

After carefully consider the advantages and disadvantages of both tools, and after with Infotopics, the decision was to focus on processes in TOPdesk. The perspective to broaden Infotopics' clients list was particularly crucial for this decision.

CHAPTER 4 – BUSINESS PROCESS MINING

This chapter discusses the use of the Process Mining extension. The sub research questions that are answered in this chapter are:

1) *How can business Process Mining help the domain municipalities'' clients deal with the targeted business process?*
    a. *How can the business process be implemented in Process Mining?* The method shows the implementation of data from a business process in the Process Mining extension. The implementation is shown step by step to give an idea of how the Process Mining extension works. The implementation is done with data from a real state taxes objection process.
    b. *How can the analysis resulting from the business Process Mining lead the clients to reflect and improve the business process?* After the implementation of the data, the business process model is analysed. The opportunities and challenges of Process Mining are discussed.

4.1. Method

In chapter 3, a business process was chosen to target and put in Process Mining. The process that was chosen were the internal processes in TOPdesk. The interviewees were asked if they had available data of TOPdesk for Process Mining. These municipalities had no data that was suitable for Process Mining or could not give it in connection with privacy sensitive data. Because the data from TOPdesk was not available, another available data had to be searched for. Other municipalities, with other software than TOPdesk, were asked if there was data available that could be used in this research. A client that implements their real state taxes objection process processes in Process Mining was willing to give their anonymized data set for this research. Although the research cannot show the added value of implementing a TOPdesk process in Process Mining, the research can show what the added value is of a business process in Process Mining.

As aforementioned, the process that is implemented in Process Mining is the real state taxes objection process. Residents get once per year a document with taxes they have to pay, among which are the taxes on their real estate. The amount of taxes that the residents pays is based on the valuation of their real state, and this is something that the residents can object to. When a resident object to the valuation of their real estate, then this process starts. In what follows, you may see step by step, how the process is implemented in Process Mining

Step 1 – Put data in Tableau

The municipality provided an Excel sheet with the data. There are other ways to provide the data for Process Mining, such as through a text file, a PDF file and a JSON file. The data that is necessary for Process Mining is:

- CaseID *(ZAAKNR)*
- Activities *(LABEL_STAP)*
- Start time *(TTSTART)*
- End time *(TTEINDE)*

The necessary data is all provided, the names in the brackets are how the data is named in the excel that is used. Also, some extra information is provided such as the employee that worked

on the activity *(GEBRUIKER).* All the information is put in Tableau. The excel sheet is uploaded into Tableau

Step 2 – Make nodes and links sheet

The next step is to make two worksheets named: NODES and LINKS. The nodes worksheet entails information about each process step. Figure 12 shows the nodes sheet that is used for this business process. The *LABEL_STAP* give the 5 activities that are in this business process, which are:

1) Calling/requesting information of client *(18. BELLEN/INFO OPVRAGEN)*
2) Request a valuation by appraiser *(19. INPANDIG OPGEVRAAGD)*
3) Advise by appraiser about real estate *(20. ADVIES WONINGEN)*
4) Check of appraiser *(70. CONTROLE DOOR TAXATEUR WONINGEN)*
5) Decision will be made + notice of objection will be certified *(80. UITSPRAAK + FIATTEREN WONINGEN)*

This gives the information that there are 5 steps in this process. On the right side of the activities is information given about every activity. The information of *AANTAL ZAKEN* gives the number of cases that run through the activities, so 1400 cases run through the activity calling/requesting information of clients. The information of *AANTAL GEBRUIKERS* gives the number of employees working on these activities, so 9 employees work on requesting a valuation by appraiser. The last column gives the average duration of the activity in seconds. This means for example that the step where the decision is made takes on average 382 seconds.

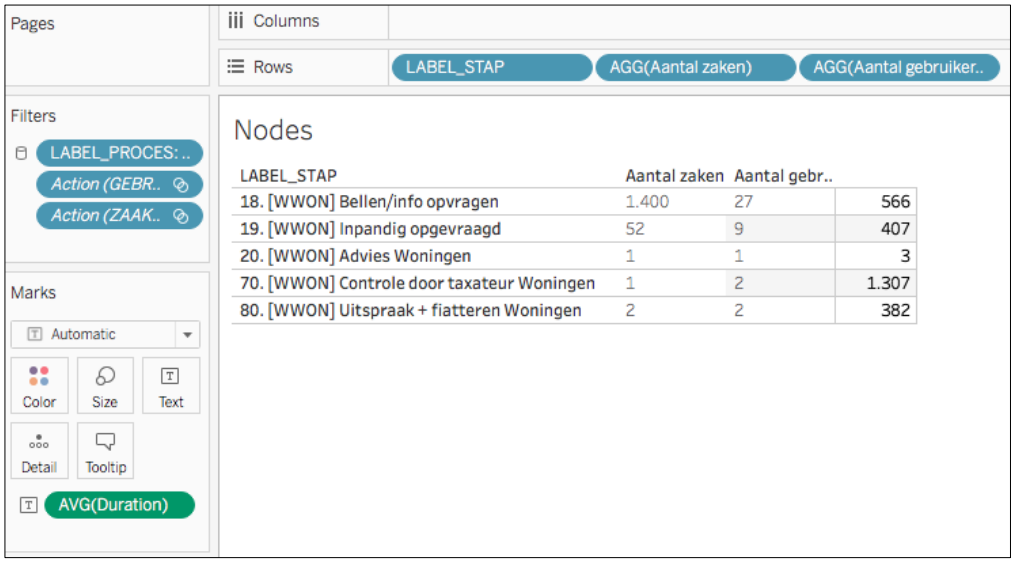
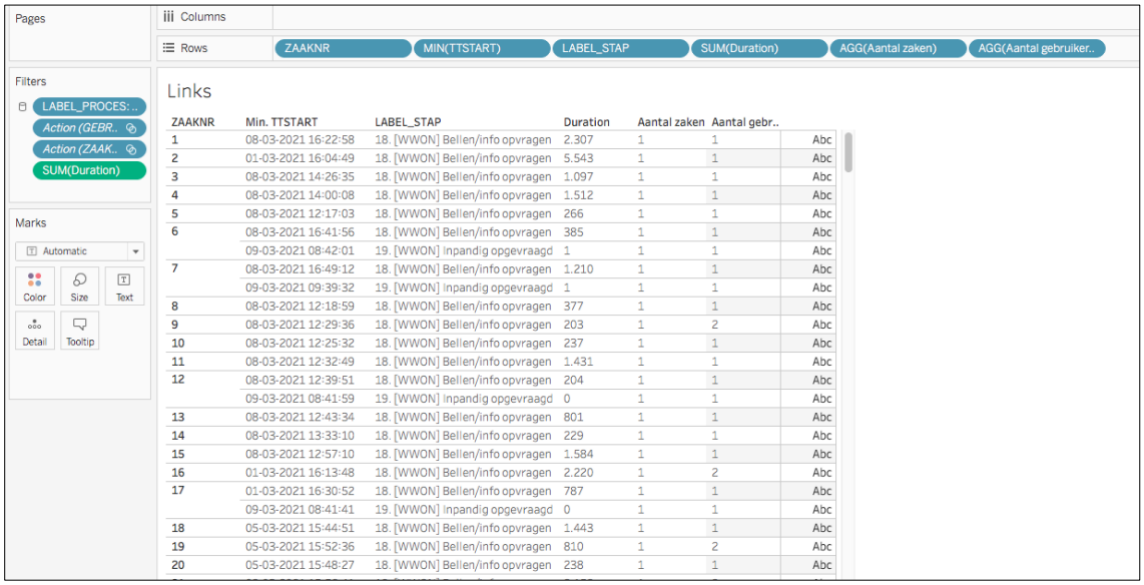


Figure 12 Nodes worksheet

Next is making the links sheet, which gives more information about each case that is running through the business process. Figure 13 shows the links sheet that is used for this business process. There are in total 1400 cases in this datasheet. The first column shows each case described with ZAAKNR, i.e., each case has their own number, which works as their identifier. The second column gives the minimum start time (*Min TTSTART*), meaning the start time of

the activities that are in the case. This gives information about when each activity starts in the case, and thus when the case starts. The third column are the activities that are in the case (*LABEL_STAP*). In figure 13, some cases have 1 activity and others 2, also showing which activities there are in the case. The duration in seconds of every activity in the case are given in the fourth column. The last two columns give the number of cases *(AANTAL ZAKEN)* and number of employees that work on the activity *(AANTAL GEBRUIKERS)*



ZAAKNR	Min. TTSTART	LABEL_STAP	Duration	Aantal zaken	Aantal gebr..	
1	08-03-2021 16:22:58	18. [WWON] Bellen/info opvragen	2.307	1	1	Abc
2	01-03-2021 16:04:49	18. [WWON] Bellen/info opvragen	5.543	1	1	Abc
3	08-03-2021 14:26:35	18. [WWON] Bellen/info opvragen	1.097	1	1	Abc
4	08-03-2021 14:00:08	18. [WWON] Bellen/info opvragen	1.512	1	1	Abc
5	08-03-2021 12:17:03	18. [WWON] Bellen/info opvragen	266	1	1	Abc
6	08-03-2021 16:41:56	18. [WWON] Bellen/info opvragen	385	1	1	Abc
	09-03-2021 08:42:01	19. [WWON] inpandig opgevraagd	1	1	1	Abc
7	08-03-2021 16:49:12	18. [WWON] Bellen/info opvragen	1.210	1	1	Abc
	09-03-2021 09:39:32	19. [WWON] inpandig opgevraagd	1	1	1	Abc
8	08-03-2021 12:18:59	18. [WWON] Bellen/info opvragen	377	1	1	Abc
9	08-03-2021 12:29:36	18. [WWON] Bellen/info opvragen	203	1	2	Abc
10	08-03-2021 12:25:32	18. [WWON] Bellen/info opvragen	237	1	1	Abc
11	08-03-2021 12:32:49	18. [WWON] Bellen/info opvragen	1.431	1	1	Abc
12	08-03-2021 12:39:51	18. [WWON] Bellen/info opvragen	204	1	1	Abc
	09-03-2021 08:41:59	19. [WWON] inpandig opgevraagd	0	1	1	Abc
13	08-03-2021 12:43:34	18. [WWON] Bellen/info opvragen	801	1	1	Abc
14	08-03-2021 13:33:10	18. [WWON] Bellen/info opvragen	229	1	1	Abc
15	08-03-2021 12:57:10	18. [WWON] Bellen/info opvragen	1.584	1	1	Abc
16	01-03-2021 16:13:48	18. [WWON] Bellen/info opvragen	2.220	1	2	Abc
17	01-03-2021 16:30:52	18. [WWON] Bellen/info opvragen	787	1	1	Abc
	09-03-2021 08:41:41	19. [WWON] inpandig opgevraagd	0	1	1	Abc
18	05-03-2021 15:44:51	18. [WWON] Bellen/info opvragen	1.443	1	1	Abc
19	05-03-2021 15:52:36	18. [WWON] Bellen/info opvragen	810	1	2	Abc
20	05-03-2021 15:48:27	18. [WWON] Bellen/info opvragen	238	1	1	Abc

Figure 13 Links worksheet

Step 3 – Put the information in the extension Process Mining

When the links and nodes sheet are complete, the dashboard with the extension can be made. First a new dashboard needs to be opened. Then the links and nodes sheets need to be added to the dashboard. At last, the extension needs to be uploaded. If all these three things are in the dashboard, the Process Mining extension can be made. Figure 14 shows the information that is required to make the Process Mining model. The nodes data consists of:

1) **Nodes sheet** – the nodes worksheet needs to be selected
2) **Event label** – the activities should be selected
3) **Nodes measure** – one selects the measure of the activities that will be shown in the process mining model. Part of this data is the duration (in seconds), therefore the process model map will show the duration at every step.

The links data consists of:

1) **Links sheet** – the links worksheet needs to be selected
2) **Event label** – the activities should be selected
3) **Case identifier** – the cases should be selected
4) **Link measure** – the measure is selected. In this model, the number of cases was chosen for the links measure. Hence, the number of cases will be displayed between the activities.

When all this data is selected, the Process Mining model can be made by Tableau. The next session discusses the results of the Process Mining model.

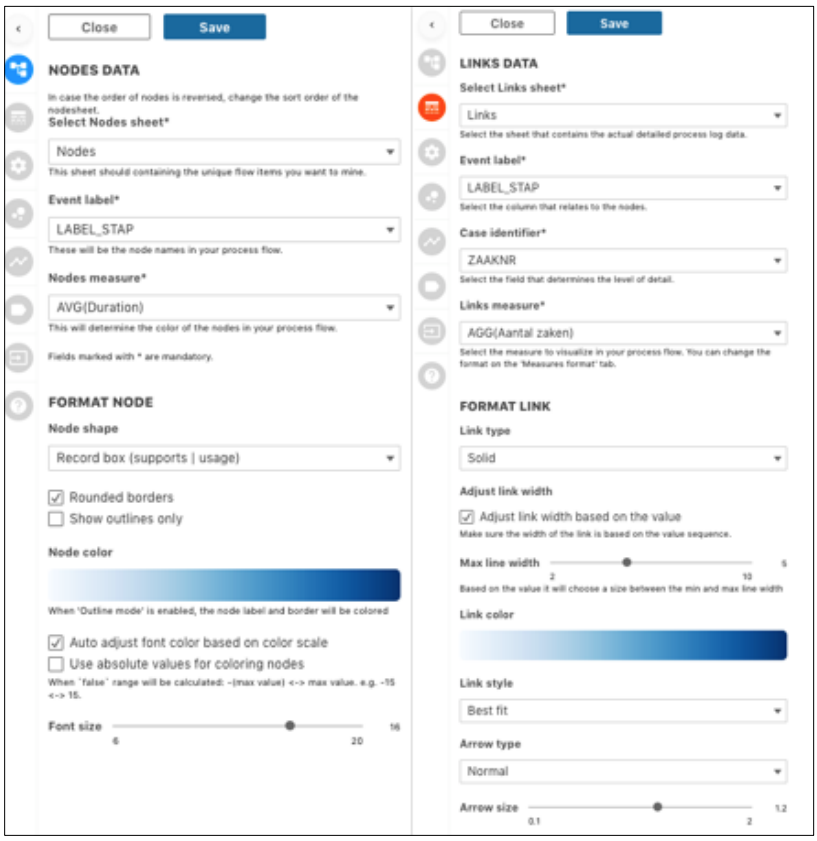


Figure 14 Implementation data for Process Mining

Step 4 – Extra worksheets

To make the Process Mining dashboard interactive, new worksheets need to be configured. The advantage of making the Process Mining model interactive is that this way, one may zoom in on specific cases or employees, thus focusing on specific details of the process. For this business process, the focus is on how long each case takes and how much cases each employee does. There is a lot of other information that can be put in these interactive worksheets, such as on average, how long each employee on average goes through a case.

4.2. Results

In figure 15 the Process Mining model is shown after all the data is put in. The previous section described such input data.

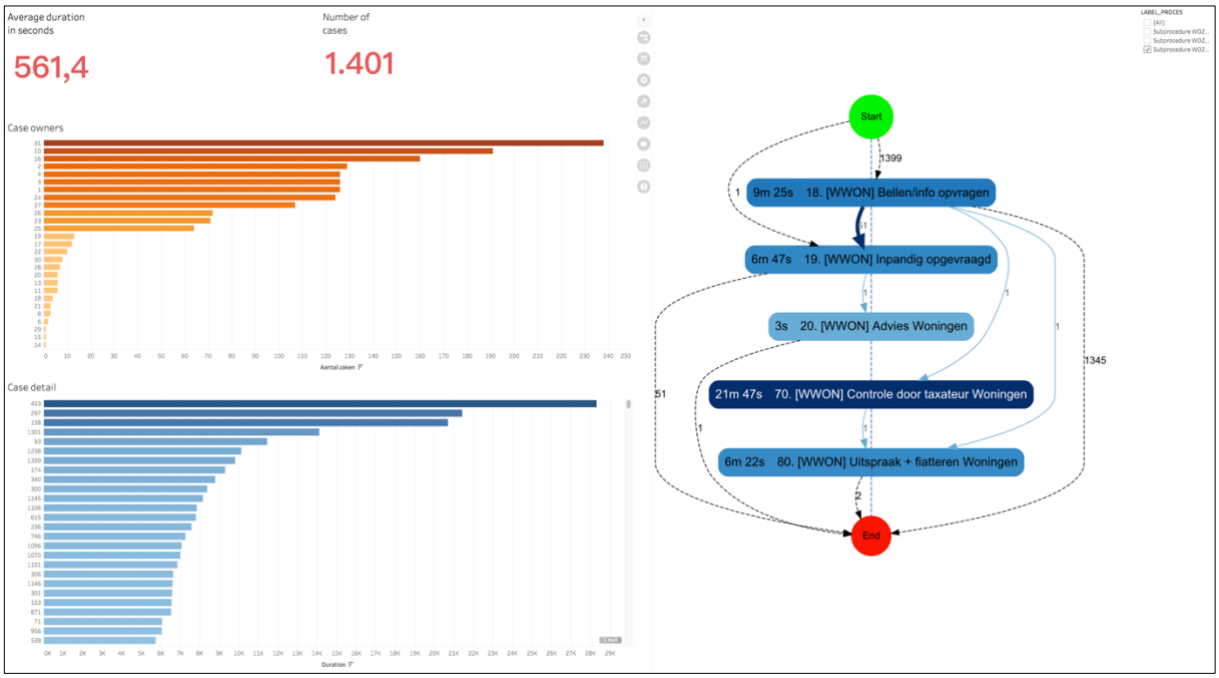


Figure 15 Process Mining dashboard

Below the results of the Process Mining model will be discussed based on different perspectives.

1) Data

When the data was received by the municipality, the data analyst of the municipality noted that not all the activities are registered in the dataset. The conclusion was that there was something wrong with the module that they use to make event logs. This is one of the reasons why some of the data that is used in this Process Mining model is not complete and, in some cases, not right. The use of incomplete data is a big problem in Process Mining, since it may lead to inaccurate conclusions and consequently, it may make the stakeholders take wrong decisions.

The municipality started this business process in Process Mining with less activities than they have at the moment. After discussing their previous model with the employees that work with this process, some activities were added. As a result of that, their software needed an update to register these new steps. It is interesting that there is a conversation between the executive side of the business process and the data side of the business process. The data side has most of the time, not a real idea of how the process really goes, since they often just look at the numbers. With the help of the executive side, the Process Mining model becomes more accurate. **Concluding, it is important to discuss the Process Mining model with the executive side of the business process**.

The data was all put in the extension, and hence some information immediately stands out. First, the Process Mining model is analysed. The data shows that there are **1401 cases** running

through this business process (the number of cases is shown in figure 15 in left corner above). But there are only **1400** running in the model, and **1399** cases run from the start node immediately to the first activity. One case goes immediately from the start to the second activity. This is not correct, since every case should go to the through the first activity to reach the second activity. This is also an error in the data, this probably is caused by an update in the software. As a consequence, we concluded that the first activity of this particular case is not registered.
After the first activity **1345 cases** go to the end node and **51** go to the second activity. Considering this information, it looks like it is possible that after the first activity, the business process may stop. This is not the true; every case goes through all the five activities. The problem here is that the next activities are not executed yet, therefore these activities are not registered. The same problem happens with the second activity, where **51 cases** go to the end node.

In this dataset, the data is not complete, because the activities are not executed yet. This has a reason: the document with the taxes is sent at the end of February. From then on, the citizen's objections on this document are sent to the municipality. This dataset was received half March. Hence, that the first activities are done, but the execution of the rest of the activities still need to be done. If the data were received two months later, then a lot more cases would have run through the last three activities.

Concluding, it is important to find out if certain data is not correct. After that, it is possible to search for a solution for these data problems. It is also important to encounter these data errors by looking at the data and talking to the stakeholders. If the municipality wants to search for certain bottlenecks, it is important to check if the data is correct.

2) Activities and cases

The Process Mining model can be used to look at the cases and the activities. A lot of information can be extracted from the Process Mining model. After analysing the Process Mining model, the results are discussed with the municipality. The information that was important for the municipality to get out of the Process Mining model is described below:

- Municipalities have a legal term to reply for some of their business processes. This means that according to the law, they must respond within this legal period. The legal term for the objection process is three months. With the Process Mining model, it is easy to see whether the cases remain within this legal term. Each case has a duration time, so when this duration exceeds the three months, the municipality knows that this case is not within the legal terms. In the Process Mining model in this research, there is just one case run through the whole business process. But in this Process Mining model of the municipality, all the cases eventually run through the whole process. Then it is easy to see which cases did not finish in time and why. Moreover, it is possible to spot which activities took too long (bottlenecks) that the whole case was not within legal terms. With this information it is possible to zoom in and take actions where needed.
- The information given in the nodes tells a lot about the activities. In the Process Mining model, different measures can be shown, such as the duration of the activities and the number of cases running through the activities. The duration shows how long on average the activities run. With this information, it is feasible to see where the

bottlenecks are. Which activities run the longest and why. Then one may ask: is this something the municipality can decrease or are these activities also dependent on external factors? In this Process Mining model, steps 1 and 4 run the longest. Step 1 is dependent on external factors; it depends on their customer. For example, it could be that the customer has a lot of questions, then activity 1 has a long duration. Step 4 is less dependent on external factors and hence, this could be a good point to zoom on. Then it is important to look at why is this activity is taking so long, and how they could decrease this duration.

- In addition to looking at the duration of the activities, it is also possible to look at the number of cases running through the activities. This provides different kinds of information. First of all, it is possible to check whether certain activities are carried out. In this Process Mining model, there is a control in step 4, so every case should run through this control. This is necessary due to the regulations according to the laws that have been established. The Process Mining model shows already one case that is not going through the activity of the control. This case was discussed with the municipality, and we discovered that this was an error in the data. Although this was an error, there is still an opportunity to check if the necessary activities are being performed. If this activity is not done, it is easy to zoom in and look who the case owner was. Then it is possible to check with the case owner, why the activity in question is not being performed and take the necessary measures to avoid that this grave mistake happens again

  It is also possible to see if cases run more often through an activity. In this Process Mining model, it means that more case owners are on this case. This happens when an employee does not know what to do with the case and sends it to another employee. An example is shown in case 297 in figure 16. In this case there are two employers in one case.

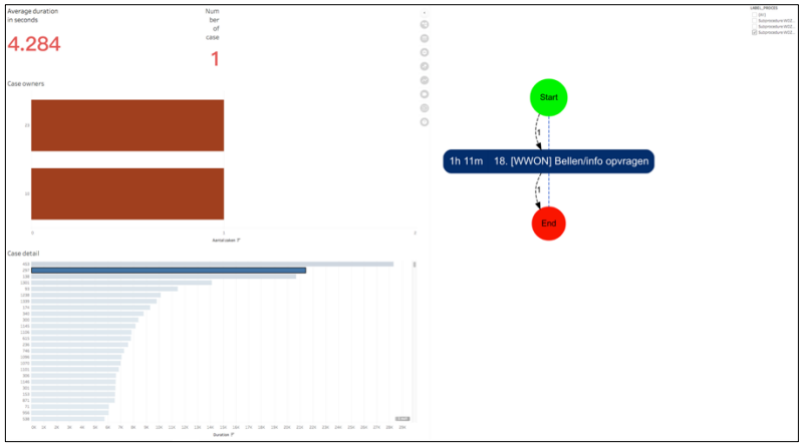


Figure 16 Process Mining dashboard - case 297

The municipality focuses on the fact that appraiser does the advice at once. This means that the appraiser does not send the case to another appraiser. This information cannot be shown in this Process Mining model, but it shows in the municipalities Process Mining model. When this is the case; an arrow goes from the activity into the same activity. Just as shown below in figure 17, the number of cases running again through the activity is shown beside the arrow.

Figure 17 example of cases running through an activity

The Process Mining model can show which particular cases are running again through the activity. With this information it is possible to see which case owner often sends cases to other appraisers. Then it is possible to give this case owner extra training to get better at this activity.

One of the big advantages of Process Mining in Tableau is the interactivity of the model. In the previous section, the possibility for extra worksheet is discussed. For this business process and extra worksheet is made where the time of every case is displayed. The worksheet is shown in figure 15, as the blue graph in the inferior left corner. In figure 18, a more detailed figure is shown. In the Process Mining workbook is possible to click on this bar of the longest case and get the details of this particular case (case 453) in the Process Mining model. In the appendix, figure 19 shows how the Process Mining model looks like in this particular case. The information of case 453 is:

1) Only the first activity is in this case
2) There is one case owner and that case owner 27
3) This one activity has a duration of 3hours and 55min

This single case model shows so much information about just one case. The advantage of using Process Mining in Tableau makes it so much easier to zoom in on certain cases, activities and case owners. It is possible to zoom in a lot more data if it is available.

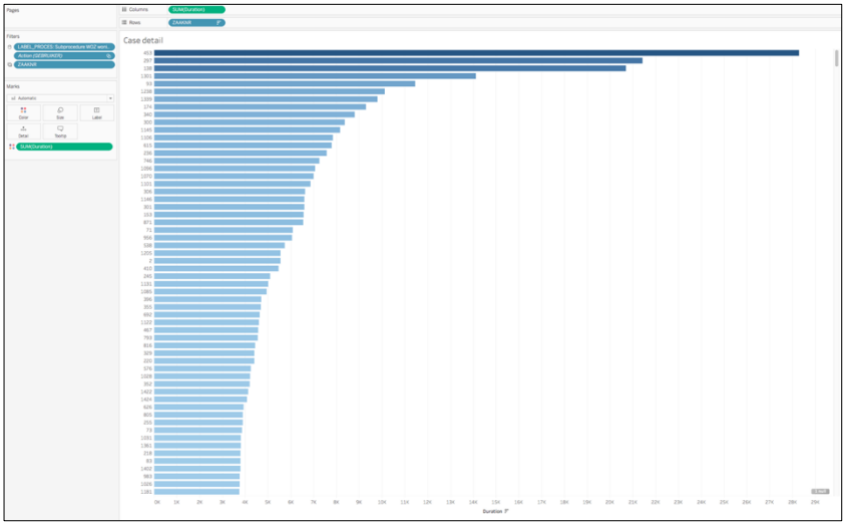


Figure 18 Process Mining dashboard – Case detail

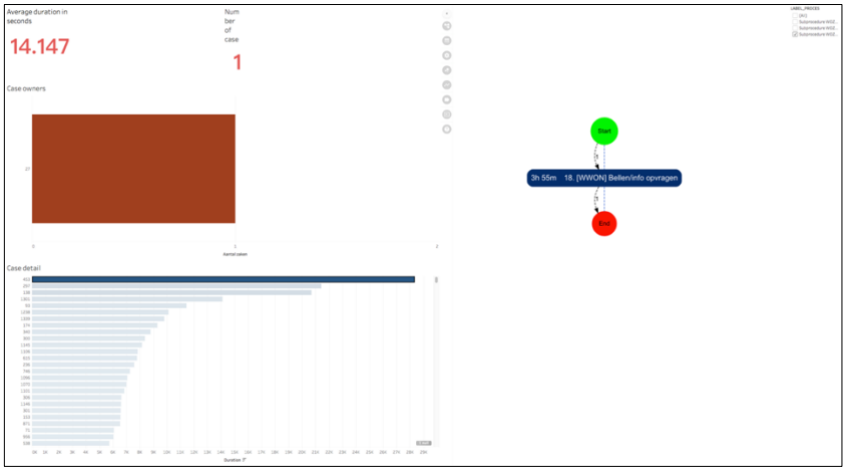


Figure 19 Process Mining dashboard - case 453

3) Case owner

In the Process Mining model, it is possible to look at the case owners. The case owner is the municipality employee who works on a particular case. In this business process, it is possible that more than one case owner works on a case. This happens when one of the employees does not know something and sends the case to another (usually more experienced) employee to work on the case. In this dashboard, another worksheet is added. This worksheet gives information about the number of cases each case owner has. Figure 20 is a more detailed worksheet of this same case. There are different kinds of worksheet that Tableau can make, showing distinct information out of the same data. In general, there are some advantages and disadvantages about getting knowledge of their employees. This is the topic of the discussion in what follows:

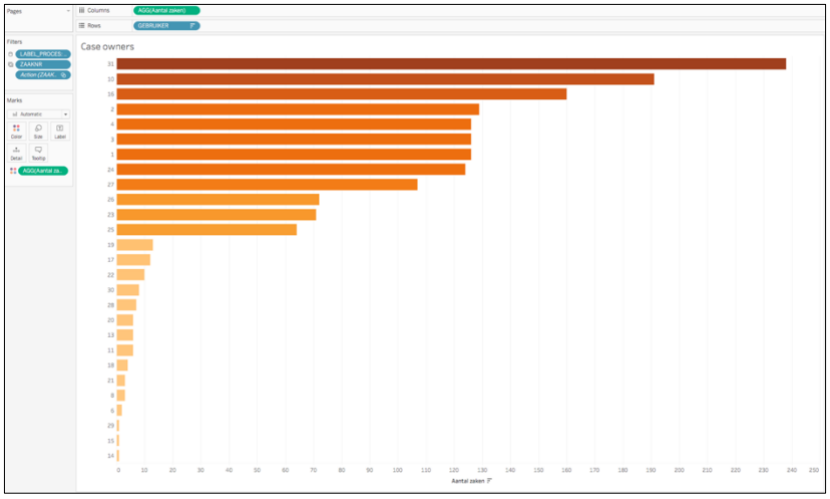


Figure 20 Process Mining dashboard - Case owner

The worksheet in figure 20 shows the number of cases a case owner works on. It shows clearly that **case owner 31** has worked on most of the cases. This is not necessarily true, because it could also be that this case owner sends his cases to other case owners. In that case, **case owner 31** does not work on all the cases that are shown in the graphic. Looking closely at one case owner, the average duration can be shown. These durations can be compared to the average duration of every case. When the case owner is below the average, it means that he

is slower than most of his colleagues. This is interesting information for the manager, because the Process Mining model shows clearly which employees are fast and which ones are slow in their work. As a manager, this information can be used in negotiations, since this data is fact based, so there is not much the employee can say against. When employees are on average slower than the rest of the employees, it is possible that they need to have an extra training or more explanations about the activities they are doing. The manager can negotiate with the employee based on the data, However, there are some disadvantages about this:

- There can be outliers. This means that it can be that one or two cases took extremely long, because of certain complications. These outliers could possibly take the average higher. Of course, it is also possible the other way around, that some cases took extremely short periods and are not really representative of the average. It is critical to take these outliers out when calculating the average, because it is not really representing the average of the employee.
- There can be some downsides when managers really focus on the data that is possible to get from Process Mining and when the managers impose consequences on it. This data really focused on the duration of the activities and cases. It is possible that the relationship between manager and employee deteriorates. It can be difficult for employees to always be monitored and be addressed when cases do not go smoothly. It is also possible for employees to manipulate their data, if improved data is in their advantage. For example, they can ensure that the registration of the duration is shorter than it actually is.

  Another disadvantage of the focus on duration is that employees can be set against each other. Cases are sent to each other if employees do not actually know what to do with the case. When the case is too difficult, employees can refuse because their average could rise due to a difficult case. It can also cause that employees to take only the easy and short cases and leave the rest of the cases to other employees, which can keep their average low.

4.3. Conclusion

The real estate taxes objection process is not the targeted process that was chosen. Unfortunately, there was no TOPdesk data available. Because of this the user case of TOPdesk failed. Another municipality would give data, this was the real estate taxes objection process. Objection processes are in every municipality; therefore, this user case can also be interesting for Infotopics. Below is the conclusion of every sub research question and their success criteria described.

How can the business process be implemented in Process Mining?

- ***Have an implementation plan where it is stated clearly how the business process can be implemented in Process Mining and where every step of the implementation is described.***

Together with an expert of Infotopics the real estate taxes objection process is implemented in Process Mining. It is clearly shown how the business process was implemented and which information is necessary to implement it in Process Mining. With this information, it is possible to implement a business process, considering that it has correct data. The steps are described in detail in the chapter, but here they are in a compact form:

1) Put the data in in the system of Tableau
2) Make the two worksheets, one for the information about the nodes and one for the information about the links
3) Put the data in the Process Mining extension
4) Make additional worksheets

The implementation also depends on what kind of insights the municipalities want to gain. Different kind of variables can be displayed in the dashboard. It is possible to display so much information in the Process Mining dashboard, therefore it is important to have an idea what kind of information is important for improving the business process or which variables are important to measure. With an idea about possible opportunities, it is much easier to search in the Process Mining extension.

How can the analysis resulting from the business Process Mining lead the clients to reflect and improve the business process?

- ***Have a list of opportunities where it is clear how clients can reflect and improve their business process.***

In the ideal situation, a TOPdesk process was implemented in Process Mining. This was not possible, because there was no data available. During some meetings with other companies that use TOPdesk, it became clear that it is possible to use the data from TOPdesk for Process Mining. In this research, it was not possible to show that this data can be used. This research shows that opportunities of Process Mining for municipalities. This is shown on the basis of the real estate taxes objection process of one of the municipalities. This municipality was willing to share their data for this research.

The data is implemented in Process Mining and after analysing the Process Mining model together with the municipality, some opportunities for insight were noticed. These insights are gained from the Process Mining model. This information gained from the Process Mining

model can help municipalities improve their business processes. The important insight the municipality gained from their Process Mining model were:

- The duration of each individual case. The process Mining model gives them insight in the cases that are not finished in time. This gives possibilities to zoom in on the particular cases and search for causes. If the causes are found it is possible to look for solutions and this can cause that cases are more often finished in time. This will improve their business process
- The duration of each individual activity. The Process Mining model can show the average duration of the activities. This information can be used to search for the bottleneck in the business process, so which activity takes the longest. This information can be used to search if it possible to reduce the duration of the activity. This could decrease the overall duration and will improve the business process.
- The path of a case. This gives information about which activities the case is running through. The Process Mining model shows the path of each case, so when a case is not running the preferred path it is easy to zoom and find the reasons why the case it not running the preferred path. With this information solutions can be found, and more cases deviate from the preferred path, this will improve the business process.
- Information about the case owners. In the Process Mining model different sort of data about the case owners can be put in. This gives information about the competence of the employer. If the average duration of the case owner it low, it is possible to talk to the case owner and find the reasons why it is below average. This information and training can ensure that average of the employer increases. This will improve the business process.

If there is more data available, then it is also possible to analyse the process even further, using Process Mining.

However, we also highlight that Process mining has some disadvantages/limitations. The first is finding the correct data. When data is used it is still possible that the data is not correct. This can cause that the Process Mining model does not represents the real and correct data. Due to this it is possible that the wrong conclusions are being drawn. It is therefore important that when the Process Mining model is made to check it with somebody that is working on the business process. This person has an idea of how the business process is really working and can see if variables and elements are not correct.

The second disadvantage is the information gained from employers. It is a moral question if it all right to monitor your employers all the time. The next question is what the manager is going to do with the information, it is possible that there can be consequences for the employers. In the worst-case employers might try to manipulate their data if this is in their advantage. This can create an unpleasant atmosphere at work. It is therefore important to really discuss what should be done with the data and find the best way to use it, without stressing employers with the results of the Process Mining model.

CHAPTER 5 – BUSINESS PROCESS MODELLING

In this chapter, a BPMN model is made of a business process in one of the municipalities that was not using Process Mining. The targeted process during this research is a process in TOPdesk, but that was not possible, so we had to revise it completely, making a new BPM. During the interviews, it was decided together with the stakeholders that processes in the social domain have the most benefits when improved. These processes focus on the customer, namely the residents of the municipality. The municipalities were asked if it was possible to model one of their business processes. Preferably it was a business process of 25-30 steps and if possible, a business process that is in the social domain.
The sub research question that is answered in this chapter are:

1) *Which opportunities does Process Mining give to improve the targeted business process?*
    a. *How can the targeted business process be represented in a business process model?* The business process modelled in this chapter is a process about the request for the right care for youth. The BPMN model is modelled in Bizagi.
    b. *In which ways do the mined business process deviated from the modelled business process?* In the results the difference can be found between the mined and modelled model.
    c. *How can Process Mining lead the clients to reflect and improve the business process?* This chapter focuses on looking at the added value of Process Mining for municipalities that are not using Process Mining. After the business process is modelled and analysed, the possibilities of Process Mining and the added value are described.

5.1. Method

This business processes starts when there is *a request for care for youth.* This request comes from the child or the parents. These facilities can mean a personal budget for care, but it is also possible to get care that has already been established. To model the business process, interviews were planned with the programmer of this business process. During these interviews, the interviewee explained the business process step by step. Every step in this business process is described below.

The child or parent is the customer in this process. They can request a claim for facilities through mail or telephone. The municipality is working on an online application to request the claims. This request is received by the one of the youth customer managers. The **youth customer manager** that is assigned to this specific case, *sets up claim* from the **customer**. If it takes longer than 8 weeks to make the decision about the claim, a *notice of the delay* is sent to the **customer**. Eventually when the *decision about the claim is made,* there are two options:

1) Approved

This process will start if the claim is approved. The first step that the **youth customer manager** has to do is to *schedule a date for an evaluation*. This planning of the evaluation date starts another process about the evaluation of the customer care. Besides planning the evaluation, a *reminder is added for the evaluation data*. In the next step, there is

information *recorded about the customer experience*. Once this is all done, *the settlement is set up* by the **youth customer manager**. There are two possible kind of cares that the customer can get:

a) PGB (Personal budget)

This kind of care means that the customer decides from whom they are purchasing the care or facility. The customer is in charge of their own care. When deciding for this settlement *a provision document is created* by a **specialist in youth care**.

b) ZIN (Care in kind)

When deciding for this settlement, the municipality will determine which care organization provides the care or facility. When deciding for this settlement it is possible that there is already a provision document. When there is no provision document, a *provision document is created* by the **youth customer manager**.

If the settlement is done and the provision documents are created, the process moves further with the financial administration employee. This **financial administration employee** *makes the perspective plan* and after that, *sends the perspective plan to the customer together with the settlement*. After the documents are sent to **the customer**, *the settlement is controlled* by the **financial administration employee**. If this settlement is rejected, then *the youth customer manager discusses the adjustments with the financial administration employee*. After discussing the adjustments, the settlement is adjusted by the **financial administration employee**. After the settlement is approved or the rejected settlement is adjusted, the **financial administration employee** *makes the settlement official.* After this setup, the **financial administration employee** *controls the provision document* that is made in earlier steps. Moreover, the **financial employee** *makes the checklist for the youth care* and after that *closes the work process*. When, the work process is closed, *the documents are uploaded* in the *InProcess* database.

2) Rejected

This process starts when the claim of **the customer** is rejected. The first step that the **youth customer manager** takes is *setting up the rejection settlement*. When this is done, a colleague *controls the rejection settlement*. If the rejection settlement is not approved, the **youth customer manager** needs to *adjust the rejection settlement*. After the document is controlled and adjusted when needed, **the data processing employee** *creates the perspective plan*. If the perspective plan is done it *is sent to the customer together with the rejection settlement.* After this, it is all sent to the **data processing employee,** who *closes the work process*. As the work processes is closed, the *documents are uploaded* in the *InProcess* database.

Taking into consideration all this information, the business process model can be made. The elements are used in modelling the process are shown in figure 21. The results of this business process model are discussed in the next section. These results will describe possible opportunities for insights that Process Mining could give in this business process. In the previous chapter, there are some opportunities for using Process Mining described regarding a municipality that already used Process Mining. The results here will also describe possible improvement after gaining these insights.

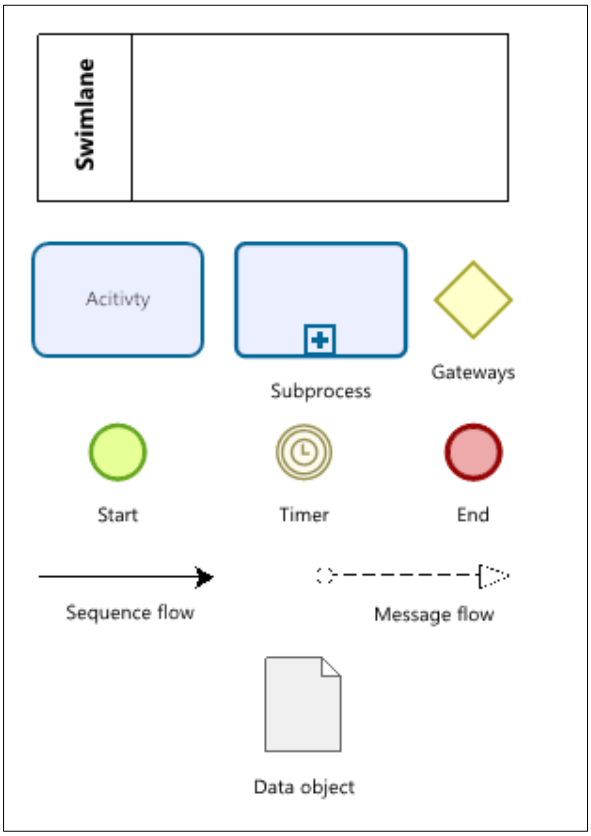


Figure 21 BPMN elements

5.2. Results

In figure 22, the business process model of the *request for the right care for youth* business process is displayed. As mentioned, this model is made using the Bizagi modeler. Previous drafts of this model were discussed with the municipality and after some changes, figure 22 shows the resulting business model.

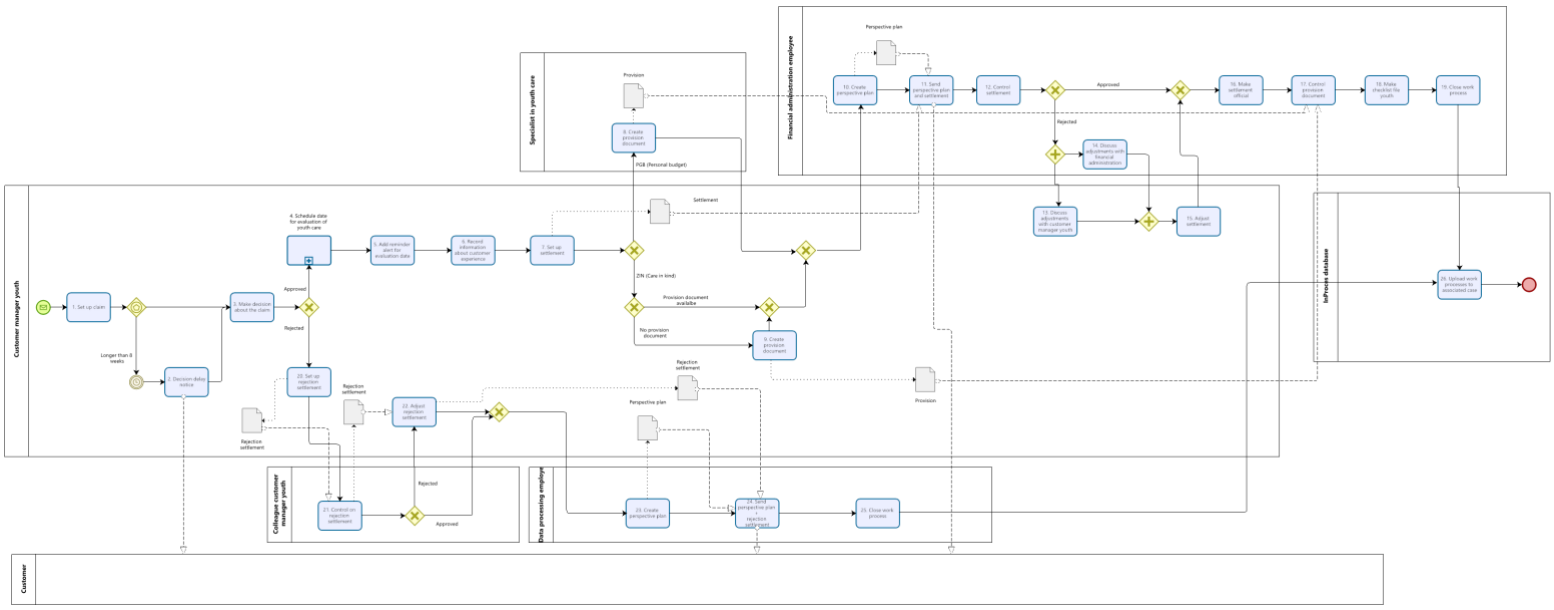


Figure 22 BPMN of objection process

The BPMN model shows step by step how the business process works. This makes it easy for employees to see which activities they have to do after finishing an activity. It is a great way to get an idea of how an organizational process runs, or at least should run. With this information, there are also possibilities to adjust the process, for example to delete an activity that is not really necessary; or to add new activities that are currently missing. Many different employees are involved in this business process. Thus, this is also an opportunity to reduce the number of employee roles involved in the process, in case that is beneficial for the organization. In that case, this means that some roles must take over the activities of the removed roles in the process.

There are some notable steps in this BPMN model of the *request for the right care for youth* business process, which will be discussed below:

- In step 12, there is a control on the settlement (the settlement itself is made in step 7). This settlement contains information about the claim. In the previous step, step 11, the settlement is sent to the customer. It is striking that the settlement is first sent and that the afterward the check is done. It would be expected that the settlement is checked first and sent to the customer afterwards. After consultation with the municipality, they indicate that the settlement is checked only for internal reasons. So, it does not affect the settlement for the customer. Since we understand their reasons, these steps were kept as they are.

- In step 17, there is a control on the provision document. It is remarkable that after this activity there is no choice between approved of rejected. Normally, it is possible to decline after a check, after which the document can be modified. In this case, no adjustment will take place after the control. The municipality has indicated that the document is always correct, so no adjustment is required. The document is used for internal reasons. So again, no change was necessary at this point.

After analysing the BPMN model and discussing the model with the municipality, there are some features of Process Mining that can add value to this business process. Since, this business process is only shown in a BPMN model, there is no actual data about this business process. There are no duration times, no number of cases and no case owners. Here it follows a discussion (in topics) of how the use of Process Mining could benefit (add value) to this municipality:

- In step 2, a delay notice is sent to the customer if the decision takes longer than 8 weeks. This is of course an activity that is not preferred, since the municipality wants to make the decision in 8 weeks. The cases running through this activity can be easily demonstrated in Process Mining. Below in figure 23, it can be seen what it might look like in Process Mining. For example, there are 1000 cases that go through this business process. With Process Mining it is easy to see how many are running through the activity of sending a delay notice. It is possible to zoom in on these particular cases and find more information about these cases, for example which case owner is going through this activity the most. Talking to this case owner can give the municipality an idea why this activity occurs, and possibly finding a solution for this**. This information gives them an opportunity to reduce the number of sending decision delays.**

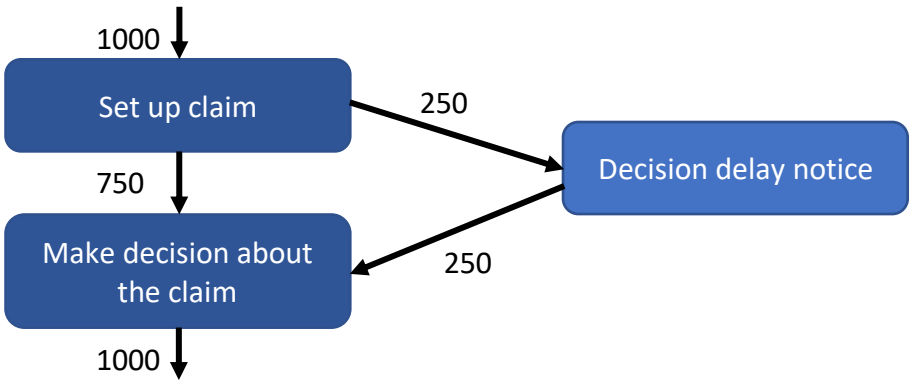


Figure 23 example of the path cases can run

- With Process Mining it is possible to view the duration of the activities and the cases. The duration the cases provides information about how long it takes for each case to go through the entire process. This business process could show how long a customer is in the youth care process. Some business processes have a legal term in which the customer must get an answer, go through certain activities or go through the entire process. Process Mining can show how long the cases run; with this information it can be seen whether the case is compliant with legal standards. If a case is not completed on time, it is easy to zoom in this case and look for the answer why this case is not on time.

The duration of the activities provides information about how long each activity lasts. This information can be used to search for bottlenecks is the business process. When looking for the answer as to why the case is overdue according to legal standards, it is possible to zoom in on the activities. This allows to search for the activity that is taking the longest and to zoom in on the activity. Perhaps this activity depends on external factors, such as customer response. Then it is more difficult to change the duration. However, there is a possibility when the activity does not depend on external factors (we saw examples of both kinds in chapter 4). Then it is possible to look for reasons why the activity is taking so long. It may be unclear to case owners what actually needs to be done in this activity, in this case additional training may be necessary. **The added value is that it is possible to find bottlenecks in the business process, decrease the duration for cases and to stay within legal standards.**

- This business processes shows a control activity in both its the sub-processes. In a lot of municipalities, the four-eye principle is important, sometimes it also required by law. This principle means that four eyes have to look at the document to check it if it is correct. With Process Mining it is possible to see if all the cases are checked in the control activity. In the Process Mining model, it shows that a case does not go through the activity. It is then possible to zoom in on the case and look for possible causes together with the case owner. **The added value of Process Mining is that it easy if the correct activities are done**. Sometimes it is required to take particular activities in a business process. Below in figure 24, is an example of how Process Mining model looks like when the activity is missed.

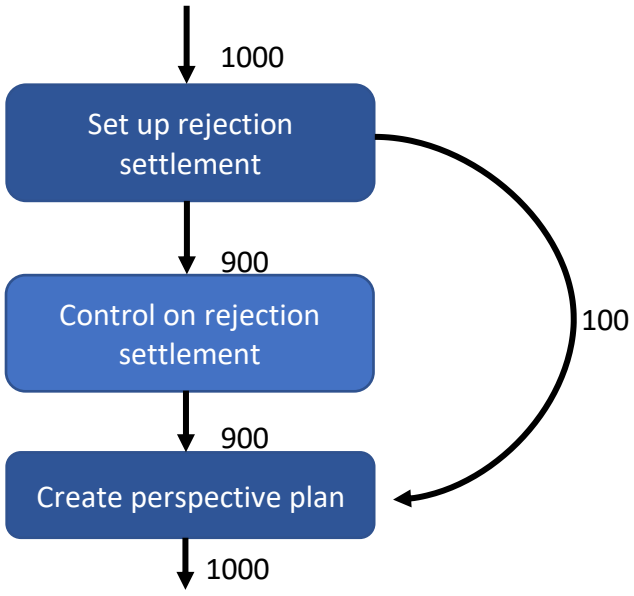


Figure 24 example of check if the correct path is followed

- Extra data can be added to Process Mining, such as the case owners. These are the employees working on the particular case. With Process Mining it is possible to zoom in on this extra data. If the data about case owners are added to Process Mining, it is possible to zoom in on the case owners. With this information, the work activities of the employees can be monitored. This can give a lot of information about the

employees' work, for example how long they work, which activities they are taking and how many cases they do. The Process Mining model can zoom in on the case owners and show their information. This information can help with looking for solutions to decrease to duration and take the right steps. It is possible that additional training is necessary or that the work instruction manual says otherwise. It is important to speak to the employee with the information received from Process Mining and look for solutions. **The added value is to gain a better insight into how employees are doing at work.** As mentioned in chapter 4 (please refer to this chapter), this benefit also has some collateral effects that are not so good, so all this should be taken into account when deciding how to use Process Mining.

- The two types of models, BPMN and Process Mining, are totally different. The BPMN model is really detailed, every step is displayed. The BPMN model clearly shows who the employees are that work in the process, and which employees does which activity. It is possible to show which decisions are made in the business process and what kind of document are sent between different activities. The whole process is easily shown and can be used like a guideline through the process. In this BPM model, there is no information about some variable, such as duration and number of cases. The Process Mining model is more schematic. The activities are displayed and the information that is implemented in the model is shown. The Process Mining gives a good view of the variables and their values. The Process Mining does not really show the guidelines through the process. Also, it does not show all the activities that are running through the process, only the activities that can be measured in time. The decisions that have to been taken through the process and the documents that need to be sent are not displayed at all in the Process Mining model. **The benefit here is to profit from information given by two different kinds of models to make better decisions within the organization.**
  Below in table are the differences between the two models summarized.

Table 3 difference between BPMN and Process Mining

Characteristics	BPMN	Process Mining
Detailed description of the sequence of activities	X	
Information about which role does each activity	X	
Process duration is shown		X
Number of cases running through each activity		X
Decisions are shown	X	
Shows which documents are sent and to who	X	
Shows variables and their values		X
Guideline through the business process	X	
Shows only the activities that can be measured		X

5.3. Conclusion

In the conclusion the sub questions are answered, and the success criteria are described.

How can the targeted business problem be represented in a business process model?

- ***Have a business process model where every step of the business process is displayed.***

This business process is in the social domain. The social domain is big part of the municipality and also an important part because there is a lot of contact with customers. Therefore, business processes in the social domain are interesting to improve, because this improved business process will have a positive side for the customers. The process is modelled in Bizagi and is modelled with the language BPMN. In chapter 5, a detailed map is shown where every step is displayed.

In which ways do the mined business process deviates from the modeled business process?

- ***Have an analysis of the minded business process where the difference w.r.t the modeled business process is clear.***

The BPMN model and the Process Mining model have different advantages and disadvantages. Creating a Process Mining model is only possible then the municipality has an idea of their business process. To create the correct and structured data for Process Mining, it is important to know how the activities are running through the business process. Due to this it is important to have an BPMN model or another model that gives a clear picture of the business process. With this information to get the correct data, with this data it possible to check if the business process is running as described in the BPMN model. As a conclusion, the two models need each other. With the BPMN model it is easier to know where to search for data and what kind of data. With Process Mining it is possible to check whether the business process described in the BPMN model is correct.

How can Process Mining lead the clients to reflect and improve the business process?

- ***Have recommendations where it is clear how clients can reflect and improve their business process***

After analysing a business process model within a municipality, this chapter shows that there are a lot of opportunities for Process Mining in these kinds of business processes. This is one example of a business process, but Process Mining can be used on almost every process. Of course, there should be correct and structured data. If this is available, Process Mining can give so much insight in the variables of a business process. In chapter 4, a business process was implemented in Process Mining. In chapter 4, different opportunities were found for insights that could give improvements in the business process. These insights are compared to the business process in the BPMN model and analyzed which of these insights can improve the business process. Below are the opportunities for insights that can be interesting for the business process:

1) Duration of activities
2) Duration of cases
3) Number of cases running through an activity
4) The path a case has.
5) Competence of a case owner.

Gaining the insight does not solve any problem. When the municipality gains the insights, it is important to look for causes, for example by entering into a conversation with the case owners. Different variables in the business process can have different causes. Once the causes have been identified, the municipalities can respond to them. After that, it is possible to compare the variables of the business processes. This provides information whether the variables have changed. It is not the case that if the municipality gets the insight, then the problem is magically solved. The Process Mining extension only gives insight in opportunities for improvement. The municipality needs to be smart about these insights and work them out in good decisions.

The municipality of this business process is only just starting to capture its business processes in models. Hence, it is still not clear to the municipality exactly how some business processes work. Some parts of the request for the right care for youth process has been changed after an analysis of the model with the municipality. It means their model was not really correct. As a result, Process Mining seems too much of a challenge for the time being. If the business process models are not stable, it is difficult to get the correct data for Process Mining. Because if the activities in the processes do not work as expected, it is difficult to register the correct data.

CHAPTER 6 – CONCLUSION AND RECOMMENDATIONS

This chapter concludes this work by providing the answer to the main research question. The limitations of the research are described in the next section. After that, the recommendations are given to Infotopics, together with possible future work. In addition, the contribution of this research on various aspects is explained.

6.1. Conclusion

When developing this research, it became clear that Process Mining had a bigger potential than we anticipated, since it is generally applicable to almost all business processes of the interviewed municipalities. As described in chapters 4 and 5, Process Mining can provide many insights on how the business process can be improved, what er the reasons for delays, among other issues.

The main research question was:

How can Infotopics use the extension Process Mining for the domain municipalities' clients in order to improve their business process?

After analyzing the Process Mining model as well as the elicited BPMN model, it became clear that Infotopics can support municipalities as well as other types of clients in using Process Mining to improve their processes in different ways.

First, we present two problems that are particular of municipalities, and explain how Process can help solve these problems:

- **Municipalities do not answer to the customer within a legal term.** If the municipality does not respond within the legal period, in the worst-case, the municipality has to pay a fine to the customer. It is therefore important to answer within this legal term. In general, either the whole case should be handled within a legal term, or a part of the case must be handled within a legal period. Process Mining shows perfectly which cases or part of the cases are longer than what is specified by legal standards. In other words, **Process Mining provides insights into which cases take longer than the legal term**, after which it is up to the municipality to look for reasons why these cases take too long.
- **Business processes in municipalities do not comply with the four eyes principle**. Four eyes principle is a widely known term inside the municipalities, meaning that the activity must be controlled by two people. **Process Mining can show if the case has taken this path, therefore it shows if the four eyes principle is guaranteed.** In case it is not, the municipality needs to take action to make sure that each activity in the business process is executed by two people.

Next, we describe three other problems that can happen within municipalities but are also general and can be found in other types of Infotopics clients. For each problem, we indicate how Process Mining can help.

- **The case does not run through the preferred path of the business process.** Process Mining can find outliers of the preferred path. Some activities are less preferred, such as sending a delay notice to the customer when an activity has taken too long. **Process Mining shows which cases go through these activities**. Some activities need to be done after another activity. Such in the case that a municipality has certified and not

certified employees, the certified employees always need to be checked. **Process Mining easily shows if this preferred path is taken or not.**

- **The business process is taking too long.** The municipality wants to find the bottlenecks to improve the business process. This is applicable for almost every business process. **Process Mining shows how long each activity takes on average and which takes the longest**. To improve the business process, the municipality has to look into the activities and search for possible improvements.
- **Employees are taking too much time to complete a case or activity.** Process Mining shows the data that can be related to the efficiency or competence of each employer. The time taken by each employer can be compared to the average time per activity. **Process Mining shows which employers deviates the most from the average.**

These insights can give municipalities the opportunity to improve their business processes. Needless to say, Process Mining only gives information about how the business processes are being executed. It is up the municipalities to search for solutions to improve the business processes.

6.2. Discussion

In this section, different limitations of this research are discussed.

- In this research only seven municipalities were interviewed about Process Mining. The limitation is that if more interviews were conducted, it could be that there is a business process that more municipalities find interesting. If you talk to more municipalities, it may be that several municipalities have the same problems in specific business processes. With this information, you may be able to choose one business process to focus on during this research based on the interviews. **Therefore, the limitation is that when more interviews were conducted another business process may be chosen.**

- Different kind of municipalities were interviewed. Some municipalities were very big, and some are much smaller. This depends on the size of the municipality. Some municipalities have different tasks, for example one municipality does the taxes of a region. Because they only do the taxes of the residents, the municipality does not have other departments that other municipalities have. Different kinds of municipalities are also interviewed during this research. This made it more difficult to find one business process to focus on. **Therefore, the limitation is that when the same kind of municipalities were interviewed results could have been different.**

- The dataset provided by the municipality for the implementation in Process Mining implementation was incomplete and contained some errors in the data. If this dataset would be complete with all the data, it is possible that we could extract more information out of the Process Mining model. With more data and information, it could be that more opportunities specific for municipalities come to light. **The limitation is that if the dataset had been complete and error free, more or different conclusions could have been taken.**

6.3. Recommendations

Hereby we provide three main recommendations for Infotopics:

Offering a service to extract the right data for Process Mining. During the research, the main issue for enabling the use of Process Mining is having right and structured data. Many municipalities are not in the phase of getting the right data. Sometimes it is just too early to start with Process Mining, because they are just starting to get more digitized. Because some municipalities are not really digitized, it is difficult to use Process Mining for them. Process Mining is only available for clients that already have the right data. It is interesting for Infotopics to offer to install the system to extract the right data. With this option the step to use Process Mining gets smaller.

Searching for more insight that Process Mining can give to improve the business process of different types of clients. It is interesting for Infotopics to look for more specific insights that can improve the business process of municipalities and other kinds of clients. This can be done by analyzing more business process of the clients for which Process Mining is already implemented.

Developing plug-ins for standard Service Management tools, such as TOPdesk. A lot of municipalities apply TOPdesk to manage their services. To make the use of Process Mining easier, it would be interesting to make a TOPdesk plug-in to facilitate the data to be extracted from the managed services to a Process Mining solution. Maybe it is even a good idea to tak to the managers of TOPdesk to look into partnership possibilities. This standard plug-in for TOPdesk will make Process Mining more interesting because it is easy to use, and besides being a widely known application.

6.4. Contribution

This research contributes to different aspects:

1) This research contributes to Infotopics, giving them a better understanding of how Process Mining can be used. This research focused on the domain of the municipalities, since Infotopics has a better understanding of the user cases of Process Mining user cases in this domain.
2) Now that municipalities focus more on digitalization, Process Mining can be a handy tool for improving their business processes. This research contributes to the knowledge that municipalities have about opportunities to use Process Mining; it also gives a list of insights that Process Mining can give to improve the business process of municipalities and clients in general.
3) The research also contributes to science, because it consists of real case studies regarding the application of Process Mining.

6.5. Future work

As described in the section of recommendations there are some opportunities for future work for Infotopics. These future works are as big as a bachelor assignment, and are listed down below:

1) Create a standard Process Mining plug-in for TOPdesk. This standard plug-in extracts the right data from TOPdesk and implements it in Process Mining. This will make the use of Process Mining easier when clients already use TOPdesk to manage their services.
2) Search for more opportunities in the domain municipalities. This research focused on two business process in the municipality's domain. Municipalities have a lot more business processes with different improvement opportunities. The same research can be conducted taking other business processes into account.
3) Search for specific opportunities outside the municipality's domain. This research can also be carried out in clients of other domains such as education and healthcare. Process Mining is such a promising extension, that is why it is worth to search for more user cases outside the municipality's domain.

REFERENCES

Aalst, v. d. W. M. P. (2012). Process mining : overview and opportunities. *ACM Transactions on Management Information Systems, 3*(2), 1-17.

Aalst, W. v. d. (2016). *Process mining : data science in action* [1 online resource (xix, 467 pages)](Second edition. ed.). doi:10.1007/978-3-662-49851-4

Andersson, B., Guarino, N., Johannesson, P., & Livieri, B. (2016) Towards an ontology of value ascription. In*: Vol. 283. Frontiers in Artificial Intelligence and Applications* (pp. 331-344).

Apps for Tableau. (2020). Process Mining. Retrieved from https://appsfortableau.com/shop/extensions/process-mining/

Cardoso, J. (2007). Complexity analysis of BPEL Web processes. *Software Process: Improvement and Practice, 12*(1), 35-49. doi:10.1002/spip.302

Fischer, M., Hofmann, A., Imgrund, F., Janiesch, C., & Winkelmann, A. (2021). On the composition of the long tail of business processes: Implications from a process mining study. *Information Systems, 97*. doi:10.1016/j.is.2020.101689

Gerth, C. (2013). *Business process models : change management* [1 online resource (xvi, 218 pages) : illustrations]. doi:10.1007/978-3-642-38604-6

Ground, C. Common ground: wat, hoe en waarom? Retrieved from https://commonground.nl/cms/view/77953921-4161-462c-af24-6ac3cd7d61a7/common-ground-wat-hoe-en-waarom

Gustafsson, A., Grönroos, C., & Helle, P. (2010). Adopting a service logic in manufacturing Conceptual foundation and metrics for mutual value creation. *Journal of Service Management, 21*(5), 564-590. doi:10.1108/09564231011079057

Heerkens, H., Heerkens, J. M. G., & van Winden, A. (2017). *Systematisch managementproblemen oplossen*: Noordhoff Uitgevers.

Holbrook, M. B. (1996). Customer Value - A Framework for Analysis and Research. *Advances in consumer research., 23*, 138.

Ibl, M., & Boruchova, Z. (2017). *Complexity analysis of business processes.* Paper presented at the Proceedings of the International Conference on Information and Digital Technologies, IDT 2017.

Ibl, M., & Boruchová, Ž. (2017). *Measuring the complexity of user processes using shannon entropy and stochastic petri nets.* Paper presented at the CHIRA 2017 - Proceedings of the International Conference on Computer-Human Interaction Research and Applications.

Infotopics. (2020). Infotopics DNA - Haal waarde uit data. Retrieved from https://infotopics.nl/over-ons/

Leroi-Werelds, S., Streukens, S., Brady, M. K., & Swinnen, G. (2014). Assessing the value of commonly used methods for measuring customer value: a multi-setting empirical study. *Journal of the Academy of Marketing Science : Official Publication of the Academy of Marketing Science, 42*(4), 430-451. doi:10.1007/s11747-013-0363-4

Lloyd, S. (2001). Measures of Complexity: A Nonexhaustive List. *IEEE Control Systems, 21*(4), 7-8. doi:10.1109/MCS.2001.939938

Mendling, J. (2008). *Metrics for process models : empirical foundations of verification, error prediction, and guidelines for correctness* [1 online resource]. doi:10.1007/978-3-540-89224-3

Product plan. (2020). Value vs. Complexity. Retrieved from https://www.productplan.com/glossary/value-vs-complexity/

Recker, J. (2010). Opportunities and constraints: The current struggle with BPMN. *Business Process Management Journal, 16*(1), 181-201. doi:10.1108/14637151011018001

Reinkemeyer, L. (2020). *Process mining in action : principles, use cases and outlook* [1 online resource (216 pages)]. Retrieved from https://public.ebookcentral.proquest.com/choice/publicfullrecord.aspx?p=6134217
https://doi.org/10.1007/978-3-030-40172-6
https://ezproxy.lau.edu.lb:2443/login?url=https://doi.org/10.1007/978-3-030-40172-6
https://ezproxy.library.dal.ca/login?url=https://doi.org/10.1007/978-3-030-40172-6
http://www.vlebooks.com/vleweb/product/openreader?id=none&isbn=9783030401726

Rowley, J. (2012). Conducting research interviews. *Management Research Review, 35*(3-4), 260-271. doi:10.1108/01409171211210154

Sales, T. P., Baião, F., Guizzardi, G., Almeida, J. P. A., Guarino, N., & Mylopoulos, J. (2018) The common ontology of value and risk. In*: Vol. 11157 LNCS. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (pp. 121-135).

Sharma, A., Krishnan, R., & Grewal, D. (2001). Value Creation in Markets: A Critical Area of Focus for Business-to-Business Markets. *Industrial Marketing Management, 30*(4), 391-402. doi:10.1016/S0019-8501(01)00153-5

Tableau. (2020). What is tableau? Retrieved from https://www.tableau.com/why-tableau/what-is-tableau

Weske, M. (2012). *Business process management : concepts, languages, architectures* [1 online resource (xv, 403 pages) : illustrations](2nd ed. ed.). doi:10.1007/978-3-642-28616-2

Woodruff, R. B. (1997). Customer value: The next source for competitive advantage. *Journal of the Academy of Marketing Science : Official Publication of the Academy of Marketing Science, 25*(2), 139-153. doi:10.1007/BF02894350