Process Analysis of Reimbursement Process through Process Mining techniques.

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Abstract. This year Business Process Intelligence (BPI) challenge gives the opportunity to analyse the event log of data collected from the reimbursement process at TU/e. In particular, Technische Universiteit Eindhoven is interested in gaining information on their Reimbursement process answering particular process analysis and compliance research questions from performance and control flow perspectives. This paper tries to answer these questions through process mining techniques, in order to detect interesting insights that traditional techniques would have rarely discovered. The starting point of the question driven project described in this paper, is the discovery of the processes recorded in the event log and then attention is focused on the travel declarations reimbursement process, where as a function of several variables different performance indicators and process maps have been measured and discovered through a Process Variant analysis. Finally a critical analysis is performed and enhancement ideas are suggested.

Keywords: Process Mining · Reimbursement · BPI challenge · Question-driven Project · Process Variant analysis.

1 Introduction

The 10^{th} International Business Process Intelligence (BPI) Challenge, takes place for the second time in a row in correspondence with the International Conference on Process Mining (ICPM) [2] and, challenges participants on the analysis of a real-life event log in order to answer process owner's questions and to provide interesting and useful insights about the process recorded by the event log. The main aim of this challenge is to provide and to show to both academia and industry the real value and the scalability of process mining discipline and to put in practice its latest developments. For this year challenge, data were collected from the reimbursement process at TU/e. Starting from the different questions provided by the challenge description, this work tries to extract hidden knowledge from the collected data and to provide interesting results about the reimbursement process at TU/e that probably traditional process intelligence approaches would have never been able to discover. The questions and the solutions that this paper tries to solve and to suggest fall all under the three main process mining categories: discovery, conformance checking and process enhancement.

Different works from literature have been taken into account in order to follow a consolidated methodology that guided the following analysis [1, 6, 3] . This work can be divided into different sections, it starts with a description of the Data and of the process that should be analysed, after that, the work goes on with the description of the mining and analysis stage where process mining techniques are put in practice and finally this paper concludes with presentation of the results obtained and which are the possible improvement ideas that can be adopted to improve the process.

2 Data and Process Understanding

In this part, the main results of exploration and inspection of the data and the underlying process are briefly described.

2.1 The Data

The data are recorded for the reimbursement process at TU/e. They are spread over different files that contain data about reimbursement requests submitted from 01/01/2017 to 31/12/2018 and refer to travel permits and several request types, namely domestic declarations, international declarations, prepaid travel costs and requests for payment, where the latter refers to expenses which should not be related to trips. From the following files, it was possible to extract information about three different process typologies: declarations process, travel permit process and request for payment process all of them sub-processes of the reimbursement process.

Since there are different process typologies, the case notion is not unique and depends on the analysed sub-process. For the declaration process, the case notion is the declaration ID, while for the travel permit and request for payment processes, the case notions are respectively the travel permit ID and the Request for Payment ID.

The data sets downloaded for the challenge are briefly described by the Table 1:

Table 1: Eventlog of the example in Figure .

Data Set	cases	events	Description	Case notion
Requests for Payment	6,886	36,796	Events referring to reimbursement of expenses not related to Trips	Request for Payment ID
Prepaid Travel Cost	2,099	18,246	Events referring to reimbursement of (pre-paid travel costs) expenses that should be afforded before the trip starts	Request for Payment ID
Travel Permits	7,065	86,581	Events referring to the travel permits process, no payment is involved	Travel Permits ID
International Declarations	6,449	72,151	Events referring to the reimbursement process of International trips	Declaration ID
Domestic Declarations	10,500	56,437	Events referring to the reimbursement process of Domestic trips	Declaration ID

It was important to notice that a single travel permit can refers to multiple declarations and/or request for payments, so same of the events recorded in International Declarations, Requests for Payment and Prepaid Travel Cost Data

Sets are also presents in the Travel Permits log.

From the Data it was possible to have record of 57 different Event classes that for the sake of simplicity, at first instance, in order to have a macroscopic view of the process, were aggregated under 23 event classes.The aggregation criteria can be understood referring to Table 2.

The data contains several attributes, which most of them are on trace level rather then event level. The main attributes on trace level are:

- **Organizational Entity**: The Organization Entity in charge of the reimbursement process.
- **Amount**: The amount of the reimbursement request.
- **Permit Project Number**: The number of the project associated with the reimbursement request.

2.2 The Process

From the process execution log, as mentioned previously, it is possible to extract knowledge about 3 different processes. From the description of the challenge, it was possible to understand briefly the reimbursement process flow. The Request for payment and Declaration sub-processes follow a similar process flow. The employee firs submit a request for reimbursement and then the request is sent for approval to the travel administration. It can be subjected to two different outcomes, the request can be approved first by the administrations and than if necessary by other process stakeholders or it can be rejected so the employee can resubmit or reject the request. If the approval flow has a positive result, the payment is requested and made.

On the other hand the travel permit process follow a slightly different flow, from the fact that no payment is involved. In this case if the travel permit approval flow has a positive result a trip can take place, indicated with an estimated start and end date. These dates are not exact travel dates, but rather estimated by the employee when the permit request is submitted. The actual travel dates are close to the given dates in most cases. When the trip is ended the travel permit process can be considered ended and the employee can submit a travel declaration to request the reimbursement.

3 Mining & Analysis

In this section Process mining techniques are applied to the event logs downloaded for the challenge and the main goal is to answer research questions defined by the process owner and to extract hidden knowledge recorded by the process execution event data. This work can be considered as a ***"Question-driven"*** [6] project since the research questions that process mining techniques try to solve are specific questions and are defined a priori. Before applying discovery

Table 2: Eventlog of the example in Figure .

Activity	Aggregated Activity
Declaration APPROVED by ADMINISTRATION Declaration APPROVED by BUDGET OWNER Declaration APPROVED by PRE_APPROVER Declaration APPROVED by SUPERVISOR	Declaration APPROVED
Declaration FINAL_APPROVED by DIRECTOR Declaration FINAL_APPROVED by SUPERVISOR	Declaration FINAL_APPROVED
Declaration FOR_APPROVAL by ADMINISTRATION Declaration FOR_APPROVAL by PRE_APPROVER Declaration FOR_APPROVAL by SUPERVISOR	Declaration FOR_APPROVAL
Declaration REJECTED by ADMINISTRATION Declaration REJECTED by BUDGET OWNER Declaration REJECTED by DIRECTOR Declaration REJECTED by EMPLOYEE Declaration REJECTED by MISSING Declaration REJECTED by PRE_APPROVER Declaration REJECTED by SUPERVISOR	Declaration REJECTED
Declaration SAVED by EMPLOYEE	Declaration SAVED
Declaration SUBMITTED by EMPLOYEE	Declaration SUBMITTED
End trip	End trip
Payment Handled	Payment Handled
Permit APPROVED by ADMINISTRATION Permit APPROVED by BUDGET OWNER Permit APPROVED by PRE_APPROVER Permit APPROVED by SUPERVISOR	Permit APPROVED
Permit FINAL_APPROVED by DIRECTOR Permit FINAL_APPROVED by SUPERVISOR Permit FOR_APPROVAL by ADMINISTRATION Permit FOR_APPROVAL by SUPERVISOR	Permit FINAL_APPROVED
Permit REJECTED by ADMINISTRATION Permit REJECTED by BUDGET OWNER Permit REJECTED by DIRECTOR Permit REJECTED by EMPLOYEE Permit REJECTED by MISSING Permit REJECTED by PRE_APPROVER Permit REJECTED by SUPERVISOR	Permit REJECTED
Permit SAVED by EMPLOYEE	Permit SAVED
Permit SUBMITTED by EMPLOYEE	Permit SUBMITTED
Request For Payment APPROVED by ADMINISTRATION Request For Payment APPROVED by BUDGET OWNER Request For Payment APPROVED by PRE_APPROVER Request For Payment APPROVED by SUPERVISOR	Request For Payment APPROVED
Request For Payment FINAL_APPROVED by BUDGET OWNER Request For Payment FINAL_APPROVED by DIRECTOR Request For Payment FINAL_APPROVED by SUPERVISOR Request For Payment FOR_APPROVAL by ADMINISTRATION Request For Payment FOR_APPROVAL by SUPERVISOR	Request For Payment FINAL_APPROVED
Request For Payment REJECTED by ADMINISTRATION Request For Payment REJECTED by BUDGET OWNER Request For Payment REJECTED by EMPLOYEE Request For Payment REJECTED by MISSING Request For Payment REJECTED by PRE_APPROVER Request For Payment REJECTED by SUPERVISOR	Request For Payment REJECTED
Request For Payment SAVED by EMPLOYEE	Request For Payment SAVED
Request For Payment SUBMITTED by EMPLOYEE	Request For Payment SUBMITTED
Request Payment	Request Payment
Send Reminder	Send Reminder
Start trip	Start trip

algorithms to the event logs, an exploratory visual analysis on the event log was conducted. For most of the activity performed in this stage, it was used the most popular open source software on process mining: ProM [7].

3.1 Visual Analysis

In Figure 1 and 2, it is possible to see the dotted chart respectively of the domestic and international travel declarations. Each event is depicted as a dot in a two dimensional plane. The vertical axis represents the case of the event, while the horizontal axis represents the timestamp of the event [4].

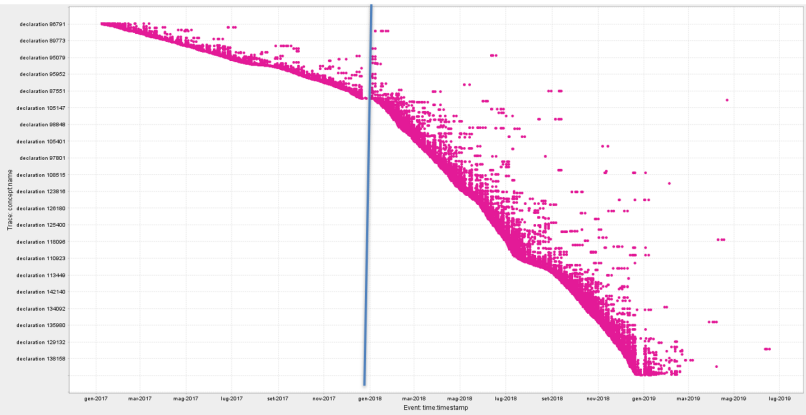


Fig. 1: Dotted chart of domestic travel declarations

As it is clear looking both the two Figures, the trend of the charts seems to be different between the 2017 and 2018 travel declarations, this is due to two main reasons. The first one is due to the availability of data: in 2017 data were collected about only two departments while in 2018 event data were recorded for the entire organizations. The second reason is due to a process drift between 2017 and 2018 cases: the process changed slightly on several occasions in 2017, since it was a pilot year respect to the process observed in 2018. This concept will be understood and explained later in the following paragraphs. Both the two reasons lead the chart to have the right side with an highest dot density respect to the upper-left side, that means more events per day were recorded in 2018 respect to 2017. From both the two charts, dividing the cases between 2017 and 2018 reimbursement requests, it is possible to notice that the frequency of travel declarations submitted per day resulted almost constant over time, since the slope of the two graph seems to be constant. There are some area in white that correspond to holidays or weekends periods where no operations were executed. However, some periods where the frequency has changed over time have been noticed. In particular looking at Figures 1 and 2, it is possible to

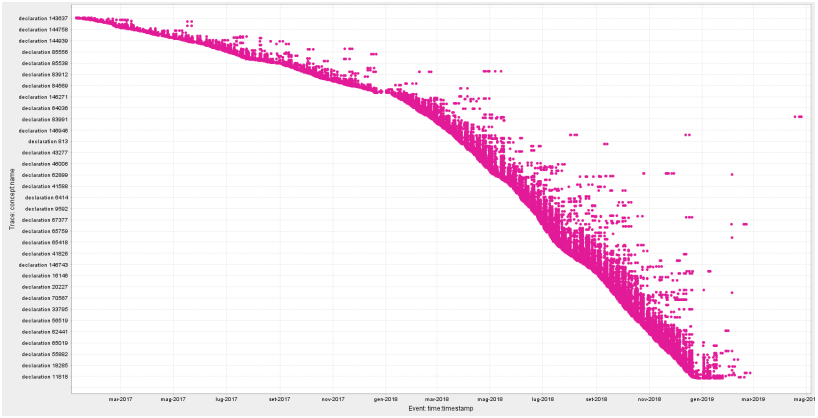


Fig. 2: Dotted chart of International travel declarations

notice a deceleration of the number of travel declaration submitted per day in correspondence with the summer months.

(a) *Domestic Travel declarations* (b) *International Travel declarations*

Fig. 3: Dotted Charts of Travel declarations from a case duration perspective

Looking at Figure 3, from a case duration perspective, it is possible to notice that, for most of the domestic travel declarations, the throughput time seems to remain in a certain range for all the analysed period, while for the international

travel declarations the average throughput time of 2018 cases seems to be slightly longer than the 2017 ones. Nevertheless, some outlier cases, from a duration perspective, seems to be present as can be seen from the dots that are far away from the zone with highest dot density.

3.2 Process Discovery

After a brief event log visual analysis, it was possible to start the process discovery phase, where the main output was to discover the as-is Reimbursement Process Model. As already said in the previous lines, the reimbursement process can be viewed as made by three different sub-processes, so in this paragraph three different process models have been discovered. For this phase, the models have been discovered using the aggregated events as explained in Table 2. At first instance the inductive miner (IMf) [5] has been applied to the different event logs to give a first shape of the different as-is processes and then Heuristic and Fuzzy miner [8] have been executed in order to improve the performance quality of the discovered process models in terms of fitness and precision. This last step was useful to detect some process patterns that were not discovered by the inductive miner.

Travel Declaration Process

This section describes the models which depict the process of reimbursement request related to travel declarations. In Figure 4 and 5, it is possible to see respectively the Petri net and direct follow graph of the travel declaration process discovered using process mining algorithms.

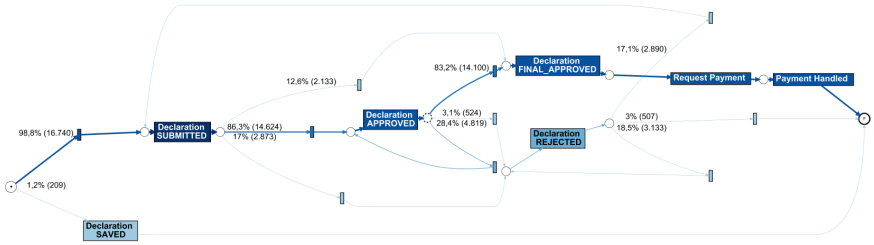


Fig. 4: Petri net of Travel declaration process

The most common flow is depicted in both the two figures by paths labeled in dark blue and starts when the declaration is submitted by an employee. Then the declaration is approved multiple times and if the approval outcome is positive the payment is first requested and then handled by the system. During the process, however, the declaration can be rejected in many instance. Usually, the event declaration rejected, when recorded, occurs after the declaration submission,

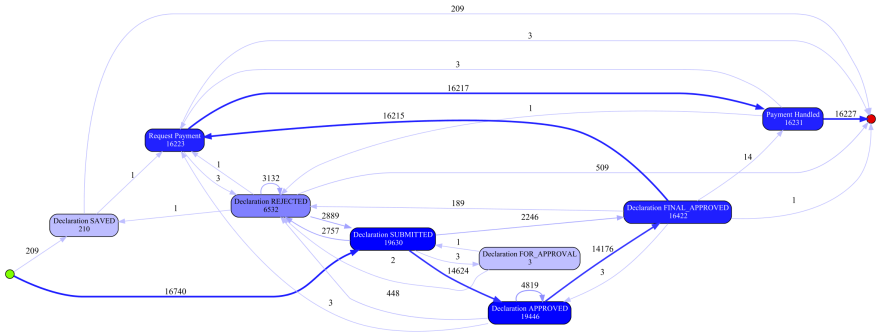


Fig. 5: Direct follow graph of travel declaration process

however, as can be seen in Figure 5 some rejections after one or more approval declarations have been recorded. After the declaration rejection, the process can be considered complete or the declaration can be resubmitted after some changes made by the employee. Looking the two graphs, it was possible to notice in addition, that there are some cases made by one activity: declaration saved in which the system recorded that a new travel declaration had been created into the system by the employee but no activities have been performed to it.

Travel permit Process

This section describes the models which depict the process flow of a travel permit request.The flow, as already said, is slightly different from the travel declaration process described in the previous lines since no payment is involved. The employee, before starting an international travel, should submit a travel permit that must be approved before the trip start. As can be seen from Figure 6 and 7, the most frequent path starts with the permit submission, than several permit approval are performed and if the outcome is positive the trip can take place. However it can occur that the permit is rejected so the travel permit should be resubmitted. It is interesting to notice that, in some cases the travel permit have been approved or even submitted after the end of the trip, and they can be considered as something anomalous from a normative perspective.

Request for Payment Process

This section describes the models which depict the process flow of a Request for Payment. It is a reimbursement request similar to a travel declaration, so the process flow of the two processes can be considered comparable. This concept can be clear looking at the two discovered process maps depicted in Figure 8 and 9 that are similar to the two graphs in Figure 4 and 5, the only difference is that in this case the case ID is a request for payment that stands for reimbursement requests submitted for expenses undertaken before the travel start or to expenses not travel related.

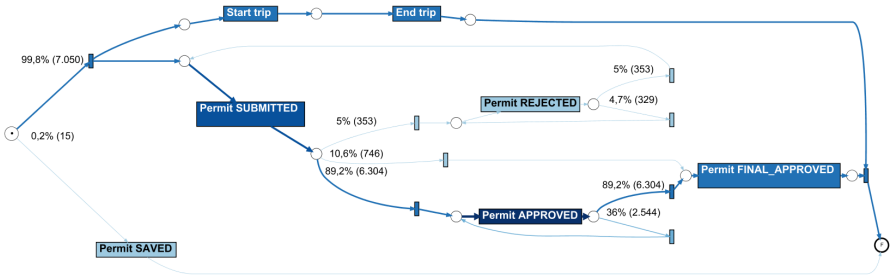


Fig. 6: Petri net of Travel permit process

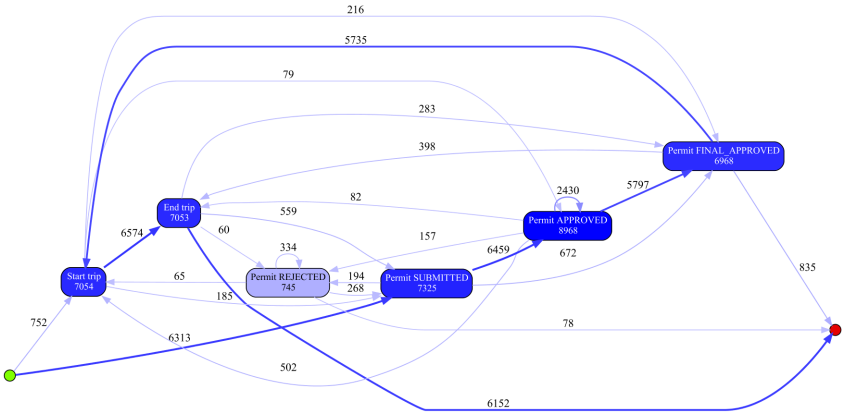


Fig. 7: Direct follow graph of Travel permit process

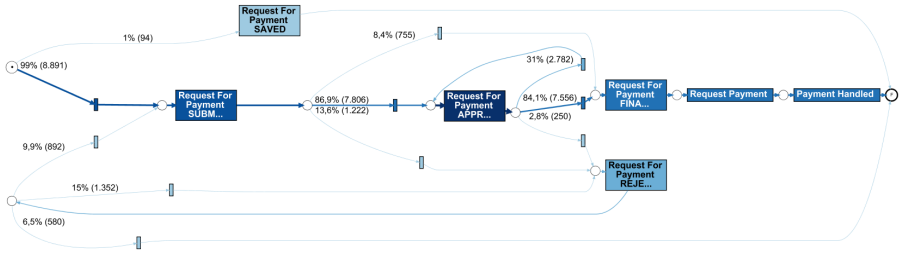


Fig. 8: Petri net of Request for Payment process.

3.3 Question Driven Analysis

As already introduced in the previous sections, the analysis stage of this work follows predefined questions that are of interest to the process owner. The starting point of the analysis are research questions presented in the challenge description and the discovered process models described in the previous lines. Attention

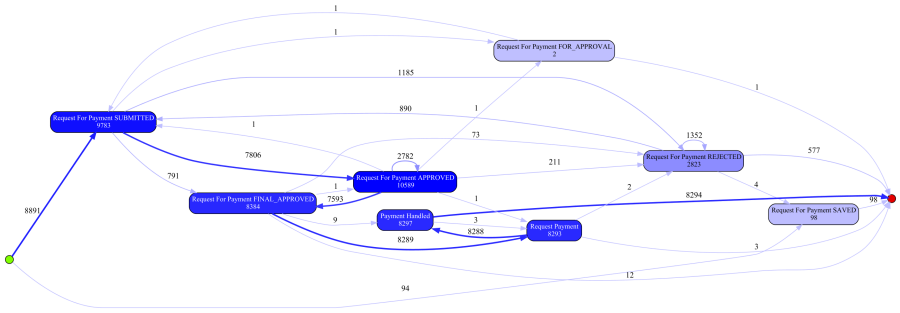


Fig. 9: Direct follow graph of Request for Payment process

in this stage, is focused especially on the analysis of the travel declaration process flow and performance, since most of the questions refer to this particular reimbursement request sub-process.

What is the throughput of a travel declaration from submission (or closing) to paying?

To answer to this question it was important to perform an alignment between the event log and the discovered process maps and then, it was possible to extract the cases where the event "payment handled" occurred. For this cases, the elapsed time between event "Declaration submitted" and "Payment handled" was computed and the results are summarized in Table 3.

Table 3: Descriptive statistics: Throughput time

Statistics Throughput time										
Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
throughputtime	16231	0	12,759	0,129	16,449	1,065	6,144	8,405	14,070	429,072

For 16231 travel declarations where a payment was performed, the average throughput time is 12.759 days while the Median is about 8.4 days. As can be seen from the boxplot in Figure 10, some outlier cases were presents.

Is there are difference in throughput between national and international trips?

Starting from the extracted cases of the previous question it was possible to perform a statistical test to determine whether the mean and the variance of the national and international throughput Time differ significantly. The results of the T-test are summarized in Figure 11a while the variance test results are summarized in Figure 11b

As can be notice, from the Figure 11 it is possible to affirm that the average throughput time can be considered different between domestic and international

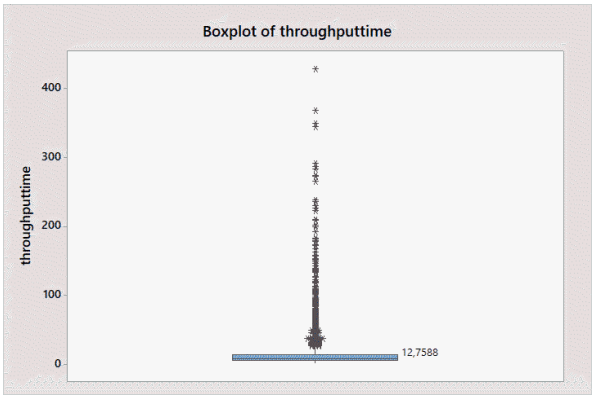


Fig. 10: Direct follow graph of Request for Payment process

Method

μ_1: mean of throughputTime when declarationType = dom
μ_2: mean of throughputTime when declarationType = int
Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: throughputTime

declarationType	N	Mean	StDev	SE Mean
dom	10044	11,6	15,8	0,16
int	6187	14,6	17,4	0,22

Estimation for Difference

Difference	95% CI for Difference
-2,991	(-3,522; -2,460)

Test

Null hypothesis H_0: $\mu_1 - \mu_2 = 0$
Alternative hypothesis H_1: $\mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-11,04	12132	0,000

(a) *Two-Sample T-Test and CI: throughputTime; declarationType*

Method

σ_1: standard deviation of throughputTime when declarationType = dom
σ_2: standard deviation of throughputTime when declarationType = int
Ratio: σ_1/σ_2
The Bonett and Levene's methods are valid for any continuous distribution.

Descriptive Statistics

declarationType	N	StDev	Variance	95% CI for σ
dom	10044	15,755	248,227	(14,129; 17,572)
int	6187	17,359	301,334	(15,142; 19,907)

Ratio of Standard Deviations

Estimated Ratio	95% CI for Ratio using Bonett	95% CI for Ratio using Levene
0,907613	(0,759; 1,084)	(*; *)

Test

Null hypothesis H_0: $\sigma_1 / \sigma_2 = 1$
Alternative hypothesis H_1: $\sigma_1 / \sigma_2 \neq 1$
Significance level $\alpha = 0,05$

Method	Test Statistic	DF1	DF2	P-Value
Bonett	*			0,280
Levene	57,14	1	16229	0,000

(b) *Test and CI for Two Variances: throughputTime vs declarationType*

Fig. 11: Statistical test results for mean and variance

declarations since the p value is 0.00 and the null hypothesis can be rejected. The throughput time for national trip is about 11.5 days while for the international ones is about 14.5 days. On the other hand, the null hypothesis for the variance test can not be rejected considering the Bonnet test result.

Are there differences between clusters of declarations, for example between cost centers/departments/projects etc.?

Before answering to this question, it was important to understand which are the relevant clusters that can be found in the travel declarations data. As mentioned before, travel declarations can be grouped between international and domestic and by year 2017 and 2018, in addition several attribute can be considered as cluster criteria, however not all of them are relevant for this analysis. At first instance, it was possible to divide the international declarations by the department unit in charge of handling such reimbursement requests: through a Pareto analysis, it was possible to understand which were the main ones. As can be notice by looking at Figure 12, most of the international travel declaration can be grouped by 9 different departments.

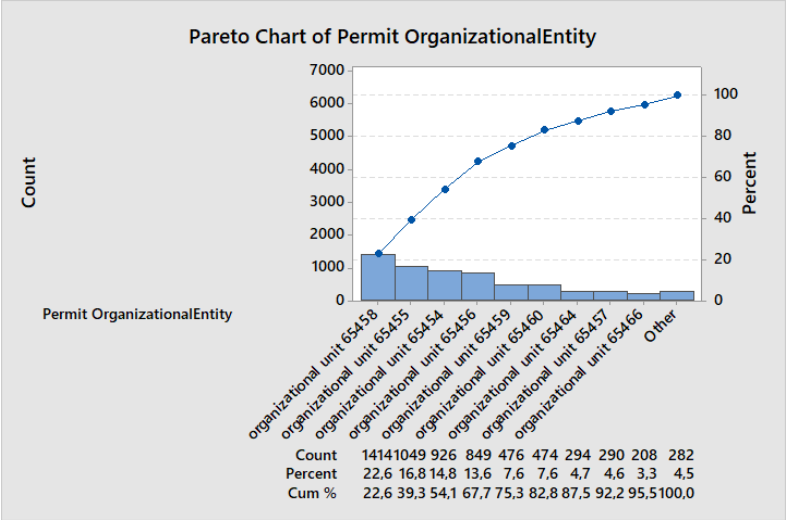
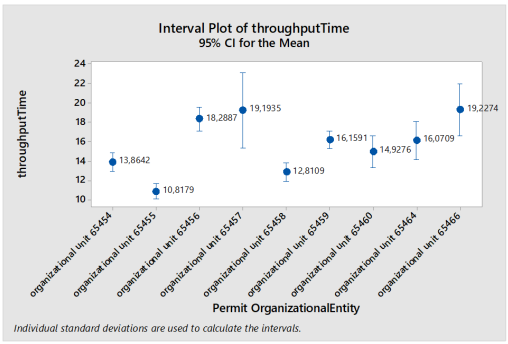


Fig. 12: Pareto chart of organizational entity

Following the same criteria, it was not possible to find other relevant variables that could have been used to cluster the declarations, it was only possible to group the declaration between the ones linked to projects and the ones not.

It was possible to detect some relevant differences for the throughput time for declarations handled by the different organizational units, this can be notice looking at the interval plot in Figure 13. The throughput time of international declarations change considerably as a function of the different organizational units in particular for Units 65457 and 65466 the mean time is more than 19 days and this suggests that something is not going as planned for such Organizational Entities. Referring, on the other hand, to travel declarations submitted in 2017 and 2018 it was possible to notice an increase of the throughput time for the



Descriptive Statistics: throughputTime

Statistics

Variable	Permit OrganizationalEntity	N	N*	Mean	SE Mean	StDev	Minimum	Q1
throughputTime	organizational unit 65454	911	0	13,864	0,477	14,386	1,087	6,592
	organizational unit 65455	1041	0	10,818	0,394	12,721	1,194	5,989
	organizational unit 65456	840	0	18,289	0,626	18,130	1,985	9,923
	organizational unit 65457	288	0	19,19	1,96	33,30	1,31	6,97
	organizational unit 65458	1399	0	12,811	0,485	18,136	1,255	5,960
	organizational unit 65459	464	0	16,159	0,468	10,092	1,259	10,063
	organizational unit 65460	465	0	14,928	0,822	17,723	1,292	6,351
	organizational unit 65464	293	0	16,07	1,00	17,14	2,30	7,91
	organizational unit 65466	208	0	19,23	1,36	19,59	2,16	7,17

Variable	Permit OrganizationalEntity	Median	Q3	Maximum
throughputTime	organizational unit 65454	10,105	16,086	178,072
	organizational unit 65455	7,251	11,233	167,026
	organizational unit 65456	14,159	21,210	349,815
	organizational unit 65457	12,01	21,16	429,07
	organizational unit 65458	8,050	13,312	235,368
	organizational unit 65459	13,943	20,077	70,217
	organizational unit 65460	11,042	17,274	272,201
	organizational unit 65464	11,87	16,85	209,45
	organizational unit 65466	12,59	23,89	137,38

Fig. 13: Interval plot and descriptive statistics for international declarations grouped by organizational unit.

international ones, while it was not possible to found a significant difference between international travel declarations linked to project and the one not. This concept is clear looking at the descriptive statistics for the different clusters summarized in Figure 14.

Results for Year = 2017

Statistics

Variable	declarationType	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median
throughputTime	dom	2141	0	11,597	0,446	20,659	1,279	5,115	7,099
	int	1500	0	12,734	0,400	15,501	1,255	6,071	8,267

Variable	declarationType	Q3	Maximum
throughputTime	dom	11,034	368,194
	int	14,083	230,240

Results for Year = 2018

Statistics

Variable	declarationType	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median
throughputTime	dom	7903	0	11,625	0,159	14,139	1,065	6,116	8,040
	int	4687	0	15,210	0,261	17,873	1,087	7,070	10,839

Variable	declarationType	Q3	Maximum
throughputTime	dom	13,041	290,906
	int	17,268	429,072

Statistics

Variable	Permit ProjectNumber	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median
throughputTime	Project	3956	0	14,686	0,263	16,555	1,087	6,961	10,322
	UNKNOWN	2231	0	14,474	0,396	18,703	1,194	6,287	9,998

Variable	Permit ProjectNumber	Q3	Maximum
throughputTime	Project	17,150	429,072
	UNKNOWN	16,028	349,815

Fig. 14: Descriptive statistics of clusters of declarations

What is the throughput in each of the process steps, i.e. the submission, judgement by various responsible roles and payment?

To answer to this question, the graph presented in Figure 5 was extended with additional information. The event "Declaration APPROVED" was divided in

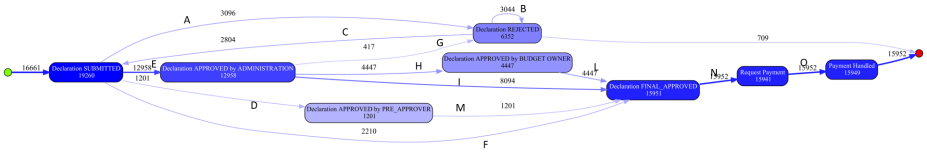


Fig. 15: Direct follow graph of travel declaration process with Approval activities labelled by role.

Table 4: Descriptive statistics: Throughput time

Path	A	B	C	D	E	F	G	H	I	L	M	N	O
MEAN	**3.52**	2.97	**3.33**	1.43	1.40	1.08	2.51	2.35	2.25	1.94	1.90	**3.19**	**3.53**
ST.DEV	19.92	4.68	12.74	8.17	9.89	7.22	3.33	4.00	3.47	3.86	2.22	6.87	2.26

multiple tasks by various responsible roles, and the resulting Direct Follow graph can be seen in Figure 15. Each path of the graph is labeled with a letter, and the mean and standard deviation flow time between each activities are summarized in Table 4.

Where are the bottlenecks in the process of a travel declaration?

From the Table 4, it is possible to detect the main bottlenecks of the travel declaration process, long sojourn times are present between the submission of a declaration and when it is rejected, and when is rejected by the employee and then resubmitted, more than 3 days pass between these activities. In addition, long sojourn times are present also in the final part of the analysed process, when the declaration is final approved more than 6 days pass before the payment is handled, in particular path N and O takes respectively 3.19 days and 3.53 days, and it is something anomalous since "Request Payment" and "Payment Handled" are activities performed by the system and margins of improvements are present.

How many travel declarations get rejected in the various processing steps and how many are never approved?

Looking at the process model in Figure 4 it is possible to notice that after the submission of a travel declaration 17% of them are rejected while 3% of the total analysed travel declarations are rejected before they are final approved. As already described in the previous lines, when a travel declaration flow has a negative outcome the employee can resubmit or not the declaration, and at about 3% of the total declarations are not resubmitted by the employee, so in this case, the process ends when the travel administration rejects the declaration.

How many travel declarations are booked on projects?

From the downloaded event logs, it was possible to have some additional information for some cases by the attributes present in the data-sets, in particular for international travel declarations it was possible to understand if the submitted declaration was linked to some project. For all the 6450 analysed international reimbursement requests, 60% of them, 4116 declarations, are booked on projects.

How many corrections have been made for declarations?

Referring to the previous Question, the declaration that were submitted more than one time per case, can be considered as the ones that were subject to some corrections. Looking at the graph in Figure 4, of the aligned cases at about 17% of the total declarations were resubmitted after they were rejected by the travel administration.

Are there any double payments?

To answer to this question, it was possible to refer to the Direct follow graph depicted in Figure 5, and in particular the zoomed view in Figure 16. After the occurrence of the event payment handled, the process instance can be considered completed, however it was possible to detect that for 3 cases the last event of these traces was not Payment Handled, that means something occurred after the system reimbursed the employee. However, looking in detail Figure 16 it is possible to notice that the last event for these anomalous traces was Request Payment, so no double payments were recorded by the analysed event log, since the event Payment Handled was not recorded twice in any trace.

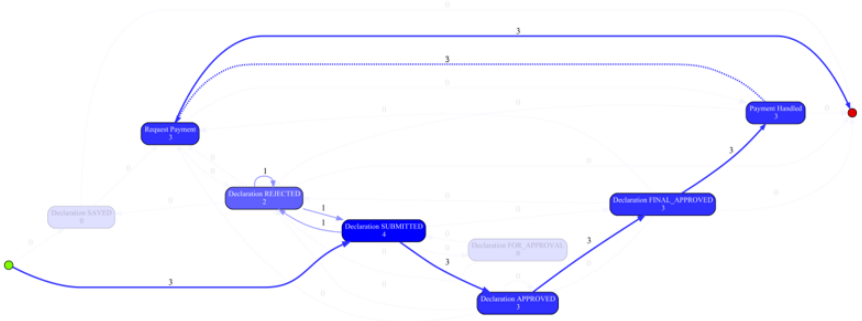


Fig. 16: Zoom on anomalous traces to check double payments

Are there declarations that were not preceded properly by an approved travel permit? Or are there even declarations for which no permit exists?

From a normative perspective, for international declarations before submitting a reimbursement request, it should be mandatory that a travel permit is

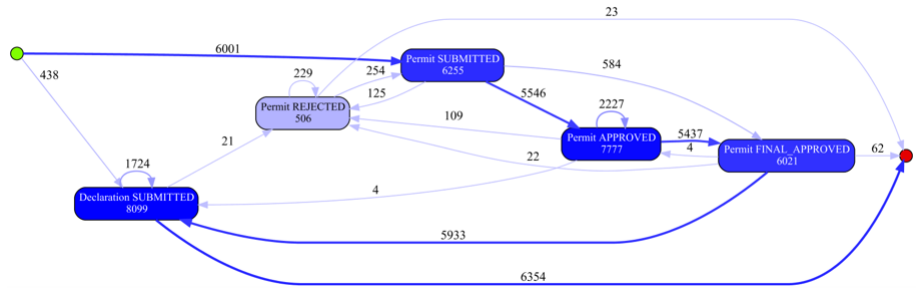


Fig. 17: Direct follow graph of travel permit process with declaration submitted.

first submitted and then approved. However, analysing the process information recorded in the travel permit event log some declaration were not preceded properly by an approval travel permit. This concept is clear looking at Figure 17, event "Declaration Submitted" in some traces occurred not after the travel permit is final approved. In the graph there are some income arcs that link transition "Declaration Submitted" with activities different than "Permit FINAL APPROVED". In addition, there are even 438 declarations that were submitted without the submission of any travel permit.

How many travel declarations are first rejected because they are submitted more than 2 months after the end of a trip and are then re-submitted?

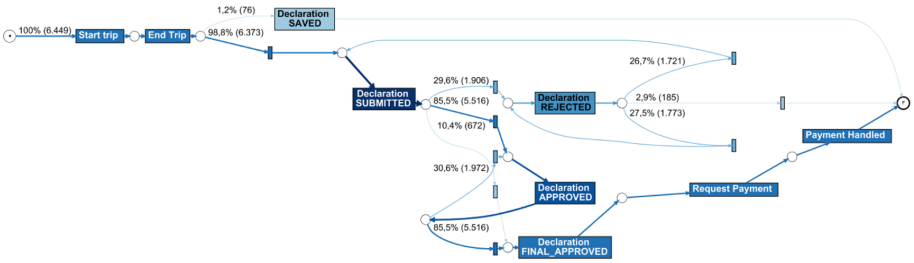
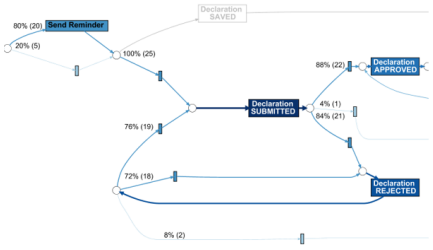


Fig. 18: Petri-net of travel declarations submitted more than 2 months after the end of a trip.

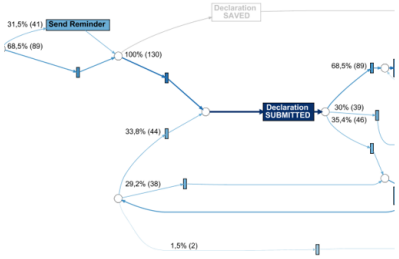
To answer to this question, it was import to extract the cases where the declarations submission occurred 2 month later than the end of the trip. From the extracted cases, it was possible first to discover the Petri-net and then to align the events with the graph. The results are shown in Figure 18 where it is possible to detect that 29,6% of the aligned cases were rejected, of which more than 26% of the total cases were then resubmitted by the employee.

Is this different between departments?

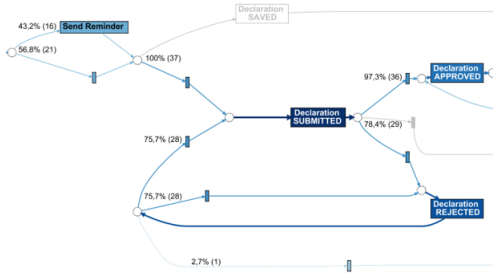
From the extracted cases used in the previous question, it was possible to group them by the different organizational units and then to perform an alignment to answer the following question. It was discovered that the percentage of cases submitted more than 2 months after the end of a trip and then resubmitted varies significantly between the different department. In Figure 19, it is shown a zoom on the alignment results for organizational units 65459, 65458 and 65456 where, as can be notice from the picture below, the considered percentage is respectively more than 80%, about 35% and more then 78%.



(a) *Alignments of Organizational Unit 65459 cases.*



(b) *Alignments of Organizational Unit 65458 cases.*



(c) *Alignments of Organizational Unit 65456 cases.*

Fig. 19: Alignments of travel declarations submitted more than 2 months after the end of a trip between departments.

How many travel declarations are not approved by budget holders in time (7 days) and are then automatically rerouted to supervisors?

To answer to this question, at first instance it was performed an extraction of the cases where activity "Declaration APPROVED by SUPERVISOR" was recorded and then the direct follow graphs of the following cases, that it is shown in Figure 20, was discovered. As can be notice by the graph, 104 declarations

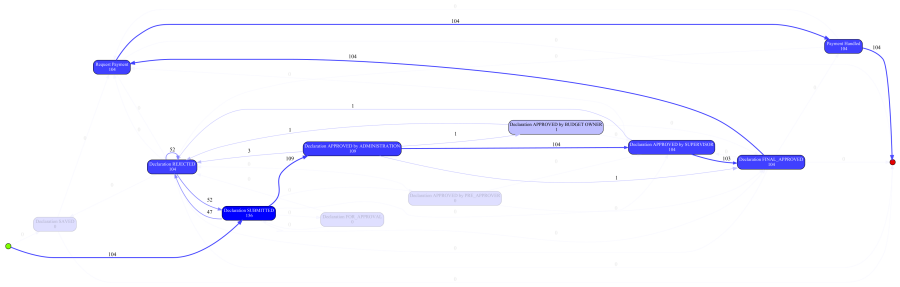


Fig. 20: Direct Follow graph of declaration approved by Supervisor.

where subjected by an approval by a supervisor and for this traces it was possible to analyse the flow time between the activities "Declaration APPROVED by ADMINISTRATION" and "Declaration APPROVED by SUPERVISOR". In conclusion, it was discovered that for this traces only 18 cases were not approved by budget holders in time and were then automatically rerouted to supervisors.

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