Analysis of the reimbursement process

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Abstract. The 2020 Business Process Intelligence Challenge is centered on understanding and analyzing the reimbursement process at TU/e. We analyzed the data provided by process owners using a variety of analytical tools. In this report, we outline our understanding of the data and the process, present findings from the exploratory analysis of the event log data.

1   Introduction

Like the previous editions, the 2020 BPI Challenge provides a unique opportunity to analyze a real-world business process based on event log data, using a different tools.

As part of the BPI Challenge 2020, Eindhoven University of Technology (TU/e) provided data on corporate travel of its employees. TU/e employees often travel to conferences, other universities for project meetings, or meetings with colleagues in the field.

1.1   Data description

The data is split into 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 (think of representation costs, hardware purchased for work, etc.). The files contain data from 2017 (only two departments) and 2018 the full TU/e.

2   Overview

2.1   Data Overview

Let's consider the number of cases in each of the log files.

Table 1. The number of cases in the logs

Data	Total number of cases	Number of cases for 2017	Number of cases for 2018
Domestic Declaration	10500	2240	8260

International Declarations	6449	1552	4897
Permit Log	7065	1481	5584
Prepaid Travel Cost	2099	323	1776
Request For Payment	6886	1108	5778
Total	32999	6704	26295

Table 1 shows that there is more data for 2018 than for 2017 (approximately 4 times). The number of activity types is shown in table 2.

Table 2. The number of types concept:name

Data	The number of types concept:name	Number of concept:name types for 2017	Number of concept:name types for 2018
Domestic Declaration	17	15	10
International Declarations	34	33	29
Permit Log	51	47	43
Prepaid Travel Cost	29	23	23
Request For Payment	19	13	14
Total	133	131	119

2017 was a pilot year, so the process changed several times during it. From table 2, we can see that the number of concept:name types has decreased.

2.2   Process Overview

The data shows two types of trips: national and international trips. They differ in several stages. Table 3 shows the features of national and international trips.

Table 3. Features of types of trips

Trip	Features
Domestic trips	No prior permission is needed, i.e. employee can undertake these trips and ask for reimbursement of the cost afterwards.
International trips	For international trips, permission is needed from supervisor. This permission is obtained by filing a travel-permit and this travel permit should be approved before making any arrangements.

Analyzing the presented information about corporate trips of employees, graphs of the ideal process for internal and external business trips were compiled, respectively.

Fig. 1. Ideal process of internationals trips

Fig. 2. Ideal process of nationals trips
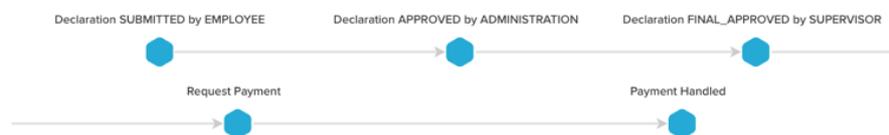
The domestics trips process is much simpler and does not require prior approval.
Prior approval is required for an internationals trips. The travel permit can be rejected and the employee can re-submit the request for permission or do nothing else. It is often the case that several declarations are submitted for a single travel permit, which can be rejected or edited for approval and subsequent compensation.

3 Question

3.1 Question 1

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

It is necessary to find out the throughput of a travel declaration. Since the data contains 2 types of trips (domestic and international), we will analyze the throughput for each type. First of all, let's take only those cases that appeared in 2018.
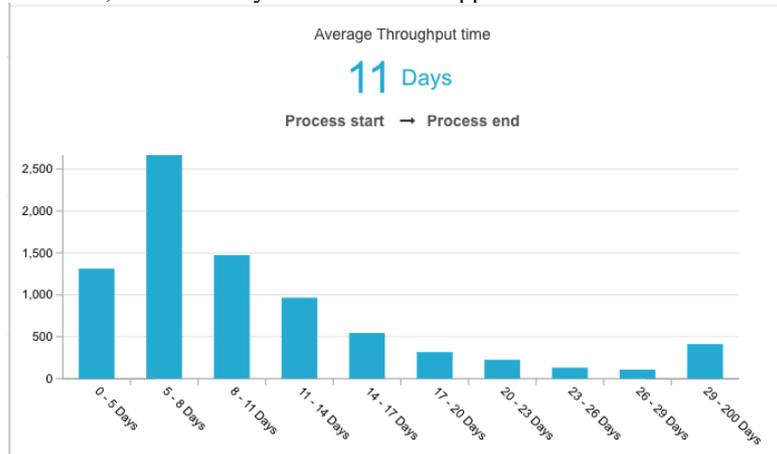

Fig. 3. Throughput of domestic declaration

In international declaration, unlike domestic declaration, the case does not appear with the filing of a declaration, but with the filing of a travel permit, and the total duration of the case is significantly increased.

For comparison with the domestic declaration, it was decided to calculate the throughput of international declaration starting from the moment the employee submitted the declaration.
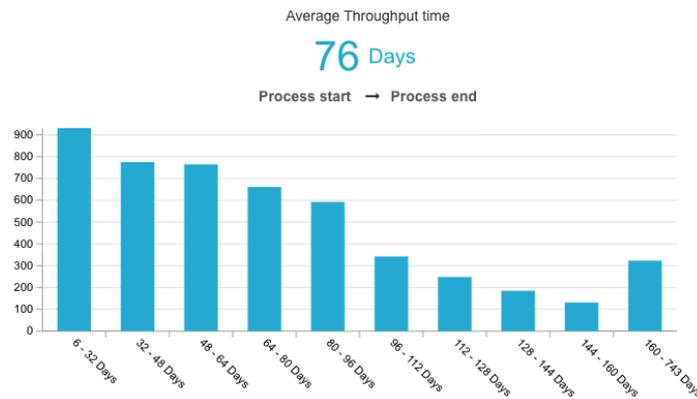

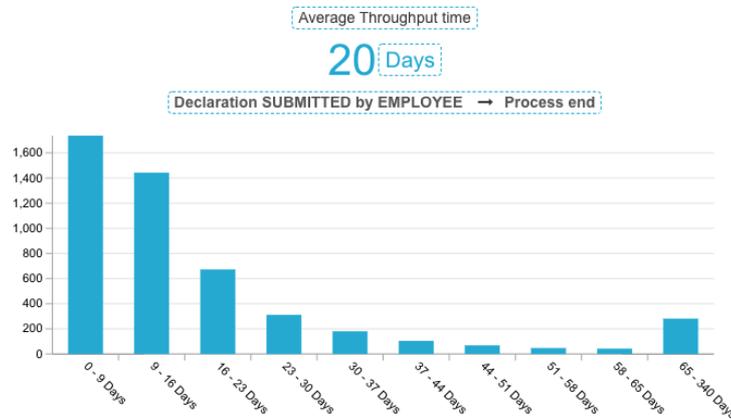**Fig. 4.** Throughput of international declaration without filter

Fig. 5. Throughput of international declaration with filter

3.2 Question 2

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

We compared the throughput of a domestic and international trip, and calculated the average trip time using data on the duration of a domestic and international trip.

Table 4. Comparison of throughput

Trips	Throughput (in days)
National trips	12
International trips without filter	76
International trips with filter	20
National + International trips with filter	16

In table 4, we see that the throughput of a domestic trip is less than the international one.

3.3 Question 3

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

Calculate the throughput in each of the process steps. To do this, first calculate the throughput from the current to the next activity and calculate the number of such transitions, and then group it by activity and find the throughput as a weighted average.

Table 5. Throughput in domestic declaration steps.

Step	Throughput

Declaration APPROVED by ADMINISTRATION	0 days 18:34:37
Declaration APPROVED by BUDGET OWNER	2 days 00:55:14
Declaration FINAL_APPROVED by SUPERVISOR	24 days 15:43:09
Declaration FOR_APPROVAL by ADMINISTRATION	1 days 00:23:43
Declaration REJECTED by ADMINISTRATION	0 days 22:26:54
Declaration REJECTED by BUDGET OWNER	3 days 13:26:15
Declaration REJECTED by EMPLOYEE	0 days 05:12:40
Declaration REJECTED by SUPERVISOR	1 days 21:16:13
Declaration SUBMITTED by EMPLOYEE	0 days 00:03:03
Request Payment	1 days 14:33:58

Table 6. Throughput in international declaration steps.

Step	Throughput
Declaration APPROVED by ADMINISTRATION	1 days 00:44:23
Declaration APPROVED by BUDGET OWNER	1 days 23:01:45
Declaration APPROVED by SUPERVISOR	1 days 01:42:41
Declaration FINAL_APPROVED by DIRECTOR	1 days 00:21:04
Declaration FINAL_APPROVED by SUPERVISOR	1 days 03:17:58
Declaration REJECTED by ADMINISTRATION	1 days 14:07:04
Declaration REJECTED by BUDGET OWNER	1 days 20:05:35
Declaration REJECTED by DIRECTOR	0 days 06:06:59
Declaration REJECTED by EMPLOYEE	1 days 04:51:16
Declaration REJECTED by SUPERVISOR	2 days 04:19:50.
Declaration SAVED by EMPLOYEE	68 days 20:47:18
Declaration SUBMITTED by EMPLOYEE	0 days 08:16:08

End trip	7 days 17:43:37
Payment Handled	63 days 02:44:36
Permit APPROVED by ADMINISTRATION	0 days 13:46:52
Permit APPROVED by BUDGET OWNER	2 days 01:47:15
Permit APPROVED by SUPERVISOR	1 days 02:00:29
Permit FINAL_APPROVED by DIRECTOR	40 days 00:35:32
Permit FINAL_APPROVED by SUPERVISOR	23 days 13:56:18
Permit REJECTED by ADMINISTRATION	0 days 11:36:32
Permit REJECTED by BUDGET OWNER	1 days 19:14:00
Permit REJECTED by DIRECTOR	5 days 00:20:00
Permit REJECTED by EMPLOYEE	1 days 06:55:17
Permit REJECTED by MISSING	0 days 01:59:00
Permit REJECTED by SUPERVISOR	1 days 06:16:59
Permit SUBMITTED by EMPLOYEE	0 days 08:45:48
Request Payment	3 days 04:13:09
Send Reminder	8 days 15:30:44
Start trip	3 days 20:03:45

3.4 Questions 4

Given questions: Where are the bottlenecks in the process of a travel declaration?
Using the throughput of process steps, calculated at the previous stage, we will find the bottlenecks. To do this, define the throughput of all stages and see which of the stages are much higher than the average value.
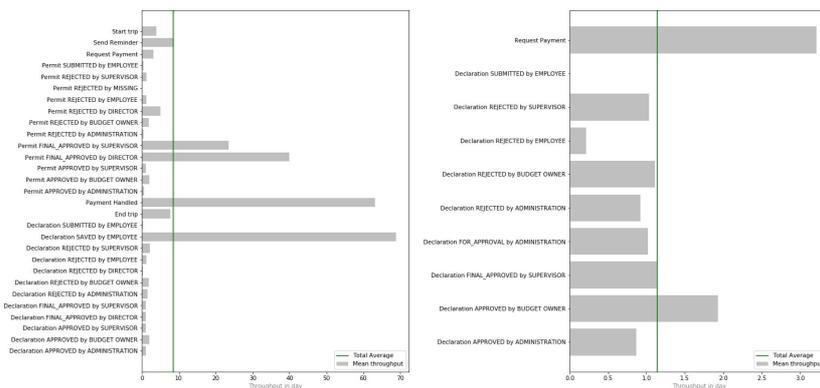

Fig. 6. Bottleneck of domestic and international trip.

The figure 6 shows that both national trip and international trip have stages that last longer than the average value:

1. Request Payment;
2. Declaration Approved by BUDGET OWNER;
3. Permit FINAL_APPROVED by SUPERVISOR;
4. Permit FINAL_APPROVED by DIRECTOR;
5. Declaration SAVED by EMPLOYEE.

3.5 Questions 5

Given question: Where are the bottlenecks in the process of a travel permit (note that there can be mulitple requests for payment and declarations per permit)?

Using the throughput of process steps, we will find the bottlenecks. To do this, define the throughput of all stages and see which of the stages are much higher than the average value.
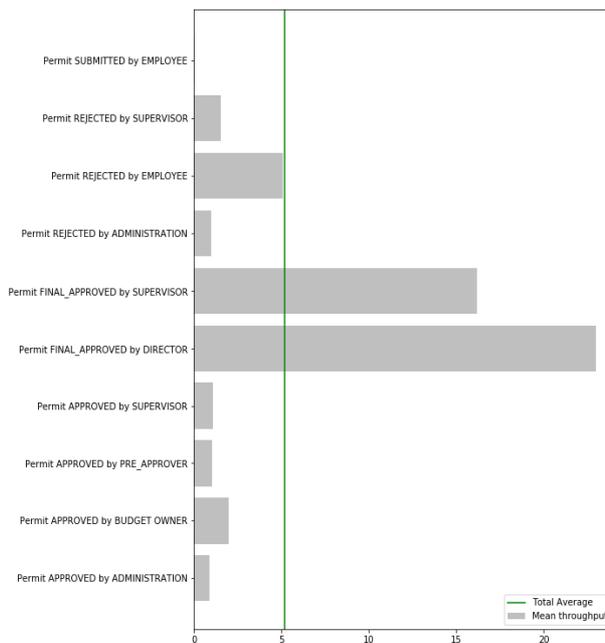

Fig. 7. Bottleneck in the process of a travel permit.

Bottlenecks in the process of obtaining a travel permit:

1. Permit FINAL_APPROVED by SUPERVISOR;
2. Permit FINAL_APPROVED by DIRECTOR.

3.6 Question 6

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

For domestic declarations, 1124 rejections were identified at various processing steps. Figure 8 shows a histogram of rejections.
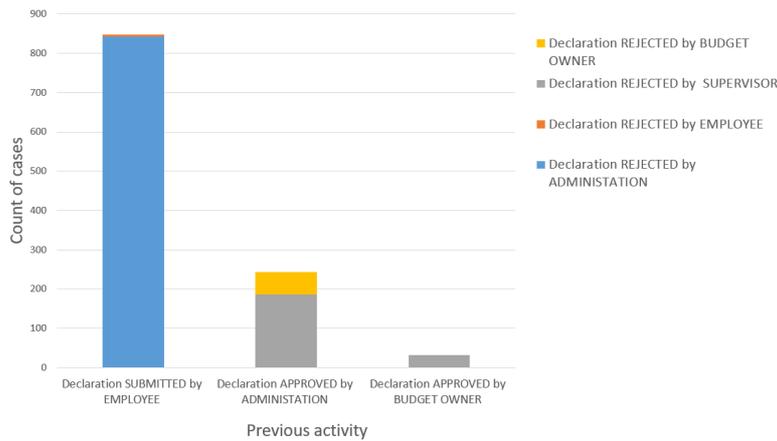

Fig. 8. Histogram of rejected domestic declarations.

It was found that there are no rejections at the end stages of the cases (Declaration FINAL_APPROVED by SUPERVISOR, Payment Handled, Request Payment).

The number of declarations never approved is 3.11% (257 cases).

For international travel, a permit is required, which can also be rejected. Since the "Declaration SUBMITTED by EMPLOYEE" event, 1344 deviations have been rejected in the various processing steps. details in the figure 8.
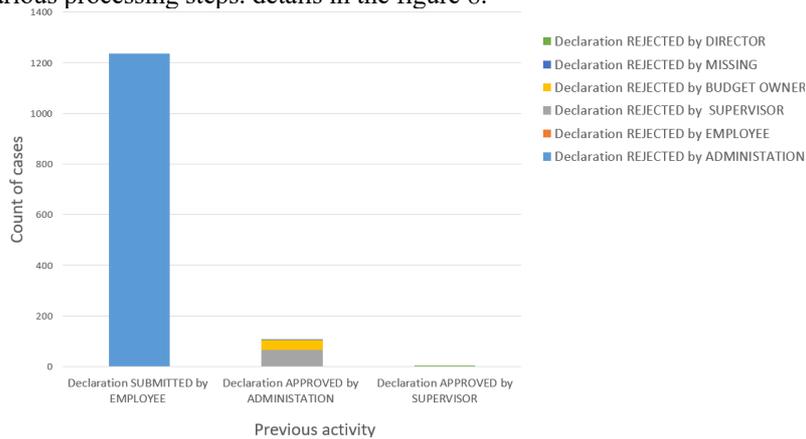

Fig. 9. Histogram of rejected international declarations.

It was found that there are no rejections at the end stages of the cases (Declaration FINAL_APPROVED by SUPERVISOR, Declaration FINAL_APPROVED by DIRECTOR, Payment Handled, Request Payment).
The number of declarations never approved is 3.13 % (153 cases)

4 Conclusion

In this challenge, we tried to answer the questions asked by the data owners (University of Technology) using Celonis and Python. Analyzing the presented events log, some deviations and bottlenecks in the process were found. In our report, we tried to display the main results of the process analysis, namely: process throughput, deviations, and unfavorable process outcome. An ideal example was presented at the beginning of our report, as a reference model with which it is possible to compare real cases.

5 References

1. Celonis, https://www.celonis.com/
2. Python, https://www.python.org/
3. BPI Challenge – Process Mining Conference 2020, https://icpmconference.org/2020/bpi-challenge/