

X International Business Process Intelligence Challenge

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Analytical report of reimbursement process at TU/e

Abstract

A study using Process Mining shows how the reimbursement process at Eindhoven University of Technology actually works. The process is organized through documentation and established requirements. The purpose of the analysis was to find bottlenecks, anomalies, deviations in the process and answers to specific questions by process steps. The Process Mining Celonis tool was used to recreate the process map and the analysis. Python and SQL tools were used for detailed analysis of business process stages.

1 Introduction

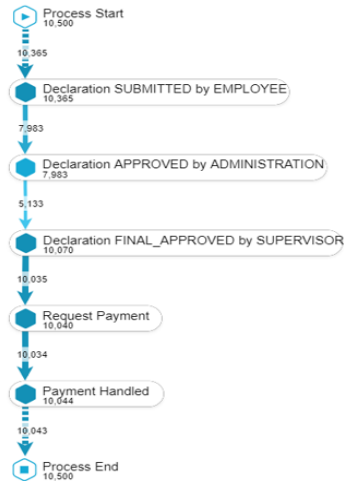
Before you start analyzing data, you need to understand the process being analyzed. This is an important step, because without understanding and immersion in the regulated process it will not be possible to structure the data correctly to create a process map and evaluate the real process. So, it is possible to distinguish several stages in the process analysis:

1. Understanding of the regulated process
2. Data preparation
3. Analysis of the "AS IS" process
4. Search for bottlenecks and deviations from the regulated process
5. Finding answers to precise questions

2 Overall understanding of the data and process.

According to the available data, we have restored two process maps: for internal travel and for international travel.

Domestic Declarations:



International Declarations:



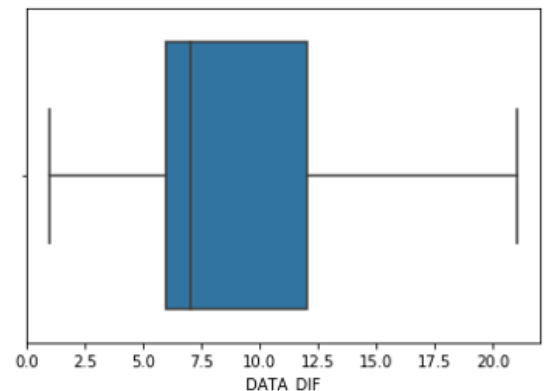
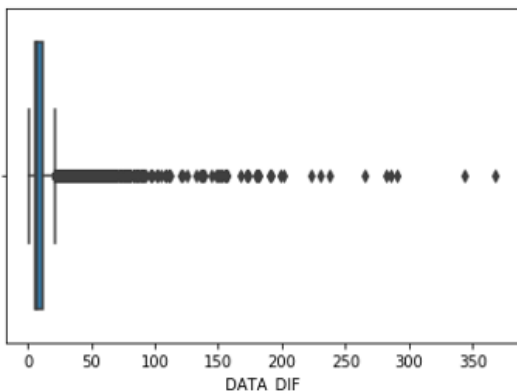
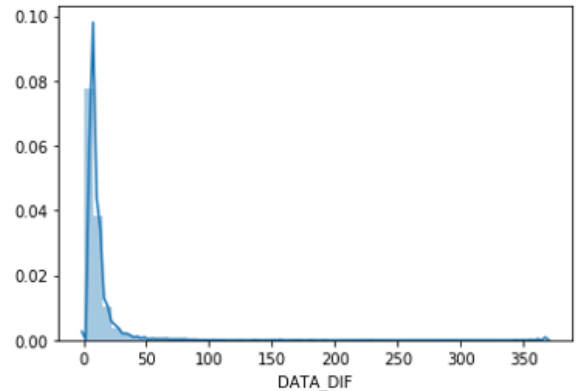
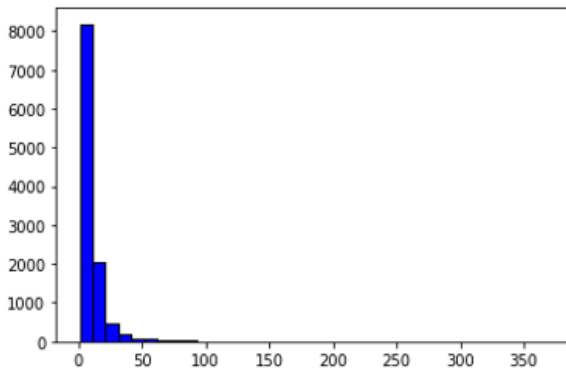
3 Analysis, answers to questions and conclusions

3.1 General questions

Question 1. *What is the throughput of a travel declaration from submission (or closing) to paying?*

When calculating the throughput of the travel declaration, from submission to payment, we built a histogram and density graph for internal and external travel declarations.

For Domestic declarations:



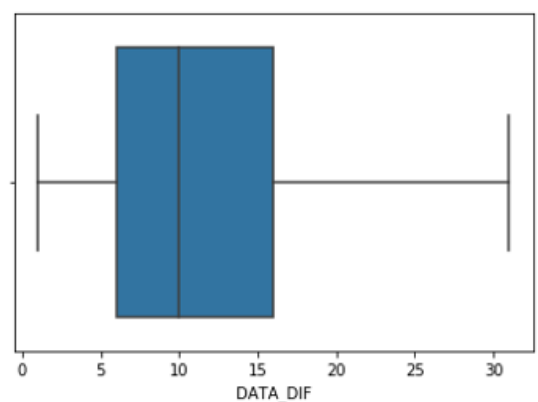
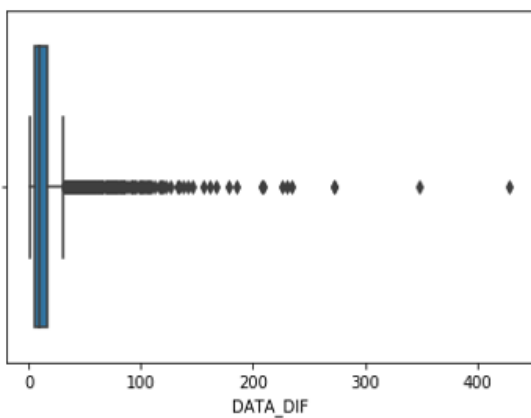
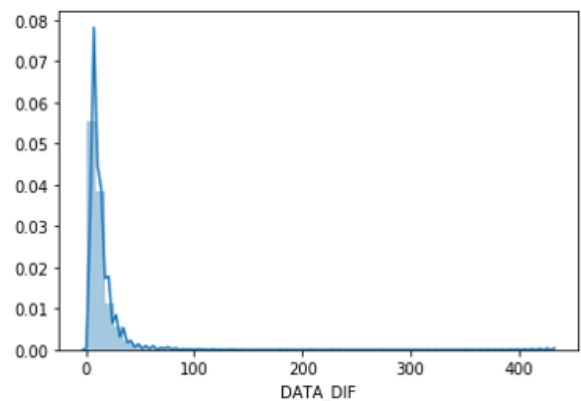
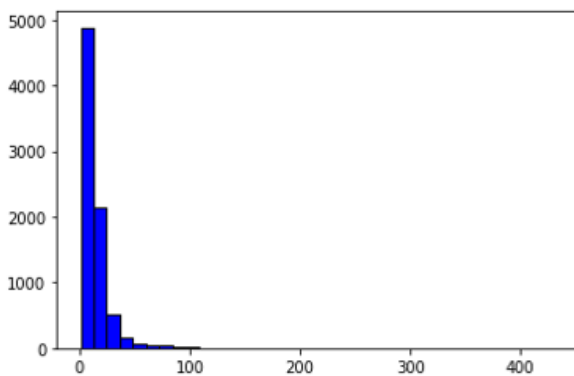
In our analysis, we found significant emissions, which indicate that there are significant time lags between filing and closing.

Statistics on the throughput of Domestic declarations:

	DATA_DIF	DATA_DIF_DAYS
count	11162	11162.000000
mean	11 days 11:18:29.005196	11.167264
std	15 days 06:34:17.603632	15.273332
min	1 days 01:33:30	1.000000
25%	6 days 01:15:31.500000	6.000000
50%	7 days 08:58:44	7.000000
75%	12 days 06:20:38.500000	12.000000
max	368 days 04:38:34	368.000000

The throughput of a travel Domestic declaration was 1 days 01 hours 33 minutes 30 seconds.

For International declarations:



As with the internal declarations, we also found emissions by bandwidth.

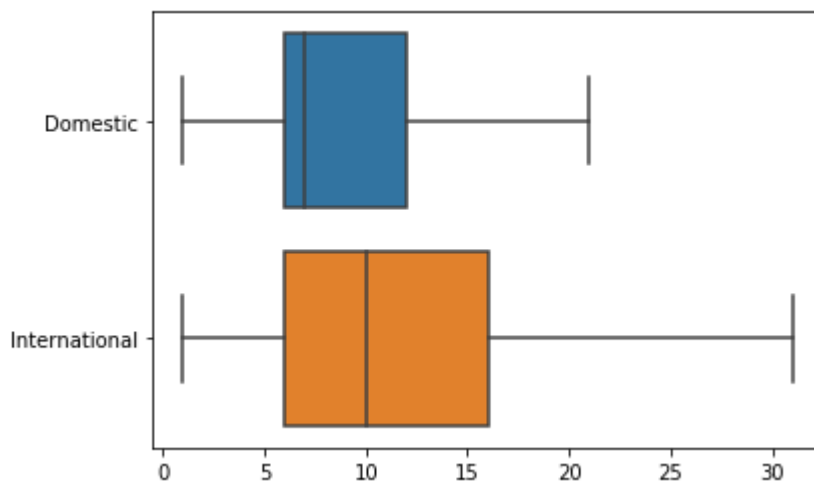
Statistics on the throughput of International declarations:

	DATA_DIF	DATA_DIF_DAYS
count	7889	7889.000000
mean	14 days 01:58:18.677272	13.771834
std	16 days 02:41:45.619186	16.109402
min	1 days 00:55:52	1.000000
25%	6 days 08:21:54	6.000000
50%	10 days 03:50:34	10.000000
75%	16 days 05:23:06	16.000000
max	429 days 02:42:28	429.000000

The throughput of a travel International declaration was 1 days 55 minutes 52 seconds.

Question 2. *Is there are difference in throughput between national and international trips?*

To compare bandwidth, we built Boxplot charts for each type of declaration without any detected emissions:

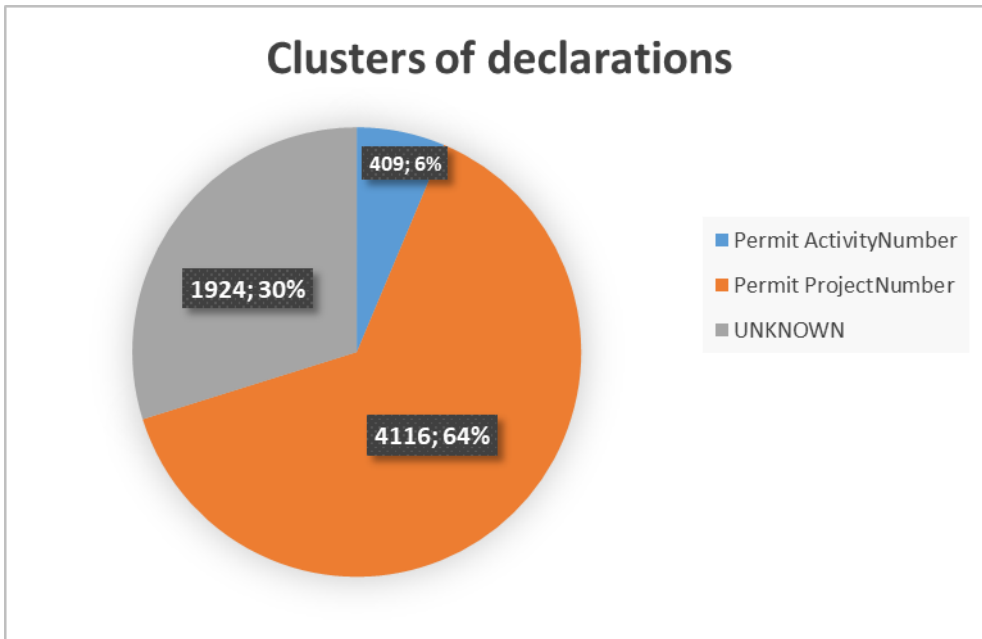


You can draw conclusions from the chart:

- The median value of throughput time for International Declaration is 3 days longer than for Domestic Declaration.
- Interquartile spread of throughput values in International Declaration is greater than in Domestic Declaration $[6;16] > [6;12]$.
- Maximum throughput values for International Declaration are higher than those for Domestic Declaration

Question 3. *Are there differences between clusters of declarations, for example between cost centers/departments/projects etc.?*

We researched data on International declaration and identified three main clusters:



In a deep analysis of each of the groups of declarations, we have identified the following facts:

TOP 15 most popular projects and activities:

Permit ProjectNumber	Number of declarations
project 426	464
project 3442	52
project 8761	47
project 647	39
project 636	38
project 1400	35
project 3318	34
project 2073	33
project 1115	30
project 1645	30
project 4528	27
project 1623	27
project 1185	26
project 8993	25
project 19841	23

Permit ActivityNumber	Number of declarations
activity 5818	32
activity 2169	23
activity 2401	22
activity 7905	12
activity 16720	12
activity 7366	10
activity 6867	9
activity 900	9
activity 9933	8
activity 9427	7
activity 2366	7
activity 16191	7
activity 38114	6
activity 2946	6
activity 9655	6

Number of declarations with tasks in progress:

Permit TaskNumber	Number of declarations
task 427	4068
UNKNOWN	2340
task 13772	15
task 648	12
task 7355	9
task 26077	5

Projects started without tasks:

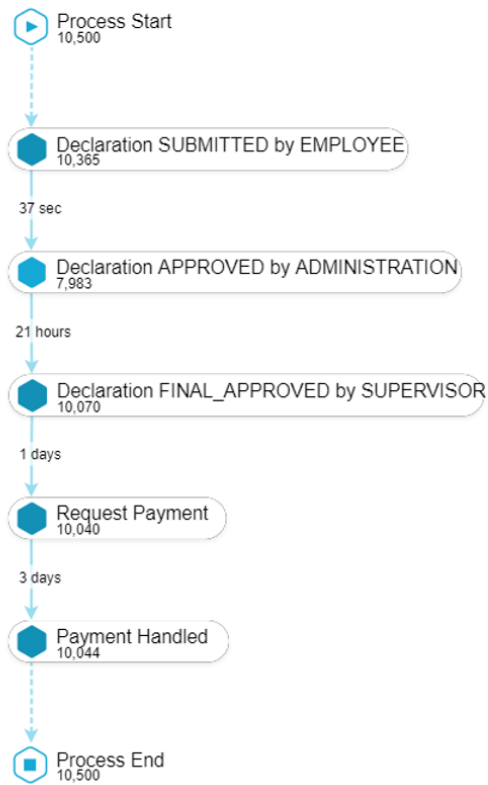
Permit ProjectNumber	Permit TaskNumber	Number of declarations
project 16442	UNKNOWN	2
project 12701	UNKNOWN	1
project 10577	UNKNOWN	1
project 44487	UNKNOWN	1
project 29194	UNKNOWN	1
project 457	UNKNOWN	1

The number of declarations processed by a certain organizational unit:

Permit OrganizationalEntity	Number of declarations processed
organizational unit 65458	1432
organizational unit 65455	1081
organizational unit 65454	957
organizational unit 65456	889
organizational unit 65459	493
organizational unit 65460	480
organizational unit 65464	305
organizational unit 65457	304
organizational unit 65466	220
organizational unit 65461	77
organizational unit 65469	50
organizational unit 65470	40
organizational unit 65472	19
organizational unit 65467	18
organizational unit 65475	16
organizational unit 65468	13
organizational unit 65473	12
organizational unit 65480	9
organizational unit 65465	8
organizational unit 65471	7
organizational unit 65482	7
organizational unit 65477	4
organizational unit 65484	3
organizational unit 65486	2
organizational unit 65488	1
organizational unit 65478	1
organizational unit 65462	1

Question 4. *What is the throughput in each of the process steps, i.e. the submission, judgement by various responsible roles and payment?*

Domestic declarations



International declarations:



Declaration	Process step	Median throughput time
Domestic	Declaration SUBMITTED by EMPLOYEE -> Permit APPROVED by ADMINISTRATION	37 sec
	Permit APPROVED by ADMINISTRATION -> Permit FINAL APPROVED by SUPERVISOR	21 hours
	Permit FINAL_APPROVED by SUPERVISOR -> Request Payment	1 days
	Request Payment -> Payment Handled	3 days
International	Permit SUBMITTED by EMPLOYEE -> Permit APPROVED by ADMINISTRATION	4 sec
	Permit APPROVED by ADMINISTRATION -> Permit FINAL APPROVED by SUPERVISOR	21 hours
	Permit FINAL_APPROVED by SUPERVISOR -> Start trip	28 days
	Start trip -> End trip	4 days
	End trip -> Declaration SUBMITTED by EMPLOYEE	6 days
	Declaration SUBMITTED by EMPLOYEE -> Declaration APPROVED by ADMINISTRATION	3 min
	Declaration APPROVED by ADMINISTRATION -> Declaration FINAL_APPROVED by SUPERVISOR	1 days
	Declaration FINAL_APPROVED by SUPERVISOR -> Request Payment	1 days
	Request Payment -> Payment Handled	3 days

Question 5. *Where are the bottlenecks in the process of a travel declaration?*

In analyzing the process of a travel declaration, we found that one of the bottlenecks in the process is the filing of a declaration by a staff member after the end of a trip, the average time for this step is 11 days.

Start of a transition	End of a transition	Count	Percentage of transitions	Recycle	Minimum transition time	Maximum transition time	Average transition time
End trip	Declaration SUBMITTED by EMPLOYEE	4268	0,604	0,946	2H 39MIN 24SEC	295DAY 19H 24MIN 20SEC	11DAY 13H 28SEC

Question 6. *Where are the bottlenecks in the process of a travel permit (note that there can be multiple requests for payment and declarations per permit)?*

Having analyzed the process of obtaining a travel permit, we found that 274 travel requests were edited, while the adjustment takes from 1 minute to 3.5 days.

Start of a transition	End of a transition	Count	Percentage of transitions	Recycle	Minimum transition time	Maximum transition time	Average transition time
Permit REJECTED by ADMINISTRATION	Request For Payment SUBMITTED by EMPLOYEE	3	0,022	0,999	23MIN 5SEC	2H 29MIN 28SEC	1H 11MIN 34SEC
Permit REJECTED by MISSING	Permit SUBMITTED by EMPLOYEE	18	0,216	0,999	2MIN 15SEC	80DAY 5H 32MIN 1SEC	10DAY 8H 27MIN 18SEC
Permit REJECTED by EMPLOYEE	Permit SUBMITTED by EMPLOYEE	248	0,718	0,996	41SEC	98DAY 2H 38MIN 23SEC	3DAY 19H 1MIN 31SEC
Permit REJECTED by SUPERVISOR	Permit SUBMITTED by EMPLOYEE	1	0,008	0,999	6H 24MIN 50SEC	6H 24MIN 50SEC	6H 24MIN 50SEC
Permit REJECTED by ADMINISTRATION	Permit SUBMITTED by EMPLOYEE	1	0,007	0,999	22H 22MIN 13SEC	22H 22MIN 13SEC	22H 22MIN 13SEC
Permit REJECTED by SUPERVISOR	Request For Payment SUBMITTED by EMPLOYEE	2	0,016	0,999	3DAY 7H 50MIN 20SEC	5DAY 5H 28MIN 9SEC	4DAY 6H 39MIN 14SEC
Permit REJECTED by BUDGET OWNER	Request For Payment SUBMITTED by EMPLOYEE	1	0,018	0,999	21H 25MIN 42SEC	21H 25MIN 42SEC	21H 25MIN 42SEC

Having analyzed the process of obtaining travel permit, we found out that 211 applications for advance payment were edited, and it takes from 1 minute to 2.5 days for the employee to make corrections.

Start of a transition	End of a transition	Count	Percentage of transitions	Recycle	Minimum transition time	Maximum transition time	Average transition time
Request For Payment REJECTED by PRE_APPROVER	Request For Payment SUBMITTED by EMPLOYEE	6	0,352	0,999	1MIN 30SEC	3DAY 19H 19MIN 17SEC	15H 19MIN 53SEC
Request For Payment REJECTED by MISSING	Declaration SUBMITTED by EMPLOYEE	1	0,142	0,999	1DAY 2MIN 49SEC	1DAY 2MIN 49SEC	1DAY 2MIN 49SEC
Request For Payment REJECTED by ADMINISTRATION	Request For Payment SUBMITTED by EMPLOYEE	15	0,075	0,999	2MIN 36SEC	9DAY 23H 34MIN 5SEC	1DAY 18H 52MIN 15SEC
Request For Payment REJECTED by ADMINISTRATION	Declaration SUBMITTED by EMPLOYEE	1	0,005	0,999	5MIN 12SEC	5MIN 12SEC	5MIN 12SEC

Request For Payment REJECTED by EMPLOYEE	Permit SUBMITTED by EMPLOYEE	1	0,004	0,999	2DAY 8H 22MIN 24SEC	2DAY 8H 22MIN 24SEC	2DAY 8H 22MIN 24SEC
Request For Payment REJECTED by EMPLOYEE	Request For Payment SUBMITTED by EMPLOYEE	164	0,694	0,997	40SEC	33DAY 1H 6MIN 56SEC	2DAY 26MIN 32SEC
Request For Payment REJECTED by MISSING	Request For Payment SUBMITTED by EMPLOYEE	5	0,714	0,999	11MIN 51SEC	7DAY 6H 54MIN 11SEC	4DAY 14MIN 57SEC
Request For Payment REJECTED by SUPERVISOR	Request For Payment SUBMITTED by EMPLOYEE	1	0,05	0,999	8MIN 35SEC	8MIN 35SEC	8MIN 35SEC
Request For Payment REJECTED by EMPLOYEE	Declaration SUBMITTED by EMPLOYEE	15	0,063	0,999	10MIN 44SEC	10DAY 10MIN 17SEC	1DAY 20H 28MIN 1SEC
Request For Payment REJECTED by SUPERVISOR	Declaration SUBMITTED by EMPLOYEE	2	0,1	0,999	23H 20MIN 20SEC	9DAY 16MIN 19SEC	4DAY 23H 48MIN 19SEC

Question 7. *How many travel declarations get rejected in the various processing steps and how many are never approved?*

We consider declarations that have a stage containing the word “rejected” in field «concept:name». Using the mining process, we build a graph and count the number of transitions from all stages containing the word “rejected”.

Domestic Declaration

Start of a transition	Count
Declaration REJECTED by SUPERVISOR	2
Declaration REJECTED by SUPERVISOR	1
Declaration REJECTED by EMPLOYEE	1081
Declaration REJECTED by BUDGET OWNER	58
Declaration REJECTED by PRE_APPROVER	85
Declaration REJECTED by BUDGET OWNER	1
Declaration REJECTED by MISSING	61
Declaration REJECTED by PRE_APPROVER	1
Declaration REJECTED by ADMINISTRATION	19
Declaration REJECTED by ADMINISTRATION	928
Declaration REJECTED by SUPERVISOR	286

International Declaration

Start of a transition	Count
Declaration REJECTED by BUDGET OWNER	1
Declaration REJECTED by MISSING	86
Declaration REJECTED by ADMINISTRATION	9
Declaration REJECTED by EMPLOYEE	1
Declaration REJECTED by EMPLOYEE	1601
Declaration REJECTED by BUDGET OWNER	39
Declaration REJECTED by PRE_APPROVER	82
Declaration REJECTED by MISSING	1
Declaration REJECTED by ADMINISTRATION	24

Declaration REJECTED by ADMINISTRATION	1510
Declaration REJECTED by SUPERVISOR	120
Declaration REJECTED by SUPERVISOR	3
Declaration REJECTED by ADMINISTRATION	6
Declaration REJECTED by SUPERVISOR	2
Declaration REJECTED by MISSING	3
Declaration REJECTED by MISSING	2
Declaration REJECTED by EMPLOYEE	36
Declaration REJECTED by EMPLOYEE	2
Declaration REJECTED by EMPLOYEE	10
Declaration REJECTED by PRE APPROVER	1
Declaration REJECTED by PRE APPROVER	1
Declaration REJECTED by DIRECTOR	4

We define a set of approved declarations, that is, those declarations that have the 'Declaration FINAL_APPROVED by SUPERVISOR' stage. Among all declarations, we define those that do not belong to the set of approved declarations. Consider the number of them.

Never approved:

Domestic Declaration

Total number of processes	429
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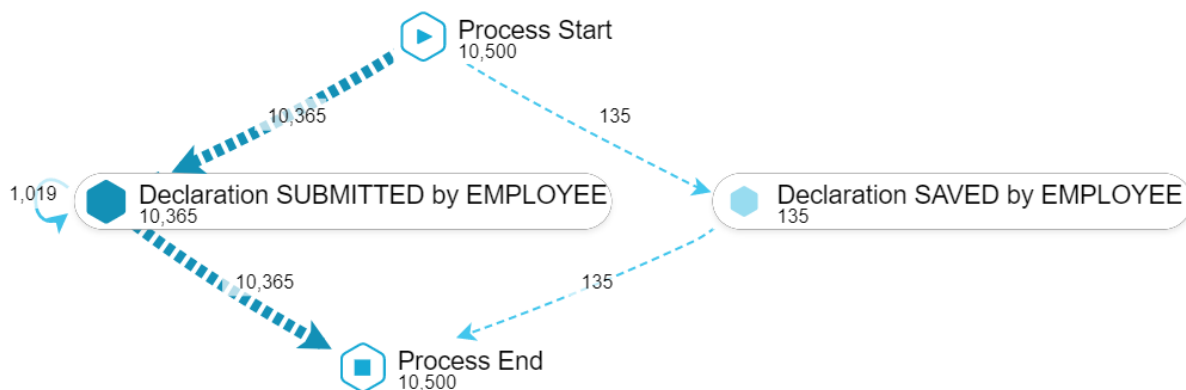
International Declaration

Total number of processes	488
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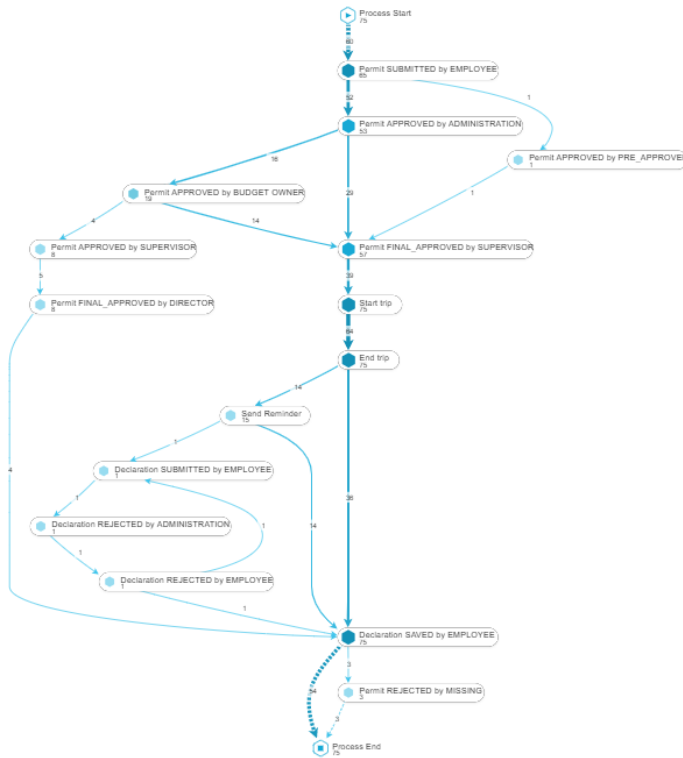
3.2 Detailed questions

Question 1. *How many travel declarations are booked on projects?*

135 Domestic Declarations:



75 International Declarations:



Question 2. How many corrections have been made for declarations?

Having analyzed all the declarations which have not passed any stage of coordination, we have revealed 1758 declarations which after editing have been agreed.

1758 declarations were corrected

Start of a transition	End of a transition	Count	Percentage of transitions	Recycle	Minimum transition time	Maximum transition time	Average transition time
Declaration REJECTED by BUDGET OWNER	Declaration SUBMITTED by EMPLOYEE	1	0,025	0,999	3DAY 22H 29MIN 32SEC	3DAY 22H 29MIN 32SEC	3DAY 22H 29MIN 32SEC
Declaration REJECTED by MISSING	Declaration SUBMITTED by EMPLOYEE	87	0,906	0,998	3MIN 27SEC	156DAY 1H 23MIN 20SEC	6DAY 21H 20MIN 34SEC
Declaration REJECTED by EMPLOYEE	Declaration SUBMITTED by EMPLOYEE	1579	0,935	0,98	42SEC	91DAY 6H 6MIN 52SEC	2DAY 12H 34MIN 2SEC
Declaration REJECTED by SUPERVISOR	Declaration SUBMITTED by EMPLOYEE	5	0,043	0,999	2MIN 31SEC	13DAY 4H 51MIN 51SEC	2DAY 20H 56MIN 31SEC
Declaration REJECTED by ADMINISTRATION	Request For Payment SUBMITTED by EMPLOYEE	7	0,004	0,999	48SEC	5DAY 22H 10MIN 15SEC	1DAY 1H 57MIN 44SEC
Declaration REJECTED by ADMINISTRATION	Declaration SUBMITTED by EMPLOYEE	50	0,033	0,999	1MIN 3SEC	14DAY 22H 38MIN 4SEC	1DAY 14H 24MIN 23SEC
Declaration REJECTED by EMPLOYEE	Request For Payment SUBMITTED by EMPLOYEE	22	0,013	0,999	1MIN 29SEC	17DAY 22H 48MIN 13SEC	1DAY 11H 21MIN 52SEC
Declaration REJECTED by PRE_APPROVER	Declaration SUBMITTED by EMPLOYEE	4	0,051	0,999	13MIN 2SEC	5H 9MIN 49SEC	1H 42MIN 24SEC
Declaration REJECTED by MISSING	Request For Payment SUBMITTED by EMPLOYEE	3	0,031	0,999	40MIN 27SEC	9DAY 20H 59MIN 36SEC	3DAY 7H 32MIN 58SEC

Question 3. *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?*

We consider declarations that have a stage «End trip». Among these declarations, we find those that have stage «Declaration SUBMITTED by EMPLOYEE» and its date later than the date of stage «End trip». However, the interval between these dates is more than 60 days. Among these declarations, we define those that have a stage containing the word “rejected” and the date of this stage is later than the date of stage «Declaration SUBMITTED by EMPLOYEE». Using the mining process, we build a graph and count the number of transitions from all stages containing the word “rejected”.

Start of a transition	Count
Declaration REJECTED by MISSING	5
Declaration REJECTED by EMPLOYEE	125
Declaration REJECTED by ADMINISTRATION	4

Using table InternationalDeclarations_Cases\$, we define the relationship between declarations and organizational units. Repeat the previous study for each organizational unit.

Department	Count
organizational unit 65454	17
organizational unit 65455	12
organizational unit 65456	12
organizational unit 65457	7
organizational unit 65458	33
organizational unit 65459	10
organizational unit 65460	10
organizational unit 65461	1
organizational unit 65464	8
organizational unit 65466	19
organizational unit 65472	2
organizational unit 65480	1
organizational unit 65482	2

Conclusion

This report presented findings based on an analysis of reimbursement process at Eindhoven University of Technology.

References

1. TUE, <https://icpmconference.org/2020/bpi-challenge/>
2. Celonis, <http://www.celonis.com/>
3. Python, <https://www.python.org/>