Process mining on Reimbursement travel costs process of a Dutch Financial Institute

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Abstract. A clear understanding of the internal business processes of any company is the basis for their optimization and increasing the efficiency of the company as a whole. Process mining techniques provide insights into common flows of activities, detect deviations and compliance issues, and report process performance. In this work, we investigated reimbursement for travel and related expenses in the Dutch the Financial Institute (TU/e) based on the analysis of event logs via process mining methods. Using mainly Python programming language and PM4PY[1] library, as well as Disco[2], we identified a number of bottlenecks and deviations in the processes under study and made recommendations for their correction and optimization of the processes in general.

Keywords: Process Mining, Event logs, Reimbursement Process

1. Introduction

Process mining as a combination of methods and techniques of business process optimization is a continuously developing sphere, the aim of which is to revise overtly or covertly functioning business processes through developing efficient patterns and receiving appropriate recommendations for the improvement.

2 Overall understanding of the data and process.

2.1 Data understanding

The files contain data from 2017 (only two departments) and 2018 the full TU/e. 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.
The log files contain:

- Requests for Payment: 6,886 cases, 36,796 events
- Domestic Declarations: 10,500 cases, 56,437 events
- Prepaid Travel Cost: 2,099 cases, 18,246 events
- International Declarations: 6,449 cases, 72151 events
- Travel Permits (including all related events of relevant prepaid travel cost declarations and travel declarations): 7,065 cases, 86,581 events

In our work, we decided not to investigate the cases started in 2017, because it was a pilot process, which had been significantly changed and now it is not of considerable interest. As a result of selecting cases started in 2018 and completed no later than 2019, we examined the following data:

- Requests for Payment: 5,778 cases, 31,820 events
- Domestic Declarations: 8,260 cases, 46,375 events
- Prepaid Travel Cost: 1,776 cases, 15,804 events
- International Declarations: 4,951 cases, 57,896 events
- Travel Permits: 5,596 cases, 71,063 events

In addition, in order to avoid distortions in time statistics, we provided the time in 'time:timestamp' columns of each file referring to one time zone.
Also, for a more in-depth analysis of international declarations, we linked the International Declarations and Prepaid Travel Cost dataframes with PermitLog via pandas dataframes.

2.2 Process understanding

Domestic declarations

Based on the information provided by the organizers on the competition website[3], as well as on the basis of data analysis, we created graphs of ideal processes. For these purposes, using PM4PY library, we selected the most common event routes corresponding to the description on the competition website and our understanding of the process.
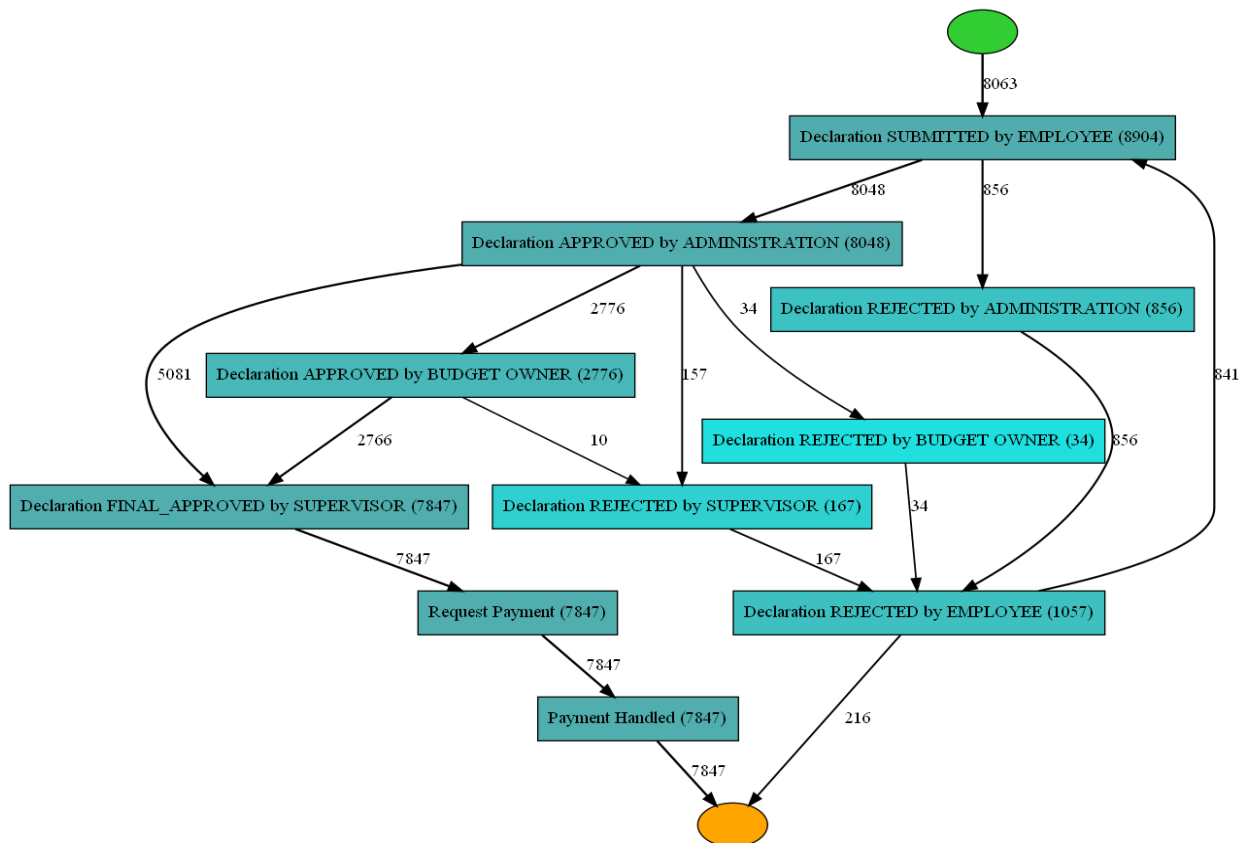

Fig.1. Reimbursement process graph for Domestic Declarations

After submission by the employee, the request is sent for approval to the travel administration. If approved, the request is then forwarded to the budget owner and after that to the supervisor. If the budget owner and supervisor are the same person, then only one of the these steps it taken. In all cases, a rejection leads to one of two outcomes. Either the employee resubmits the request, or the employee also rejects the request. If the approval flow has a positive result, the payment is requested and made.

International declarations

The reimbursement process for international declarations is much more complicated. The main difference is the need to obtain prior permission for an international business trip before it starts. The event log also shows the estimated start and end dates of the trip. In addition, in some cases, the director also needs to approve the request both for the business trip itself and for the declaration. If, after the end of the business trip, the employee has not submitted a declaration for reimbursement of expenses, then at the beginning of the second month after its end, the employee will be sent an automatic reminder - Send Reminder.

Below is a fragment of the process graph for international travel, reflecting the stage of obtaining prior permission for a business trip and sending a reminder to an employee after returning from a business trip. The process for filing and paying for international declarations themselves is generally similar to the process for domestic declarations, except that in some cases, the director also needs to approve the declaration.
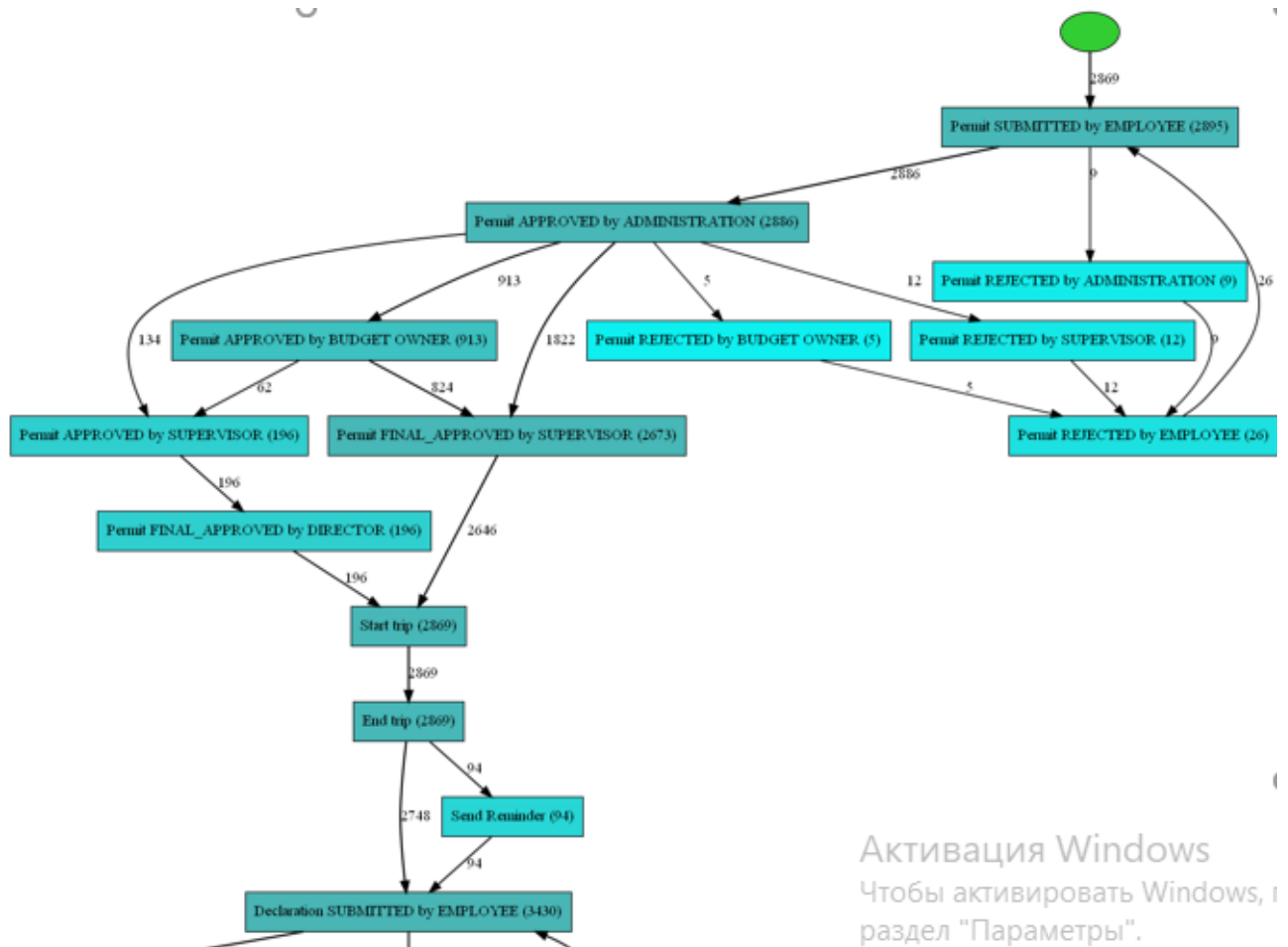
Fig.2. Fragment of the reimbursement process graph for International Declarations

Prepaid travel costs

As we understand, the reimbursement of prepaid travel costs process applies only to international travelers and is reflected in a separate event log. In general, this process is similar to the approval and reimbursement process for international travel, except that expenses are reimbursed before the trip starts, not after the trip, and there are no 'Srart Trip', 'End Trip' and 'Send Reminder' events. Instead of declaration, the request for payment form is filled in. Below is a graph of the prepaid travel cost reimbursement process.
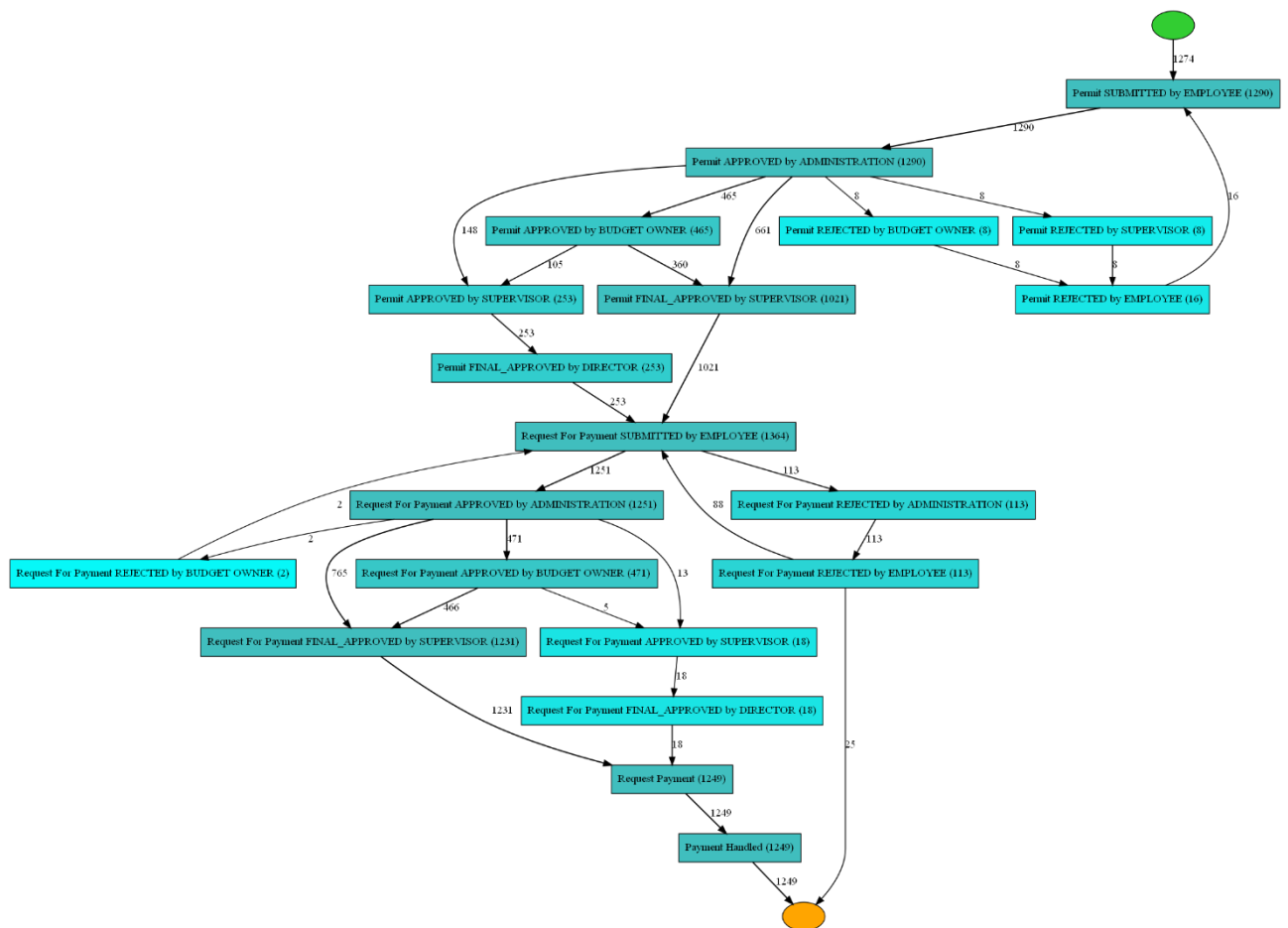
Fig.3. Graph of the prepaid travel cost reimbursement process.

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Requests For Payment

The Requests For Payment event log reflects expenses which should not be related to trips (such as representation costs, hardware purchased for work, etc.). In general, this process is similar to the reimbursement process for domestic declarations, except that in some cases, the director also needs to approve the requests for payment and instead of declaration, the request for payment form is filled out.
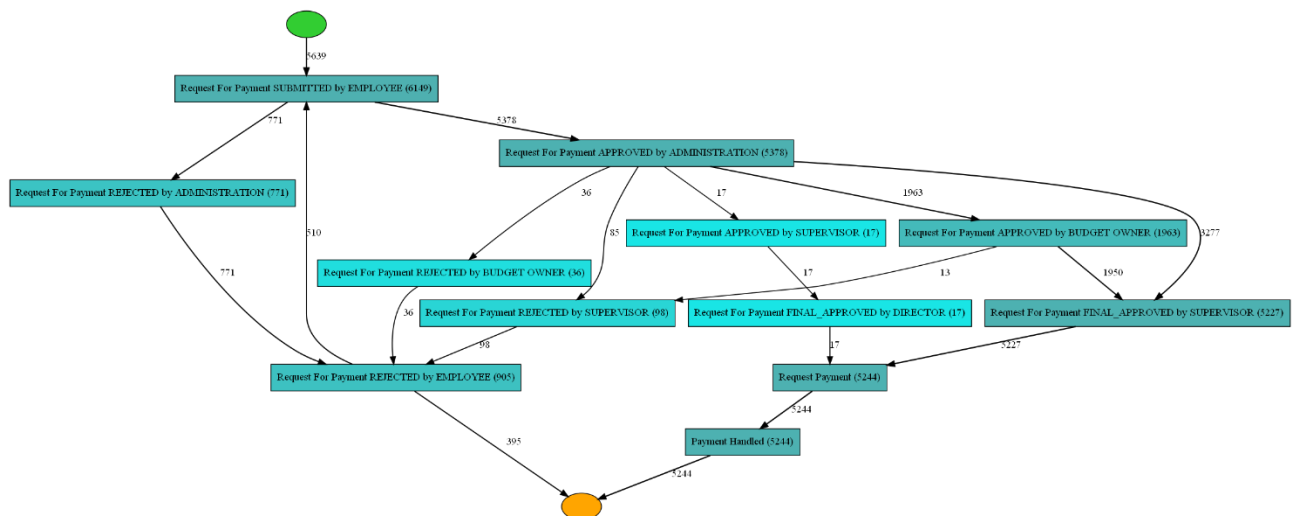

Fig.4. Graph of the Requests For Payment reimbursement process

Travel permits

The Permit log records prior international travel permits including all related events of relevant travel declarations and prepaid travel cost declarations.

A feature of the prior permission process is the ability to obtain one permission for a group business trip - multiple permission. As a result, one permit may include up to 17 travel declarations, the numbers of which are reflected in the columns 'case:dec_id_0' … 'case: dec_id_16', and up to 15 prepaid travel cost declarations, the numbers of which are reflected in the columns 'case:Rfp_id_0' … 'case:Rfp_id_14'.

In this regard, this log is the most complex and variable - it is possible to build 1114 unique routes using it. But getting the most preliminary permission is a rather simple procedure, which was reflected by us above in figure 2.

The figure to the right shows the ideal process for obtaining a prior permission and reimbursement of all associated costs. To build such a graph, we made a selection of permissions without reject events, which simultaneously include one travel declaration and one prepaid travel cost declarations. To reflect the consistent nature of prepaid travel and travel cost refunds, we renamed the 'Request Payment' and 'Payment Handled' event names to 'Request Payment (prepaid costs)' and 'Payment Handled (prepaid costs)' for prepaid travel costs refunds and to 'Request Payment (declaration)' and 'Payment Handled (declaration)' for travel declaration refunds.

As we can see, the process consists of three sequential stages:
- obtaining prior permission;
- reimbursement of prepaid travel costs before the start of a business trip;
- reimbursement of the remaining travel costs after the end of the business trip
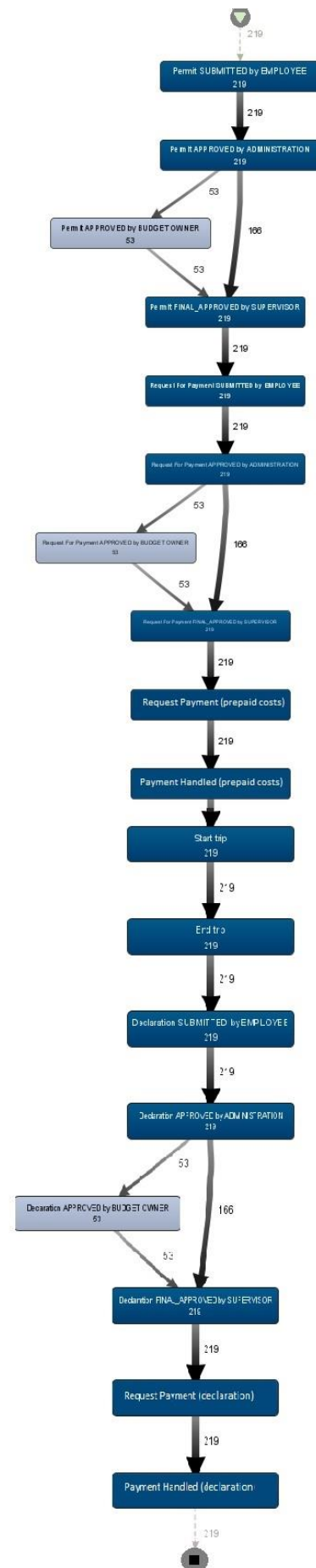
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Fig.5. Graph of the process of obtaining permission and reimbursing all travel costs

3. Our analysis

In our analysis we tried find answers of the questions organizers had prepared[3] and then we tried to obtain recommendations, which potentially would be useful for the TU/e.

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

For each of the four processes, we calculated two options for throughput from submission to paying:
1) full – for all cases, presented in the examined files
2) light – only for cases presented in the most common routes

Note: For ease of comparison and display, we give all throughput values in the tables in hours, however, when describing the results in the text, we sometimes convert hours into seconds, minutes and days.

Table 1. Throughput full version

Data				Throughput (hours)			
Name	cases	events	routes	mean	median	min	max
Requests for Payment	5,303	30,367	42	295.34	218.92	26.93	9743.83
Prepaid Travel Cost	1,687	15,285	118	252.66	214.96	28.37	2670.43
International Declarations	4,740	56,160	442	330.10	243.08	24.93	10298.71
Domestic Declarations	7,903	45,335	40	263.71	186.96	25.56	6981.73

Table 2. Throughput light version

Data				Throughput (hours)			
Name	cases	events	routes	mean	median	min	max
Requests for Payment	4,790	25,729	3	278,66	216,50	26.93	9743.83
Prepaid Travel Cost	1,106	9,896	4	239,49	192,68	28,37	1444,24
International Declarations	2,471	26,371	8	278.48	219.68	28.67	10298.71
Domestic Declarations	7,082	37,882	2	249.90	176.06	25.56	6981.73

As a result, the throughput for the most frequently encountered routes was found shorter in comparison to the full variant due to the exclusion of longer routes that are rarely found in the data. The biggest difference between throughput full and throughput light is noticeable for International Declarations.

It is also worth paying attention to the large scatter of throughputs due to the presence of cases of unusually lengthy approvals and payment of expenses - for example, for international declarations and Requests for Payments, the maximum terms for receiving refunds exceed one year.

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

From the table below it can be seen that the throughput of the domestic declarations is shorter than international flights by an average of almost 3 days when analyzed on complete data. When analyzed on the most common direct routes, the difference decreases and does not exceed one and a half days.

Table 3. Throughput for International and Domestic Declarations

Event Log	Throughput Full (hours)		Throughput Light (hours)	
	Mean	Median	Mean	Median
International Declarations	330.10	243.08	278.48	219.68
Domestic Declarations	263.71	186.96	249.90	176.06
Difference:	66.39	56.12	28.58	43.62

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

There are significant differences in throughput between cost centers. For example, the minimum average throughput of an international declaration from submission to paying is 78.7 hours for 'budget 15872' (column 'case:Permit BudgetNumber'), while the maximum is 2622.3 hours for 'budget 69085'. However, we believe such a comparison is not entirely correct due to the lack of representativeness of the data - both of these budgets have only one paid declaration. If we compare cost centers with at least 100 declarations for each budget, then the difference between the minimum and maximum average throughput value will not be so big - 228.8 hours for budget 635 and 409.6 hours for budget 522.

There are also significant differences in throughput between departments, presented in the following graph:
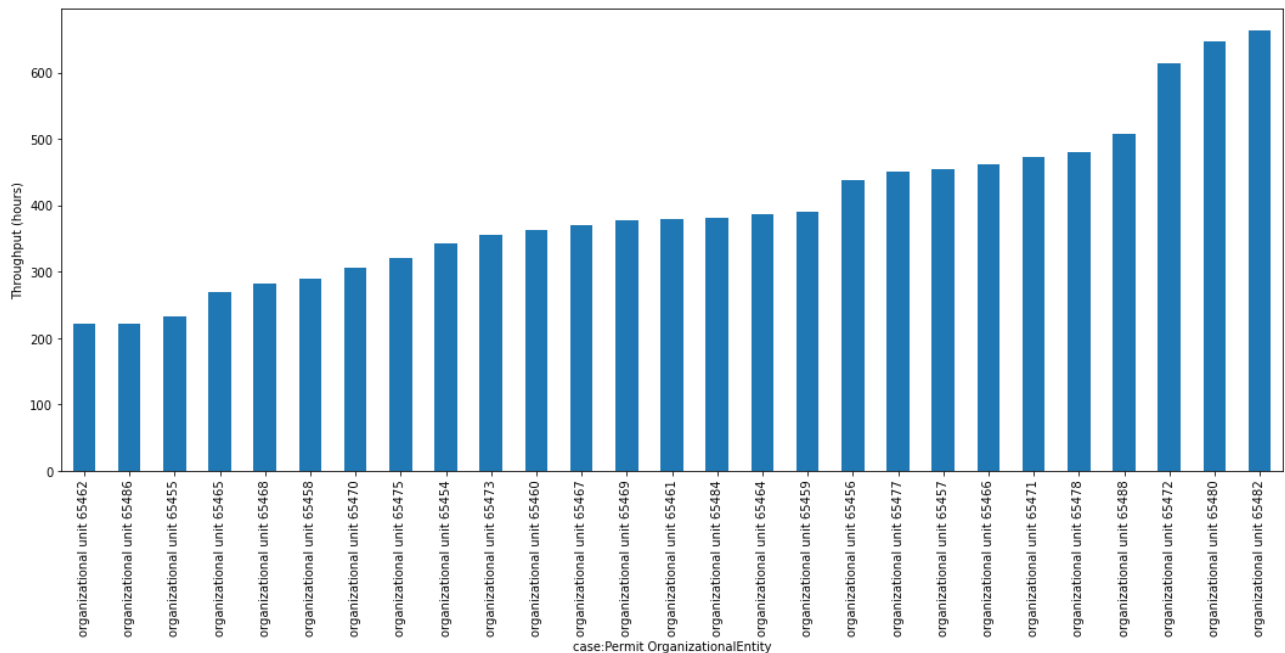

Fig.6. Differences of througput between departments

However, if we take more representative data - only those departments that account for at least 100 paid declarations, then the variability will decrease.
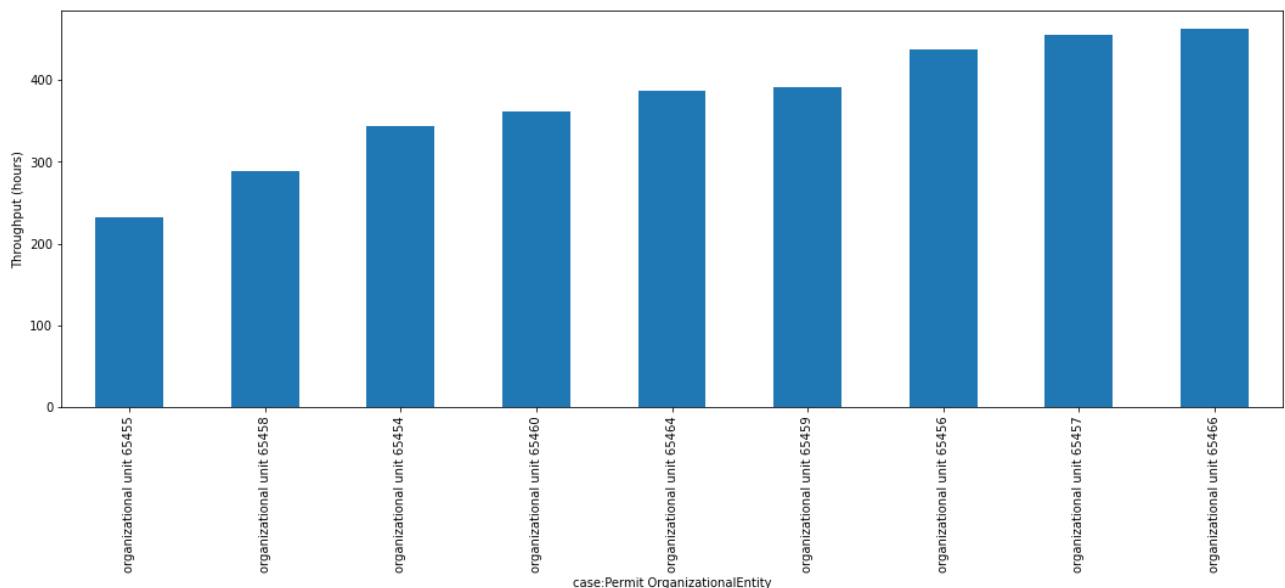

Fig.7. Differences of througput between departments (>100 cases per departments)

. For example, the minimum average throughput of an international declaration from submission to paying is 56.0 hour s for 'project 8136', the maximum is 5427.1 hours for 'project 13332'. This is due to the large number of unique values fo r the column ' - 738, as well as with a large number of cases outside projects ('UNCNOWN') – 1810. As a result, the remaining projects have no more than 26 cases per project (except for the special 'project 426' - the analysis of which is given in paragraph 3.11).

We did not do a cluster analysis of domestic declarations due to the absence of fields in the event log for fixi ng the numbers of departments and projects, as well as the presence of only one budget number for all declarations - 'bu dget 86566'

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

In order to take into account all types of process steps here, we calculated throughput for full data versions.
Appendix 1 to the report contains detailed calculations of throughput timing for each process steps, including re ject events for all responsible roles. Aggregated calculations by various responsible roles are presented here.

Table 4. Throughput in process steps on Domestic Declarations

Start events	End event	Min	Max	Mean	Median
Declaration SUBMITTED by EMPLOYEE	JUDGEMENT by ADMINISTRATION	0.000278	11261.67	60.06	0.0225
Declaration APPROVED by ADMINISTRATION	JUDGEMENT by BUDGET OWNER	0.00500	3407.13	51.35	21.29
Declaration APPROVED by ADMINISTRATION/BUDGET OWNER	JUDGEMENT by SUPERVISOR	0.00361	2043.079	57.86	24.86
Declaration REJECTED by SUPERVISOR/ ADMINISTRATION/BUDGET OWNER	Declaration REJECTED by EMPLOYEE	0.020	3671.20	72.50	23.96
Declaration FINAL_APPROVED by SUPERVISOR	Request Payment	0,00	2540.44	68.21	25.43
Request Payment	Payment Handled	2.3183	1491.48	82.81	77.13

Table 5. Throughput in process steps on International Declarations

Start event	End event	Min	Max	Mean	Median
Permit SUBMITTED by EMPLOYEE	Judgement by ADMINISTRATION	0.000278	4655.15	14.11	0.00139
Permit APPROVED by ADMINISTRATION	Judgement by BUDGET OWNER	0.0122	997.31	50.01	22.20
Permit APPROVED by ADMINISTRATION/ BUDGET OWNER	Judgement by SUPERVISOR	0.0050	1485.02	62.65	30.18
Permit APPROVED by SUPERVISOR	Judgement by DIRECTOR	0.00	1054.02	66.64	23.87
Permit REJECTED by SUPERVISOR/ ADMINISTRATION/ BUDGET OWNER/DIRECTOR	Permit REJECTED by EMPLOYEE	0.03361	686.39	54.13	24.30
Declaration SUBMITTED by EMPLOYEE	Judgement by ADMINISTRATION	0.000278	10128.10	80.15	0.18056
Declaration APPROVED by ADMINISTRATION	Judgement by BUDGET OWNER	0.00472	1339.55	79.16	27.92
Declaration APPROVED by ADMINISTRATION/ BUDGET OWNER	Judgement by SUPERVISOR	0.00639	2036.60	77.00	41.97
Declaration APPROVED by SUPERVISOR	Judgement by DIRECTOR	0.24306	521.87	62.96	24.94
Declaration REJECTED by SUPERVISOR/ ADMINISTRATION/ DIRECTOR/ BUDGET OWNER	Declaration REJECTED by EMPLOYEE	0.01222	2873.93	94.60	45.83
Declaration FINAL_APPROVED by SUPERVISOR/DIRECTOR	Request Payment	0.00	6386.37	68.06	25.66
Request Payment	Payment Handled	0.659	697.46	81.97	77.63

Table 6. Throughput in process steps on Prepaid Travel Cost

Start event	End event	Min	Max	Mean	*Median*
Permit SUBMITTED by EMPLOYEE	Judgement by ADMINISTRATION	0.000278	1318.87	12.65	0.00556
Permit APPROVED by ADMINISTRATION	Judgement by BUDGET OWNER	0.01167	695.86	56.17	24.73
Permit APPROVED by ADMINISTRATION/ BUDGET OWNER	Judgement by SUPERVISOR	0.01778	790.81	64.11	28.98
Permit APPROVED by SUPERVISOR	Judgement by DIRECTOR	0.00	1054.0	71.96	24.14
Permit REJECTED by SUPERVISOR/ ADMINISTRATION/ BUDGET OWNER	Permit REJECTED by EMPLOYEE	0.3511	667.82	79.08	34.41
Request For Payment SUBMITTED by EMPLOYEE	Judgement by ADMINISTRATION	0.000278	7247.59	26.29	0.0100
Request For Payment APPROVED by ADMINISTRATION	Judgement by BUDGET OWNER	0.04139	767.01	51.94	24.54
Request For Payment APPROVED by ADMINISTRATION/BUDGET OWNER	Judgement by SUPERVISOR	0.01194	890.12	60.27	27.65
Request For Payment APPROVED by SUPERVISOR	Judgement by DIRECTOR	1.540	190.95	67.51	46.67
Request For Payment REJECTED by SUPERVISOR/ ADMINISTRATION/ BUDGET OWNER	Request For Payment REJECTED by EMPLOYEE	0.14722	1032.83	74.02	40.28
Request For Payment FINAL_APPROVED by SUPERVISOR/DIRECTOR	Request Payment	0.00	1177.57	68.47	25.63
Request Payment	Payment Handled	24.43	659.25	85.57	79.80

Table 7. Throughput in process steps on Requests For Payment

Start event	End event	Min	Max	Mean	Median
Request For Payment SUBMITTED by EMPLOYEE	Judgement by ADMINISTRATION	0.000278	9550.74	36.88	0.00667
Request For Payment APPROVED by ADMINISTRATION	Judgement by BUDGET OWNER	0.006111	4724.82	73.57	26.11
Request For Payment APPROVED by ADMINISTRATION/BUDGET OWNER	Judgement by SUPERVISOR	0.01472	8238.96	75.92	41.15
Request For Payment APPROVED by SUPERVISOR	Judgement by DIRECTOR	0.62139	365.38	67.71	45.99
Request For Payment REJECTED by SUPERVISOR/ ADMINISTRATION/ BUDGET OWNER	Request For Payment REJECTED by EMPLOYEE	0.03639	1577.45	81.27	36.58
Request For Payment FINAL_APPROVED by SUPERVISOR/DIRECTOR	Request Payment	0.00	2337.18	83.09	28.07
Request Payment	Payment Handled	0.3350	1491.49	84.23	77.23

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

In general, the analysis of the data given in paragraph 3.4 and in Appendix 1 shows that the document flow in the TU/e is not completely electronic - most likely documents between departments and participants in the process are transferred in paper form, and only the results of the analysis are recorded in the database. For example, if there was an electronic document flow, then the throughput at the Declaration FINAL_APPROVED by SUPERVISOR / DIRECTOR and Request Payment step would be much shorter than now (almost 3 days for all types of declarations).

In this regard, **we recommend** to consider the possibility of introducing a full electronic document flow in the process of agreeing on travel declarations based on electronic copies of documents, and leaving paper document flow only at the last stage - the employee sends the original documents to the accounting department on paper only after they have been fully agreed (for example , this procedure for electronic document management operates in our organization).

We also noticed that the path takes much longer when SUPERVISOR and BUDGET OWNER have different faces. For example, the average time between the submission of the declaration and its final approval by the Supervisor for the most common direct route without BUDGET_OWNER in the international declarations of 2018 (1369 cases) is 118.3 hours, and for the most common route with BUDGET_OWNER (624 cases) is 188.6 hours. Likewise, for domestic declarations - 76.57 hours without the BUDGET OWNER (4610 cases) and 141.01 hours - from the BUDGET OWNER (2472 cases). There are no significant differences between the domestic and international declarations in the proportion of paid declarations agreed with the participation of the BUDGET OWNER in the total number of approved declarations. The share of paid international declarations agreed with the participation of the BUDGET OWNER is 37.3%, the share of paid domestic declarations is 35.4%. Due to the fact that routes with participation of BUDGET_OWNER account for more than 1/3 of all routes, the participation of the Budget owner has a significant impact on the average throughput. In this regard, **we offer** the possibility of additional delegates to the Supervisors of the BUDGET OWNER functions compared to the existing one.

Likewise, a significantly longer an approval path takes the path involving the Director for international declarations and requests for payments. However, due to the fact that the Director is involved in the approval of a relatively small number of international declarations (3.1%), prepaid travel costs (1.9%) and requests for payments (0.5%), his influence on the average throughput is insignificant.

Also, the payment procedure in the system is quite lengthy - more than 3 days. We wondered why it takes so long for the payment to take place if the Request Payment and Payment Handled events are systemic, i.e. without human intervention.

We found that the event Payment the Handled are mainly (99.4% of all payments) done in the system only on Thursdays (57.2) and Mondays (42.2%) at about 17:31 local time (domestic declarations are paid one second earlier than international and two - than Request For Payments). But this does not fully explain the lengthy throughput in the system, including the presence of a sufficiently large number of cases (555) with a duration between Request Payment and Payment Handled for more than a week. Perhaps the system has some kind of limitation that is not / is not reflected explicitly in the event logs?

Grouped all Payment Handled events by payment dates with a duration from Request Payment of more than one week (more than two weeks for December 2018, since in the last decade of December payments were not processed), we found that most of them (91.54%) were processed only on 4 dates (2019-01-03 - 36.9%, 2018-04-05 - 26.7%, 2018-05-14 - 11.5%, 2018-05-24 - 16.4%)

Grouped all events Payment Handled with duration of the Request Payment more than one week by date of payment, we found that most of them (90%) is paid only on 4 dates (2019-01-03 - 36.9%, 2018-04-05 - 26.7%, 2018-05-14 - 11.5%, 2018-05-24 - 16.4%)

Table 8. Grouping by date of Payment Handled event with a duration of more than 7 days

Date	Number of Payment handled in:				Total number	% of all
	International delcaration	Prepaid travel cost	Domestic declarations	Requests for payment		
2018-04-05	33	16	62	37	148	26.67%
2018-05-14	18	8	20	18	64	11.53%
2018-05-24	25	9	35	22	91	16.40%
2019-01-03	42	11	89	63	205	36.94%
Another date	6	6	18	17	47	8.47%
Total	124	50	224	157	555	100.0%

From this, we concluded that most likely there were budget constraints that did not allow payment of all declaration documents on time, which resulted in the fact that they were paid only after the appearance of budget allocations at the beginning of the year / second quarter. In this regard, we recommend introducing / improving the travel planning procedure in TU / e , which provides, inter alia, the availability of reserves for unplanned travel, as well as the possibility of inter-budgetary reallocations at the end of the quarter (if this is not possible now).

In addition, we drew attention to a significant difference between the median and average values at the stage of approval of the declaration by Administration - more than half of domestic declarations are approved within one minute, while the average time is more than a day. Perhaps this is due to the fact that Employee and Administration in these cases are one and the same person, or most of the declarations are completed and entered into the system not by the Employees themselves, but by mandated persons who are also entrusted with the functions of Administration. The analysis of this hypothesis is given below in paragraph 3.12.

We also analyzed the data for deviations from the ideal process flow. We found that in 17 cases the 'Payment Handled' event was started without a preliminary 'Request Payment':

- Domestic Declarations – declarations 115669, 124535, 136996, 138147, 138710, 141310, 142992,
- International Declarations – declarations 12674, 36423, 66423, 70444;
- Prepaid Travel Cost – request for payment 186345;
- Request For Payment - request for payment 164816, 174306, 176718, 181880, 183480.

At the same time, prior permission was not received for Prepaid Travel Cost 186345

In addition, we found that 6 times the 'Payment Handled' event occurred before the 'Request Payment'

Table 9. 'Payment Handled' before 'Request Payment'

Event log	case:concept:name	Request Payment time:timestamp	Payment Handled time:timestamp
PrepaidTravelCost	request for payment 186113	28.11.2018 12:23	27.11.2018 17:31
InternationalDeclarations	declaration 145798	18.05.2018 7:51	17.05.2018 17:31
InternationalDeclarations	declaration 146418	18.05.2018 7:49	17.05.2018 17:31
InternationalDeclarations	declaration 16408	16.10.2018 15:42	12.10.2018 17:31
RequestForPayment	request for payment 178808	19.12.2018 15:01	18.12.2018 17:31
RequestForPayment	request for payment 184376	21.12.2018 12:45	26.11.2018 17:31

We also found 3 cases when the 'Permit FINAL_APPROVED by DIRECTOR' event was registered in the Travel Permits log earlier than 'Permit APPROVED by SUPERVISOR'. But at the same time, the values of time:timestamp' are the same. Thus, at the same time SUPERVISOR agreed and DIRECTOR approved the same permission.

Table 10. 'Permit FINAL_APPROVED by DIRECTOR' before 'Permit APPROVED by SUPERVISOR'

case:concept:name	Permit FINAL_APPROVED by DIRECTOR time:timestamp	Permit APPROVED by SUPERVISOR time:timestamp	case:OrganizationalEntity	case:Budget Number
travel permit 3457	08.02.2018 11:55:45	08.02.2018 11:55:45	organizational unit 65454	budget 1755
travel permit 42621	08.02.2018 11:55:18	08.02.2018 11:55:18	organizational unit 65454	budget 1755
travel permit 7297	19.01.2018 16:04:49	19.01.2018 16:04:49	organizational unit 65454	budget 1755

It is worth noting that 'case:OrganizationalEntity' and 'case:BudgetNumber' are the same in all three cases.

In this regard, **we recommend** recheck all three types of the above deviations, as well as consider the possibility of introducing the automatic detection of such deviations into the automated system.

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

Due to the fact that in addition to the procedure for obtaining prior permission for a business trip, the Permit Log also reflects all procedures for coordinating and paying for international declarations and prepaid travel costs, as well as due to the presence of mulitple requests, this log in its original form is inconvenient for analysis. To solve this problem, we made a selection from the Permit Log, in which we left only the events related to the prior permission. As a result, the number of unique routes in the cleared log was reduced from 1114 to 38.

In addition, for the convenience of analyzing mulitple requests, we added two columns to the log, which reflect the number of travel declarations and prepaid travel costs associated with each permit.

Among the 5,596 unique permissions, there are no declaration numbers or payment requests in 1084 unique permissions. Within 4512 remaining approvals, 3279 approvals were given for single payment declarations and 143 - for one of prepaid travel power costs. The rest of the permits were given simultaneously either for several declarations, or for various combinations of declarations and requests for prepaid travel costs. The maximum number of declarations per one permit is 14 (traveler permit 53343), requests for prepaid traveler costs is 15 (traveler permit 22776).

Analysis of the throughput of a permit from submission to final approved by Supervosor or Director showed an even greater increase in throughput in the case of participation in the BUDGET OWNER process than for travel declarations. For example, the average time between the submission of a permit and its final approval by the Supervisor for the most common direct route without BUDGET_OWNER (3140 cases) is 61.8 hours, but for the most common route with BUDGET_OWNER (1706 cases) - 138.1 hours. The share of cases with BUDGET_OWNER in the total is 36.2%.

A more detailed analysis of these paths shows that the increase in througput with the participation of the Budget Owner is not just due to the addition of another approver, but also due to a longer analysis by the Supervisor of documents received from BUDGET OWNER compared to the analysis time of documents from ADMINISTRATION. So, the throughput at the step from 'Permit APPROVED by BUDGET OWNER' to 'Permit FINAL_APPROVED by SUPERVISOR' exceeds by more than 1 day the throughput at the step from 'Permit APPROVED by ADMINISTRATION' to 'Permit FINAL_APPROVED by SUPERVISOR'.

Table 11. Difference in throughput between steps

Start event	End event	Mean	Median
Permit APPROVED by BUDGET OWNER	Permit FINAL_APPROVED by SUPERVISOR	77.23	54.30
Permit APPROVED by ADMINISTRATION	Permit FINAL_APPROVED by SUPERVISOR	50.59	22.25
	Difference in hours	26.64	32.05
	Difference in %	52.7%	144.0%

In our opinion, this seems rather unusual, since when checking documents received directly from ADMINISTRATION, the supervisor combines the BUDGET OWNER function, which should take additional time to complete it. However, the opposite happens - performing SUPERVISOR with two functions - BUDGET OWNER and SUPERVISOR - takes less time than performing one SUPERVISOR function. Perhaps the reason is not in the duration of the function itself, but in the longer logistics of transferring documents from BUDGET OWNER to SUPERVISOR compared to transferring documents from ADMINISTRATION. In this regard, **we recommend** to find out the reason for the longer througput of a permit from BUDGET OWNER to SUPERVISOR in comparison with the througput from ADMINISTRATION to SUPERVISOR, and also consider the possibility of additional delegation of BUDGET OWNER functions to SUPERVISOR in comparison with the existing reality.

We also noted that of the 5177 requests that final approved by the Supervisor, 946 requests were finally approved only after the estimated start date of the trip ('Start trip'). At the same time, the throughput of the permits between the submission by Employee and its final approval by the Supervisor for these 946 requests was 126.3 hours, while the throughput among all 5177 request was 94.3 hours. Apparently, employees were forced to either postpone the dates of business trips relative to the planned ones or violate the rules established in ENU and go on a business trip before receiving prior permission, or even cancel the business trip. In 168 cases out of 946 of the above, neither declaration numbers nor prepaid travel costs were tied to permits, which may indicate that the business trip did not take place. In this regard, **we recommend** to provide for an expedited approval procedure in case of urgent business trips.

Also significantly increases the throughput in the final agreement the Director's participation. The throughput from submission by Employee to final approved by Director averages 192.1 hours, which is more than 2 times the throughput from submission by Employee to final approved by Supervisor, equal to 94.23 hours. The share of prior permission agreed with the Director's participation is 9.0% of all approvals.

We could not find in the data any factor that would determine the need for the Director to participate in the approval - neither any thresholds for the amount of the requested budget, nor any dependence on the department, project, cost center, etc., nor time dependence on days of the week, month, etc., nor on belonging to multiple requests.

Also, we did not find the dependence of the throughput from submission to final approved on belonging to the multiple requests.

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

Having analyzed available data, we received the following statistics on rejected declarations.

Table 12. Statistics on the number of declined declarations

.	Domestic declarations	International Declarations	Prepaid Travel Cost	Requests for Payment
Total declarations registered	8,260	4,951	1,776	5,778
Declaration submittde by EMPLOYEE	8,160	4,894	1,759	5,719
Get rejected by various responsible roles	1,072	1,351	234	917
Were not eventually approved	257	154	26	415
Rejected at checkout	0	0	0	0

Approvers reject 6.1% of applications for approval of home declarations (1229 out of 20132) and 12.6% - international ones (1651 out of 13,059). Most of the errors are detected at the first stage - when considering by Administration: 10.3% refer to home business trips (948 out of 9132) and 24% refer to international (1517 out of 6392) At the next stages of approval (Budget Owners, Supervisors), the percent of deviations drops to 2%, is the same for both types of declarations and is comparable to the percent of unapproved declarations - 3% (the same for both types of declarations). The Director rejected only 1 application out of 146. Thus, we concluded that most errors in the registration of declarations are correctable. More of them are allowed during processing international declarations. In the current process, errors are mostly identified at the first stage of the coordination and corrected. To reduce the number of corrections, **we propose** to conduct an analysis and rank errors made in the preparation of declarations. For the most common types of errors, **we propose** to make tooltips in the automated system or reminders.

3.8. How many travel declarations are booked on projects?

Among 4951 international declarations, 1898 are not tied to any project ('UNKNOWN'), the remaining 3053 declarations are tied to 737 projects, of which the largest number of declarations is tied to 'project 426' - 282.

Among 1776 prepaid travel cost 720 are not tied to any project ('UNKNOWN'), the remaining 1056 requests are tied to 361 projects, of which 'project 426' is also tied to the largest number of declarations - 72.

The analysis of international declarations and prepaid travels costs with 'project 426' is given in paragraph 3.11.

Of the 362 project numbers in prepaid travel costs, 349 are a subset of project numbers in International Declarations.

Among 5778 prepaid travel cost 433 are not tied to any project ('UNKNOWN'), the remaining 5345 requests are tied to 78 projects. Project numbers in request for payment do not overlap with project numbers in International Declarations and in Prepaid Travel Costs

3.9. How many corrections have been made for declarations?

1213 of 2894 submitted international declarations have corrections, which is approximately 24%. A total of 1502 fixes were made. Most of the changed declarations have no more than 1 correction, there are unique cases where there are 3 or 4 corrections.

848 of 8160 internal declarations have corrections, which is approximately 10%. A total of 979 corrections were made. Most of changed declaration have no more than 1 correction, there are a few cases where there are 4, 5 or 6 correction.
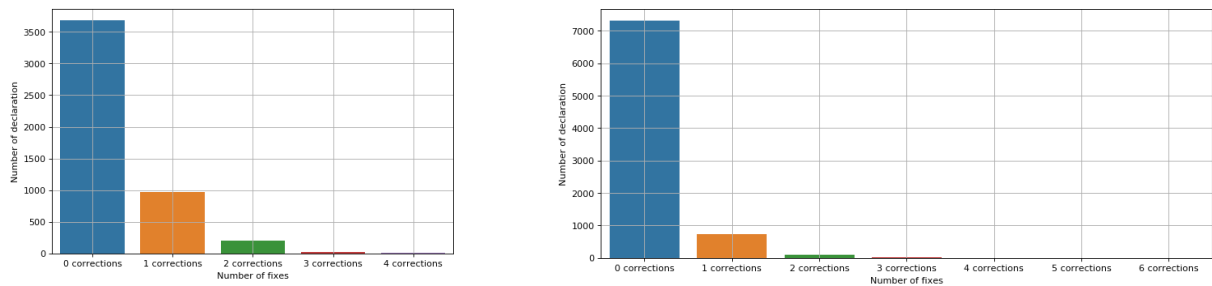
Fig. 8. Histograms of corrections in international and domestic declarations

3.10. Are there any double payments?

In the absence of data that allows identifying employees (for example, personnel number), it is problematic to accurately identify double payments, therefore, having analyzed the data, we can only make assumptions that require rechecking.

Among the multiple international declarations, there are three declarations for the same amount (declaration 45635, declaration 45633, declaration 45620) with one general travel permit 45618. The expected travel dates for all are set from 2018-04-03 to 2018-04-06. Declaration 45633 and declaration 45620 were generated and paid for within 1.5 months after the trip. But declaration 45635 was created and paid for 6 months after the end of the trip. At the same time, there is no the necessary in such cases Send Reminder in this declaration (should be sent no later than 2 months after the end of the business trip in the absence of a declaration). We assume that there was a double payment here, but this needs to be rechecked.

According to national declarations, we assume 2 cases of double payments:

1) The employee at the same time created 3 declarations for the same amount - declaration 120124, declaration 120129, declaration 120119, which were subsequently paid.

2) At the same time, the employee created 2 declarations for the same amount - declaration 140777, declaration 140785, which were subsequently paid.

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

Out of 4951 international declarations registered after 01.01.2018, 266 (5%) lack travel permits. Of these, 250 declarations have been approved and paid for. The rest were rejected at various stages. All these declarations are issued by one department "65454", as the permit number in the column 'case: Permit id', all of them have 'travel permit 423' and they all refer to one project 'project 426'. We believe that for all 266 declarations this permit number is indicated fictitiously, because:

266 (5%) of 4951 international declarations registered after 01.01.2018 lack travel permits. 250 of these declarations have been approved and paid for. The rest were rejected at various stages. All these declarations are issued by one department "65454", as the number of the permit they all have " travel permit 423" and they all refer to one project 'project 426'. We believe that for all 266 declarations this permit number is indicated fictitiously, because:

- in the Travel Permits log only one declaration is tied to it – 'declaration 428', which is not included in these 266 declarations;
- 169 of them were paid before the only permit was agreed with the 'travel permit 423' (2018-03-12 05:15:50);
- 205 declarations were paid before the start of the trip ('Payment Handled' before 'Start trip');
- 2 declarations (declaration 145798, declaration 146418) were paid before the request for payment - 'Payment Handled' before 'Request Payment';
- out of 4951 cases of 2018 in the International Declarations event log, only these 266 declarations have different values in the 'case: Permit id' and 'case: Permit ID' columns.

It is worth noting that back in 2017, 182 similar suspicious declarations were registered with 'travel permit 423' in the 'case:Permit id' column.

In this regard, **we propose** to check the validity of payment for international declarations, for which 'case:Permit id' = 'travel permit 423'.

In addition, according to 461 other international declarations, a travel permit was requested by employees after the planned start date of the trip and another 76 - on the day of the trip, which may also indicate a violation of the rules

established in the TU /e. We assume that in this case, the permit was actually received after the start of the business trip, because otherwise, the employee would indicate the start date of the trip no earlier than the current date.

We also checked the availability of travel permits for Prepaid Travel Cost. 218 documents were entered without travel permits, 190 of them were paid. At the same time, 72 documents indicate 'travel permit 423' as the permit number, similarly to International Declarations, and 'UNKNOWN' for the rest.

In this regard, **we propose** to check the validity of prepaid travel costs that do not have a travel permit.

3.12. How many travel declarations are submitted by the traveler and how many by a mandated person?

As indicated in paragraph 3.6 we noticed a significant difference between the median and average values at the stage of approval declaration by the Administration - more than half of domestic declarations are agreed within one minute, while the average time is almost two days. Similarly, for international declarations, more than half are agreed within 10 minutes, while the average time is more than 3 days. We assume that one of the explanations for this is the presence in most departments of authorized persons (for example, secretaries / assistant managers) who are entrusted with the functions of processing and filing declarations in the automated system on the basis of documents provided by Employees of this department. Also, these authorized persons are delegated the right to approve employee declarations (Administration role). Thus, after entering the declaration system, this employee has the opportunity to immediately approve them, as is the case in most cases. Unfortunately, after examining the histograms of the distribution of the throughput between submission by Employee and approved by Administration (values below the median) presented below, we did not identify any explicit thresholds that would unambiguously divide the declarations into two parts - provided by the employee himself or by an authorized person. But we assume that, at least, almost all declarations approved by the Administration no later than 20 seconds from the moment of their submission are made by a mandated person. Such declarations among domestic - 3514, international - 1502, prepaid travel cost - 756, among requests for payments – 2710.

3.13. 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 assume that 5 from 173 international declarations, submitted by an employee of more than 2 months after the end of the trip, were rejected and then re-created with a different number and paid:
- Declaration 2035 -> Declaration 2036
- Declaration 68296 -> Declaration 68297
- Declaration 33106 -> Declaration 33104
- Declaration 67992 -> Declaration 67993
- Declaration 147106 -> Declaration 146743

These pairs of declarations completely correspond to each other in terms of the 'Start of the trip' and 'End of the trip' time, as well as the values in the fields: 'id', 'case:Permit travel permit number', 'case:Pemit TaskNumber', 'case: Permit Budget Number', 'case: Permit Project Number', 'case:Permit Organizational Entity', 'case:travel permit number', 'case: Permit Requested Budget', 'case: Permit ID', 'case: Budget Number'.

3.14. Is this different between departments?

We did not find any difference between the departments for the declarations specified in 3.13. All 5 declarations were filed by employees of different departments.

We also analyzed all departments by the number of trips and the total cost.

As we can see from the charts below, employees of about 10 departments are mainly sent on international business trips. These same departments account for most of all costs.
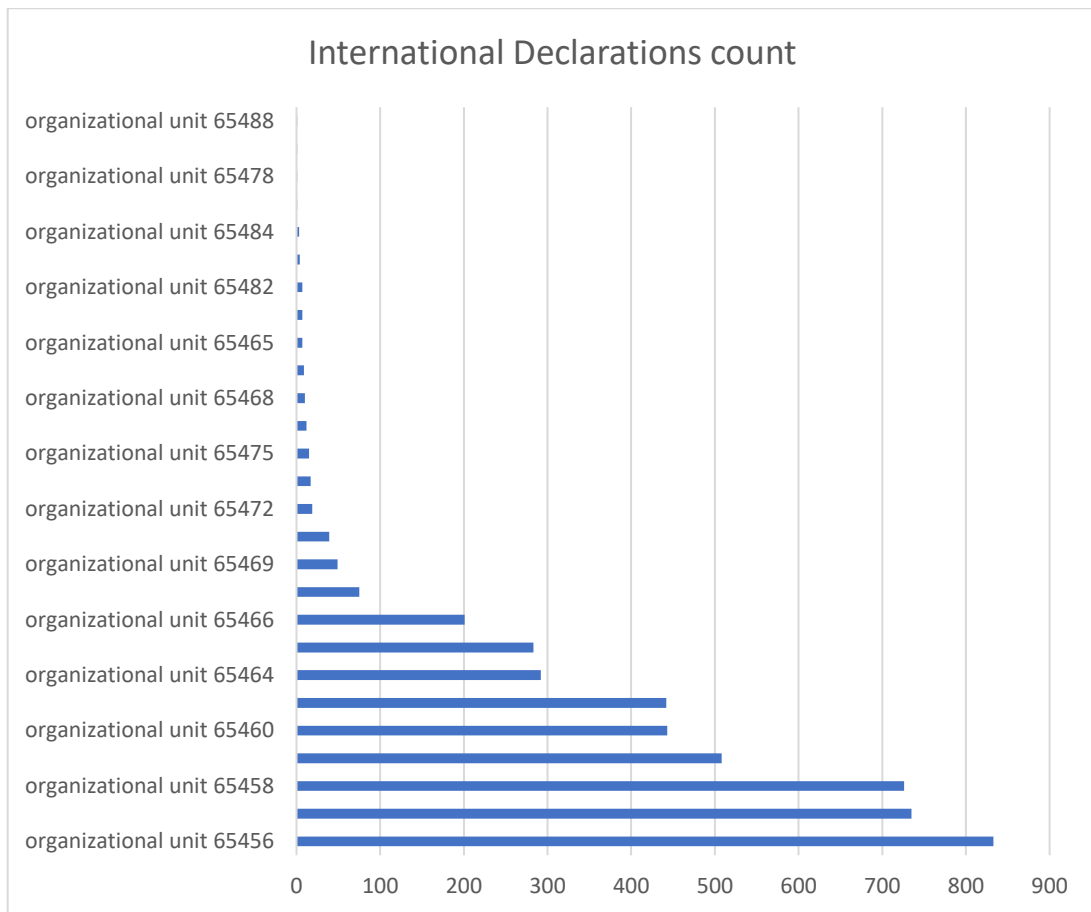
Fig. 9. Chart of the number of international trips by department
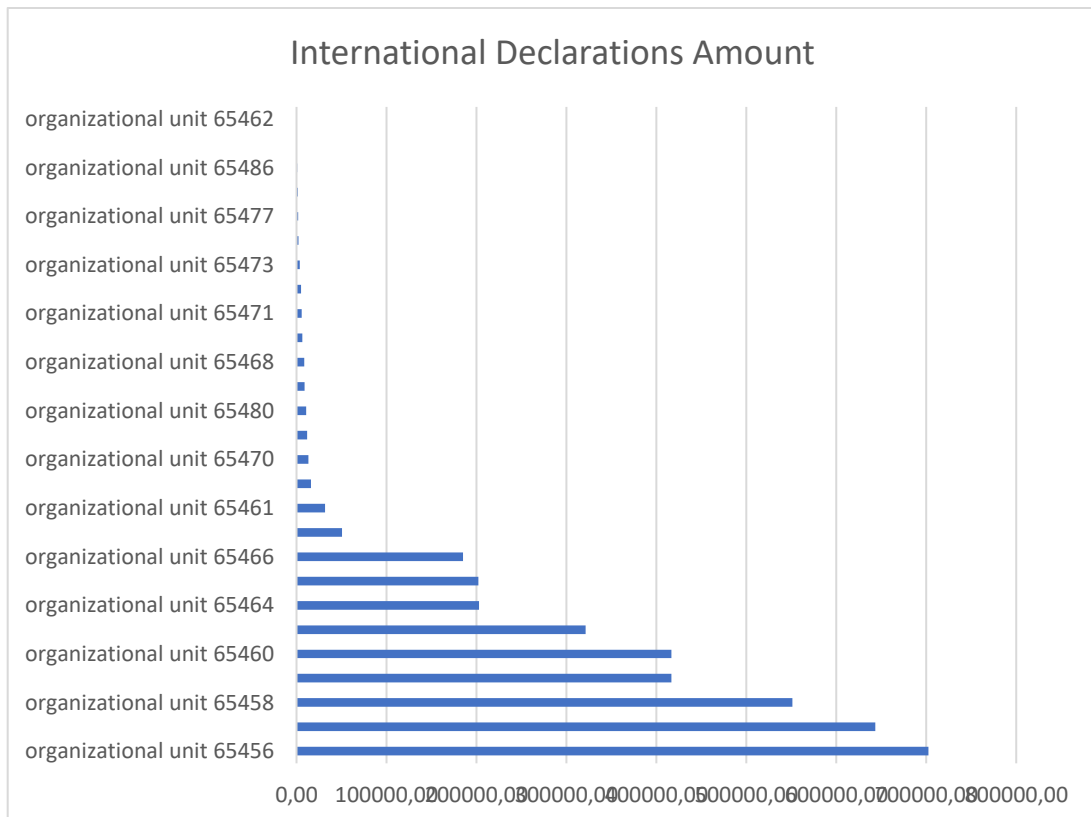

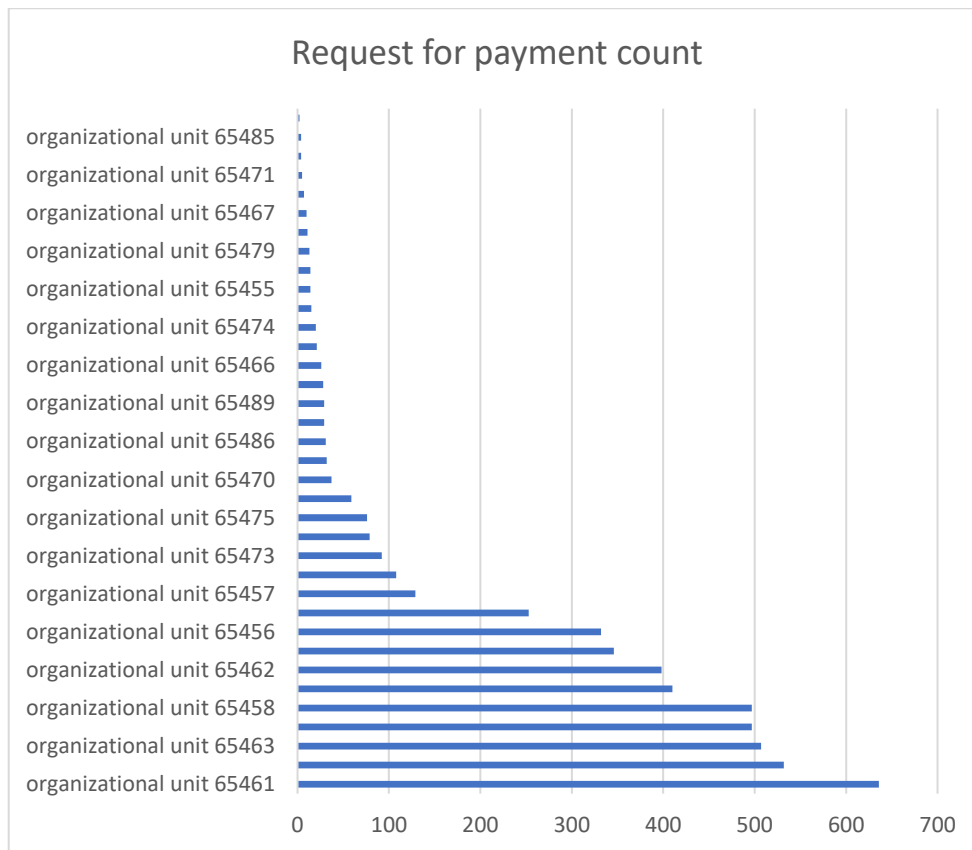**Fig. 10.** Chart of total international travel expenses by department

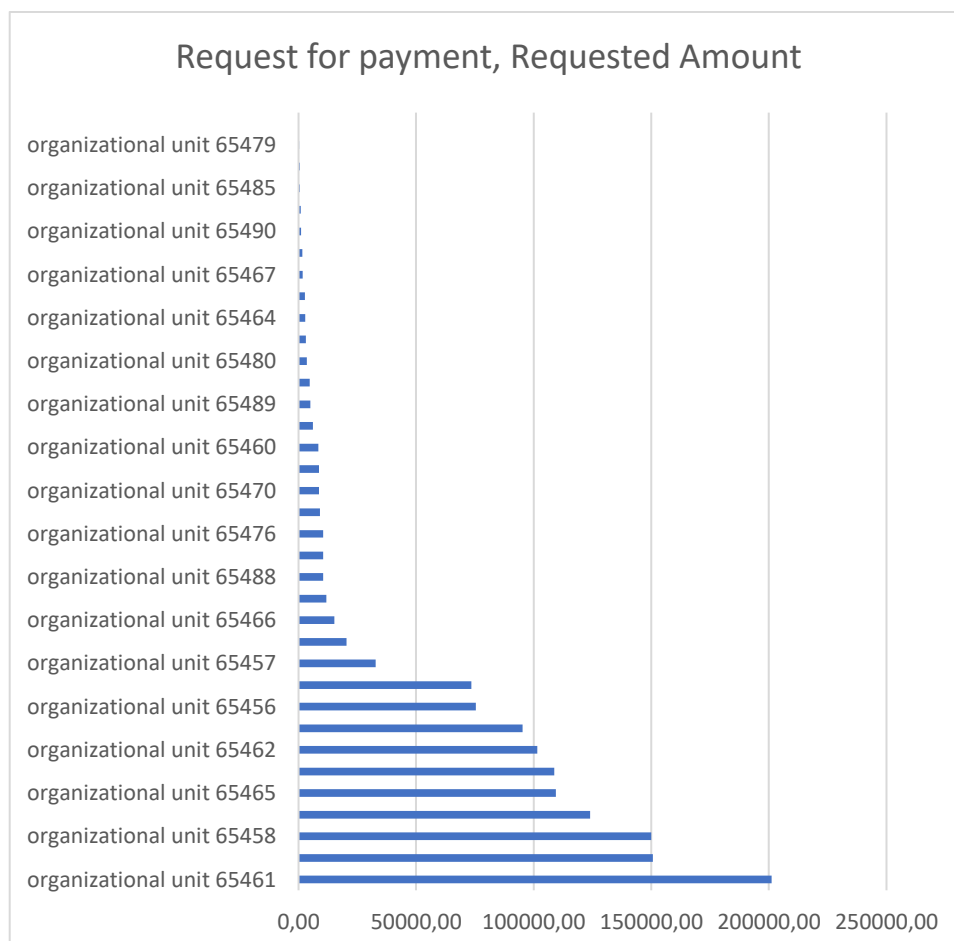**Fig. 11.** Chart of the number of prepaid travel costs by department

Fig. 12. Chart of the total amount of prepaid travel costs by department

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

We have not identified any declarations that exactly meet the specified conditions.

There are declarations that were rejected by the BUDGET OWNER in the first round of approval, but then they went through the approval procedure on the second round, bypassing BUDGET OWNER. In all such cases, the deviation occurred less than 7 days after the approval of the administration.

There is also a declaration that were considered by SUPERVISOR, passing the BUDGET OWNER, after 7 days after Administration agreement. In all these cases, we cannot say that requests were automatically forwarded to the manager from the budget holder after 7 days, since the system does not have a corresponding event type for the 'concept :name' field. In this regard, **we propose** to modify the system for unambiguous recording of such events in the log, if the system has the function of automatic redirection of declarations after the expiration of the established budget holder's approval period, or to implement such a function in case of the absence of it.

3.16. Next to travel declarations, there are also requests for payments. These are specific for non-TU/e employees. Are there any TU/e employees that submitted a request for payment instead of a travel declaration?

We have not identified any clear cases of request for payment instead of travel declaration. However, we assume there are 7 cases of double payments paid simultaneously as prepaid travel cost and requests for payment. All these pairs of cases are paid for the same amount and also have the same values in the columns 'case: OrganizationalEntity', 'case:Project', 'case:Task', 'case:Activity'.

It is worth noting that for three Prepaid Travel Costs, there are no requests for travel permission and events for its approval - the route of such cases is not typical for Prepaid Travel Cost, but for Requests For Payments. Another prepaid travel cost, which has a duplicate in Requests For Payments for the above fields, was not paid, but fully approved by Administration, Budget_Owner, Supervisor

Table 13. Double Payments in Prepaid Travel Cost and Requests For Payments

Requests For Payments				Prepaid Travel Cost				
request for payment	Submit date	Payment date	Amount	request for payment	Submit date	Payment date	Amount	Comment
154688	2018-01-31	2018-02-26	690.854995	7615	2018-02-16	2018-02-26	690.854995	
159579	2018-04-13	2018-04-30	401.435119	2832	2018-02-22	2018-03-05	401.435119	
157421	2018-03-16	2018-04-19	133.461496	185972	2018-06-15	2018-07-02	133.461496	Without travel permits and travel dates
163899	2018-04-06	2018-04-19	133.461496					
182806	2018-11-08	2018-11-22	954.448076	186488	2018-10-26	2018-11-22	954.448076	
177148	2018-12-13	2018-12-05	954.448076					
179645	2018-12-03	2018-12-10	287.430579	186550	2018-11-06	2018-11-15	287.430579	
170165	2018-06-12	2018-07-05	159.801672	26103	2018-06-15	--	159.801672	Approved, but payment wasn't requested

In this regard, **we propose** to double-check the above cases. In case of confirmation of double payments, we propose to develop an automated procedure that allows, at the approval stage, to identify cases that have signs duplication.

4. Conclusions

In this paper, we have presented our analysis of a real business process using Process Mining Techniques. We answered all the questions proposed by the organizers and offered several recommendations for optimization of processes under study.

But the main goal of the team's participation in this competition was to consolidate theoretical knowledge[4] and gain practical skills in the study of business processes using the Process Mining methodology and tools. We have gained invaluable experience in this constantly developing and extremely useful area for business and are confident that we can apply it in our work of internal auditors to study the business processes of our company.

References

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2. Disco, https://www.fluxicon.com/products/
3. https://icpmconference.org/2020/bpi-challenge/
4. https://www.coursera.org/learn/process-mining

Appendix No. 1

Table 1. Throughput per process steps on Domestic travel declarations

Start event	End event	Min	Max	Mean	Median
Declaration SUBMITTED by EMPLOYEE	Declaration APPROVED by ADMINISTRATION	0.000278	6781.98	45.47	0.0147
Declaration SUBMITTED by EMPLOYEE	Declaration REJECTED by ADMINISTRATION	0.000278	11261.67	151.00	0.0365
Declaration APPROVED by ADMINISTRATION	Declaration APPROVED by BUDGET OWNER	0.005	3407.13	51.88	21.34
Declaration APPROVED by ADMINISTRATION	Declaration REJECTED by BUDGET OWNER	0.092	308.93	41.43	12.34
Declaration APPROVED by ADMINISTRATION	Declaration FINAL_APPROVED by SUPERVISOR	0.0036	1627.10	50.05	21.29
Declaration APPROVED by ADMINISTRATION	Declaration REJECTED by SUPERVISOR	0.0475	432.21	52.58	22.72
Declaration APPROVED by BUDGET OWNER	Declaration FINAL_APPROVED by SUPERVISOR	0.0075	2043.08	72.3	46.32
Declaration APPROVED by BUDGET OWNER	Declaration REJECTED by SUPERVISOR	3.256	164.39	98.48	94.84
Declaration FINAL_APPROVED by SUPERVISOR	Request Payment	0.00	2540.44	68.21	25.43
Declaration REJECTED by SUPERVISOR	Declaration REJECTED by EMPLOYEE	0.124	2160.14	117.11	25.65
Declaration REJECTED by ADMINISTRATION	Declaration REJECTED by EMPLOYEE	0.020	1540.01	59.05	22.66
Declaration REJECTED by BUDGET OWNER	Declaration REJECTED by EMPLOYEE	0.789	3671.2	116.31	24.66
Request Payment	Payment Handled	2.32	1491.48	82.81	77.13

Table 2. Throughput in process steps on International Declarations

Start event	End event	Min	Max	Mean	Median
Permit SUBMITTED by EMPLOYEE	Permit APPROVED by ADMINISTRATION	0,000278	4655,65	14,11	0,0014
Permit SUBMITTED by EMPLOYEE	Permit REJECTED by ADMINISTRATION	0,000556	480,68	11,56	0,0014
Permit APPROVED by ADMINISTRATION	Permit FINAL_APPROVED by SUPERVISOR	0.01194	1485.02	52.05	22.45
Permit APPROVED by ADMINISTRATION	Permit APPROVED by SUPERVISOR	0,005	454,62	52.40	25.18
Permit APPROVED by ADMINISTRATION	Permit REJECTED by SUPERVISOR	0.438	333.29	54.00	22.31
Permit APPROVED by ADMINISTRATION	Permit APPROVED by BUDGET OWNER	0,0122	997,31	50,15	22,22
Permit APPROVED by ADMINISTRATION	Permit REJECTED by BUDGET OWNER	1,230	257,74	40,60	20,85
Permit APPROVED by BUDGET OWNER	Permit FINAL_APPROVED by SUPERVISOR	0.00833	1390.6	81.30	54.16
Permit APPROVED by BUDGET OWNER	Permit APPROVED by SUPERVISOR	0,04167	213,13	77.15	57.32
Permit APPROVED by BUDGET OWNER	Permit REJECTED by SUPERVISOR	1,5478	164,24	107.29	159.03
Permit APPROVED by SUPERVISOR	Permit FINAL_APPROVED by DIRECTOR	0,00	1054,0	65.71	23.71
Permit APPROVED by SUPERVISOR	Permit REJECTED by DIRECTOR	481,8	481,8	481,8	481,8
Permit REJECTED by ADMINISTRATION	Permit REJECTED by EMPLOYEE	0.1025	686.39	47.95	20.49
Permit REJECTED by DIRECTOR	Permit REJECTED by EMPLOYEE	120,3	120,3	120,3	120,3
Permit REJECTED by SUPERVISOR	Permit REJECTED by EMPLOYEE	0,0336	317,0	58.29	30,03
Permit REJECTED by BUDGET OWNER	Permit REJECTED by EMPLOYEE	0,603	148,74	59.75	43,23
Send Reminder	Declaration SUBMITTED by EMPLOYEE	1,286	5529,50	455.54	262.08
Declaration SUBMITTED by EMPLOYEE	Declaration APPROVED by ADMINISTRATION	0,000278	10128,1	82.27	0.156
Declaration SUBMITTED by EMPLOYEE	Declaration REJECTED by ADMINISTRATION	0,000556	4187,25	69.27	0,2528
Declaration APPROVED by ADMINISTRATION	Declaration APPROVED by BUDGET OWNER	0,00472	1339,6	79.50	27.92
Declaration APPROVED by ADMINISTRATION	Declaration REJECTED by BUDGET OWNER	0,036	307,79	63.20	35.36
Declaration APPROVED by BUDGET OWNER	Declaration FINAL_APPROVED by SUPERVISOR	0,043	1531,4	76.60	48.09
Declaration APPROVED by BUDGET OWNER	Declaration REJECTED by SUPERVISOR	0,292	164,39	81.94	49,99
Declaration APPROVED by BUDGET OWNER	Declaration APPROVED by SUPERVISOR	0.56	2036.6	111.99	47.60
Declaration APPROVED by ADMINISTRATION	Declaration APPROVED by SUPERVISOR	0.0250	377.55	80.47	41.92
Declaration APPROVED by ADMINISTRATION	Declaration FINAL_APPROVED by SUPERVISOR	0.00638	1368.17	75.83	29.79
Declaration APPROVED by ADMINISTRATION	Declaration REJECTED by SUPERVISOR	0.0236	432.80	104.63	69.71
Declaration APPROVED by SUPERVISOR	Declaration FINAL_APPROVED by DIRECTOR	0.2431	521.87	62.41	24.66
Declaration APPROVED by SUPERVISOR	Declaration REJECTED by DIRECTOR	142,68	142,68	142,68	142,68
Declaration FINAL_APPROVED by SUPERVISOR	Request Payment	0,000	6386,4	68,57	25,79
Declaration FINAL_APPROVED by DIRECTOR	Request Payment	0,000278	665,35	51,94	20,88
Request Payment	Payment Handled	0.659	697.46	81.97	77.63
Declaration REJECTED by SUPERVISOR	Declaration REJECTED by EMPLOYEE	0,0122	1805,14	119.40	47.75
Declaration REJECTED by ADMINISTRATION	Declaration REJECTED by EMPLOYEE	0,025	2873,93	93.56	45.80
Declaration REJECTED by BUDGET OWNER	Declaration REJECTED by EMPLOYEE	0,693	838,96	78.88	45.08
Declaration REJECTED by DIRECTOR	Declaration REJECTED by EMPLOYEE	6,114	6,114	6,114	6,114

Table 3. Throughput in process steps on Prepaid Travel Cost

Start event	End event	Min	Max	Mean	Median
Permit SUBMITTED by EMPLOYEE	Permit APPROVED by ADMINISTRATION	0.000278	1318.86	12.14	0.0014
Permit SUBMITTED by EMPLOYEE	Permit REJECTED by ADMINISTRATION	0.000278	308.77	56.34	0.0008
Permit APPROVED by ADMINISTRATION	Permit FINAL_APPROVED by SUPERVISOR	0.01778	546.55	52.12	21.69
Permit APPROVED by ADMINISTRATION	Permit APPROVED by SUPERVISOR	0.1081	790.81	54.42	22.25
Permit APPROVED by ADMINISTRATION	Permit REJECTED by SUPERVISOR	0.4375	333.29	71.67	29.75
Permit APPROVED by ADMINISTRATION	Permit APPROVED by BUDGET OWNER	0.01167	695.86	56.94	24.86
Permit APPROVED by ADMINISTRATION	Permit REJECTED by BUDGET OWNER	1.2297	92.38	23.27	15.79
Permit APPROVED by BUDGET OWNER	Permit FINAL_APPROVED by SUPERVISOR	0.08778	237.0	83.84	67.97
Permit APPROVED by BUDGET OWNER	Permit APPROVED by SUPERVISOR	0.3438	213.13	73.59	47.73
Permit APPROVED by BUDGET OWNER	Permit REJECTED by SUPERVISOR	163.67	164.50	164.29	164.50
Permit APPROVED by SUPERVISOR	Permit FINAL_APPROVED by DIRECTOR	0.0	1054.0	71.96	24.14
Permit REJECTED by ADMINISTRATION	Permit REJECTED by EMPLOYEE	0.3611	667.82	124.20	34.41
Permit REJECTED by SUPERVISOR	Permit REJECTED by EMPLOYEE	0.3511	190.41	74.01	34.05
Permit REJECTED by BUDGET OWNER	Permit REJECTED by EMPLOYEE	2.6775	140.00	51.04	43.23
Request For Payment SUBMITTED by EMPLOYEE	Request For Payment APPROVED by ADMINISTRATION	0.000278	2520.90	22.02	0.0097
Request For Payment SUBMITTED by EMPLOYEE	Request For Payment REJECTED by ADMINISTRATION	0.000556	7247.59	62.74	0.0115
Request For Payment APPROVED by ADMINISTRATION	Request For Payment FINAL_APPROVED by SUPERVISOR	0.0119	482.10	50.14	23.01
Request For Payment APPROVED by ADMINISTRATION	Request For Payment REJECTED by SUPERVISOR	0.9311	212.81	72.44	71.04
Request For Payment APPROVED by ADMINISTRATION	Request For Payment APPROVED by SUPERVISOR	0.0192	329.18	69.55	54.31
Request For Payment APPROVED by ADMINISTRATION	Request For Payment FINAL_APPROVED by DIRECTOR	1.6767	470.04	152.41	138.49
Request For Payment APPROVED by ADMINISTRATION	Request For Payment APPROVED by BUDGET OWNER	0.0413	767.01	52.25	24.59
Request For Payment APPROVED by ADMINISTRATION	Request For Payment REJECTED by BUDGET OWNER	0.1058	73.75	20.61	3.22
Request For Payment APPROVED by BUDGET OWNER	Request For Payment APPROVED by SUPERVISOR	3.9608	167.23	74.24	64.04
Request For Payment APPROVED by BUDGET OWNER	Request For Payment FINAL_APPROVED by SUPERVISOR	0.0406	890.11	73.49	46.45
Request For Payment APPROVED by BUDGET OWNER	Request For Payment REJECTED by SUPERVISOR	56.06	164.61	144.78	162.86
Request For Payment APPROVED by SUPERVISOR	Request For Payment FINAL_APPROVED by DIRECTOR	1.54	190.95	67.51	46.67
Request For Payment FINAL_APPROVED by SUPERVISOR	Request Payment	0.00	1177.57	68.73	25.87
Request For Payment FINAL_APPROVED by DIRECTOR	Request Payment	0.000278	477.95	54.98	16.95
Request Payment	Payment Handled	24.43	659.25	85.57	79.80
Request For Payment REJECTED by SUPERVISOR	Request For Payment REJECTED by EMPLOYEE	0.2458	170.06	43.63	23.65
Request For Payment REJECTED by ADMINISTRATION	Request For Payment REJECTED by EMPLOYEE	0.1472	1032.83	76.67	42.82
Request For Payment REJECTED by BUDGET OWNER	Request For Payment REJECTED by EMPLOYEE	16.9338	141.64	70.09	75.30

Table 4. Throughput in process steps on Requests for Payment

Start event	End event	Min	Max	Mean	Median
Request For Payment SUBMITTED by EMPLOYEE	Request For Payment APPROVED by ADMINISTRATION	0.000278	9550.74	37.70	0.0064
Request For Payment SUBMITTED by EMPLOYEE	Request For Payment REJECTED by ADMINISTRATION	0.000278	7536.00	30.39	0.0081
Request For Payment APPROVED by ADMINISTRATION	Request For Payment FINAL_APPROVED by SUPERVISOR	0.01472	5929.94	69.12	26.93
Request For Payment APPROVED by ADMINISTRATION	Request For Payment APPROVED by SUPERVISOR	0.2744	529.02	124.46	94.78
Request For Payment APPROVED by ADMINISTRATION	Request For Payment REJECTED by SUPERVISOR	0.04444	324.35	68.98	39.34
Request For Payment APPROVED by ADMINISTRATION	Request For Payment FINAL_APPROVED by DIRECTOR	3.9667	625.96	183.78	164.57
Request For Payment APPROVED by ADMINISTRATION	Request For Payment APPROVED by BUDGET OWNER	0.00611	25.81	74.16	26.37
Request For Payment APPROVED by ADMINISTRATION	Request For Payment REJECTED by BUDGET OWNER	0.02583	289.27	47.76	24.52
Request For Payment APPROVED by BUDGET OWNER	Request For Payment APPROVED by SUPERVISOR	12.5433	163.22	59.55	24.47
Request For Payment APPROVED by BUDGET OWNER	Request For Payment FINAL_APPROVED by SUPERVISOR	0.03916	8238.96	86.83	52.12.
Request For Payment APPROVED by BUDGET OWNER	Request For Payment REJECTED by SUPERVISOR	0.2847	189.07	101.68	145.66
Request For Payment APPROVED by SUPERVISOR	Request For Payment FINAL_APPROVED by DIRECTOR	0.6214	365.38	67.71	45.99
Request For Payment FINAL_APPROVED by SUPERVISOR	Request Payment	0.00	1393.77	82.75	28.08

Request For Payment FINAL_APPROVED by DIRECTOR	Request Payment	0.00	2337.18	147.14	24.18
Request Payment	Payment Handled	0.3350	1491.49	84.23	77.23
Request For Payment REJECTED by SUPERVISOR	Request For Payment REJECTED by EMPLOYEE	0.1542	1222.25	99.16	45.54
Request For Payment REJECTED by ADMINISTRATION	Request For Payment REJECTED by EMPLOYEE	0.03639	1577.45	80.83	37.42
Request For Payment REJECTED by BUDGET OWNER	Request For Payment REJECTED by EMPLOYEE	1.9244	147.33	38.31	23.92