**Analysis of cycle time**

**Introduction**

For the construction of the log, the actions carried out in the analyzes that answer the following questions have been used:

* Question 5 BPI Challenge 2015: Where are differences in throughput times between the municipalities and how can these be explained?

* Question 1 BPI Challenge 2017: What are the throughput times per part of the process, in particular the difference between the time spent in the company's systems waiting for processing by a user and the time spent waiting on input from the applicant as this is currently unclear ?

* Question 1 BPI Challenge 2020 : What is the throughput of a travel declaration from submission (or closing) to paying?

* Question 2 BPI Challenge 2020 : Is there any difference in throughput between national and international trips?

* Question 4 BPI Challenge 2020 : What is the throughput in each of the process steps, ie, the submission, judgment by various responsible roles and payment?

* Question 5 BPI Challenge 2020 : Where are the bottlenecks in the process of a travel declaration?

* Question 6 BPI Challenge 2020 : Where are the bottlenecks in the process of a travel permit (note that there can be multiple requests for payment and declarations per permit)?

* Question 2 BPI Challenge 2019 : What is the throughput of the invoicing process, ie the time between goods receipt, invoice receipt and payment (clear invoice)? To answer this, a technique is sought to match these events within a line item, ie if there are multiple goods receipt messages and multiple invoices within a line item, how are they related and which belong together?

The log is made up of a total of 46 different activities. First , the frequency with which each activity occurred in each response was studied without taking into account its repetition , considering as frequent activities those with a frequency higher than the average of all ( 8.37 ) . A then these activities together is their frequency:

Calculate cycle time                                                  73

Identify bottlenecks 44

Filter traces 29

Represent process map 25

Calculate number of elements 24

Compare cycle time 19

Graphing Histograms 18

Group traces 17

Calculate Percentages 14

Calculate waiting time 14

Graphing bar charts 13

As can be seen, 11 activities make up the group of the most frequent , since the frequency of each of them is higher than 8.37 .

**Analysis of frequent activities**

* Calculate cycle time ( 73 - 8 1.11 % )
  + It consists of determining the total time in the whole process, or in some events, or in a fragment of the process for all traces or for subsets of traces . In the analyzes studied, there are the following specific ways to carry out this activity:
    - Calculate cycle time for all pairs of events for all traces (13 - 1 7 . 08 %). It consists of calculating the cycle of all events for all traces, subtracting the end date of an event with the end date of the event just earlier.
    - Get cycle time of the previous question (1 2 - 1 6 . 4 3%). It consists of reusing some calculation of the cycle time made previously.
    - Calculate cycle time of the whole process for all the traces (11 - 1 5 . 06 % ) . It consists of calculating the cycle time of the entire process taking into account all the traces.
    - Calculate cycle time of the complete process for a subset of traces ( 9 - 1 2.32 %). It consists of calculating the cycle time of the entire process for a subset of traces, which has been obtained after filtering.
    - Calculate cycle time of a process fragment for a subset of traces ( 8 - 10.95 %) . It consists of calculating the cycle time of a specific part of the process after filtering.
    - Calculate cycle time of the complete process for each subset of traces ( 8 - 10.95 %). It consists of calculating the cycle time of the entire process, previously making groupings of traces based on some criteria.
    - Calculate cycle time of a fragment of the process for all the traces ( 6 - 8.21 %). It consists of calculating the cycle time of a part of the process taking into account all the traces.
    - Calculate cycle time of only a subset of event pairs for each subset of traces (5 - 6.84 %). It consists of calculating the cycle time of some events after previously making groupings of traces by some criteria.
    - Calculate cycle time for all pairs of events for a subset of traces ( 5 - 6.84 %). It consists of calculating the cycle time of all events after previously filtering traces.
    - Calculate cycle time for all pairs of events for each subset of traces (5 - 6.84 %). It consists of calculating the cycle time of all the events after previously performing some groupings of traces by some criterion.
    - Calculate cycle time of a process fragment for each subset of traces (4 - 5.47 %). It consists of calculating the cycle time of a part of the process for different groupings of traces.
    - Calculate cycle time of only a subset of event pairs for all traces (3 - 4.10 %). It consists of calculating the cycle time of specific events for all traces.
    - Calculate cycle time of only a subset of pairs of events for a subset of the traces (3 - 4.10 %). It consists of calculating the cycle time of some events after previously filtering by some criteria.
  + To observe the process with which " Calculate cycle time" is carried out, an Attribute filter with mandatory mode can be applied for said activity (figure 1) :

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Figure 1: Process map resulting from filtering by “Calculate cycle time” (16.5% most frequent activities and 5.2% paths).

* In this map it can be seen that Calculate cycle time is usually the starpoint of the process ( 33 - 45.20 %) , but it is not often the endpoint of the process ( 1 8 - 2 4.67 %). The s activity is that more is performed n previously are Filter traces ( October - 1 3 . 69 %) and Calculate number of elements ( 9 - 1 2 . 32 %) . Other activities that occur prior to Calculate cycle time and that do not appear on the map are:
  + Calculate cycle time ( 8 - 10.95 % )
  + Represent process map ( 7 - 9. 58 %)
  + Calculate percentages ( 4 - 5.4 7 % )
  + Group activities ( 3 - 4.10 %)
  + Filter events by activities ( 2 - 2.73 %).
  + Graph histograms (2 - 2.73 % )
  + Compare cycle time (2 - 2.73 % )
  + Calculating processing time (1 - 1 . 36 %) ,
  + Calculate frequency (1 - 1. 36 %)
  + Preprocess the log traces (1 - 1. 36 %)
  + Group traces (1 - 1. 81 %)
  + Filter events by attributes (1 - 1. 36 % )
  + Represent heat maps (1 - 1. 36 %) .
  + Calculate waiting time (1 - 1.36%).
  + Group events by time (1 - 1.36%) .
  + Discover the happy path of the process (1 - 1.36%).
  + Identify attribute values ​​(1 - 1.36%).
  + Temporary representation of the execution of activities (1 - 1.36%).

* Furthermore , it is noteworthy that the activities that are usually performed after calculating cycle time are: Identify bottlenecks ( 1 4 - 19.17 %) and compare cycle time (10 - 1 3 . 69 %) . Regarding Identifying bottlenecks, it should be noted that the specific form that is most used previously is Calculate cycle time for all pairs of events for all traces ( 9 - 25 %) .

* Alternatively, other activities that are carried out after Calculate cycle time and that do not appear on the map are: Calculate cycle time ( 8 - 10.95 %) , Graphically represent bar diagrams ( 6 - 8.21 % ), Represent process map (4 - 5.47 % ) , Calculate number of elements ( 5 - 6.84 % ) , Filter traces ( 3 - 4.10 % ) , Calculate frequency (2 - 2.79 %) , Group traces (2 - 2.79 %) , Calculate waiting time (2 - 2.79 % ) , Group activities (1 - 1 36 % ) , Filter events by time cycle (1 - 1 36 %) Calculate throughput (1 - 1 36 % ), represent heat maps ( 2 - 2.79 %) Calculate processing time (1 - 1. 36 %) and Filter events by attributes (1 - 1. 36 %).

* As a conclusion, it can be said that Calculate cycle time is usually performed for the complete process or for all pairs of events , in both cases using all traces . A level l process noteworthy that often done as startpoint and sometimes even the endpoint. The most frequent pre-activity for Calculate cycle time is Filter traces, and the most frequent activity after Calculate cycle time is Identify bottlenecks. Finally, it should be noted that Calculate cycle time for all pairs of events for all traces is the most frequent specific version to identify bottlenecks.

* Identify bottlenecks ( 44 - 48.89 % )
  + This activity consists of detecting events, resources, roles or patterns of activities, which represent delays or irregularities in the process. In the analyzes studied there are different ways of identifying bottlenecks in the process :
    - Identify activities as bottlenecks by applying temporal performance criteria ( 31 - 7 0.45 % ): It consists in detecting which activities have a greater cycle time, or a greater average cycle time, or increase the average cycle time of the variants , etc. , more, either calculating some type of measurements or making a graph.
    - Identify incorrect orders threads with respect to the activities path happy as bottlenecks ( 7 - 1 5.91 % ) : Consists determine having threads or orders of incorrect activities with respect to the path happy .
    - Identify bottlenecks threads as applying criteria time yield (4 - 9.09 % ) : consists of detecting that threads have an increased cycle time, or the higher average cycle time, etc . , either calculating some type of measurements or making a graph.
    - Identify organizational units as bottlenecks by applying temporal performance criteria (3 - 6.82 % ) : It consists of detecting which organizational units have a greater cycle time, or a greater average cycle time, or increase the average cycle time of the variants , etc. , either calculating some type of measurements or making a graph.

* + Using Disco, Activity filter has been performed using the Mandatory mode to obtain only the traces in which there is at least one “Identify bottlenecks” activity, with the aim of discovering the most common process carried out in the analyzes for the identification of bottlenecks in the process .

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Figure 2 : Process map resulting from filtering by “ Identify bottlenecks ” ( 30 % most frequent activities and 0 % paths).

* + From the map , it is obtained to identify bottlenecks often occurs after Calculate cycle time (1 4 - 3 1 82 %), although it also may occur after waiting time calculator (5 - 1 1.36 %). Therefore, it is common for it to be carried out after an activity in which temporary performance measurements are made. On some occasions, before Identifying bottlenecks and immediately after Calculating cycle time, it is common to perform the activity Graphically represent bar diagrams (4 - 9.09 %), which consists of representing the values ​​associated with a discrete variable, in this case, show a measure of cycle time (median, average ... etc) for each activity in the shape of a bar whose height is equal to its cycle time value, and from the diagram the bars with the highest height are identified that correspond to the necks of process bottle.

* + On the other hand, it is also frequent that it occurs after Representing the process map (6 - 1 3.63 % ) and to a lesser extent it occurs after fillings activities: Compare cycle time (3 - 6.82 % ), Filter activities (3 - 6.82%), Represent Graphically Histograms ( 2 - 4.55 % ) , Calculate Frequency (2 - 4.55 % ), Represent Heat Maps (1 - 2. 27 % ) , Calculate Trace Time Intervals (1 - 2. 27 % ) , Calculate Percentages (1 - 2.27%) , Graphically represent a circular diagram of trace attributes . Also, on 2 occasions ( 4.55 %) the Identify bottlenecks activity is the startpoint of the trace .

* + Regarding the activities that occur after Identifying bottlenecks , this is usually the endpoint of the trace ( 22 - 50 %). T lso other activities are performed after identifying bottlenecks , the most frequent being : Identify roles (4 - 9.09 %) and represent process map (4 - 9.09 % ) . Less frequently, it is also performed: Calculate frequency (3 - 6.82 %), Calculate number of elements ( 2 - 4.55 %), Graph bar diagrams ( 1 - 2.27%), Filter traces (1 - 2. 27 %), Identify resources (1 - 2. 27 %) , Identify impact of bottlenecks by organizational unit (1 - 2. 27 % ), Group traces (1 - 2. 27 % ) , Calculate percentages (1 - 2. 27 % ) , Represent graphically histograms (1 - 2. 27 % ) , Calculate waiting time (1 - 2. 27 % ), Apply machine learning techniques (1 - 2.27%), Preprocess the log traces (1 - 2. 27 % ) .

* + As a conclusion, it could be stated that for the identification of bottlenecks previously it is necessary to carry out some temporary performance measurement, such as the calculation of cycle time or waiting time, and based on this the activities that suppose delays in the process are identified. It may also be helpful to identify bottlenecks after making graphical representations of bar graphs of cycle time or representations of process maps of cycle time to detect visually. In addition, almost 50% of the times that this activity occurs is endpoint, so it is very common.

* Represent process map (2 5 - 27.78 % )
  + This activity consists of graphically representing the process map for a set or subset of traces, discovering it automatically without applying any algorithm. Such activity can be performed are the following specific ways to analyze the time cycle :
    - Represent the process map with cycle time ( 21 - 8 4 % ). It consists of representing a process map with details related to the cycle time of each event.
    - Represent process map frequently ( 4 - 1 6 %). It consists of representing a process map with details related to the times each activity is carried out, which activities are carried out before each activity and the same for later.
    - Obtain process map from the previous question (1 - 4 %). It consists of reusing a previously generated process map.
  + To observe the process of how is made "represent process map " can apply an Attribute filter with mandatory mode for that activity (Figure 3):

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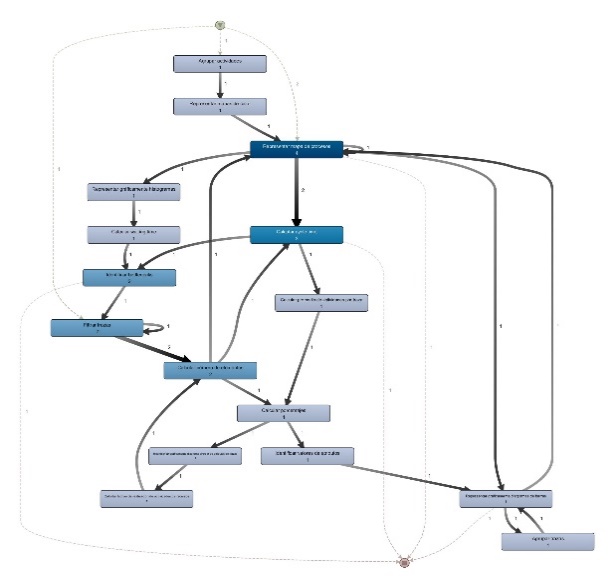
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Figure 3 : Process map resulting from filtering by " Represent process map " ( 23.8 % most frequent activities and 20 % paths).

The above figure shows that represent process map is e l starpoint sometimes ( October - 40 % ) , in addition to that much less frequently is the endpoint of the process ( 8 - 32 %) . Also it is shown on the map that prior to such an activity is the performed activities Identify b ottlenecks ( 4 - 1 6 0 0 %) and calculate cycle time ( 4 - 1 6 0 0 %) . Alternatively, other less frequent activities that are done prior to Representing the process map are: Filter traces ( 2 - 8 %) , Preprocess the log traces ( 1 - 4%), Discover process map ( 1 - 4% ), Calculate number of elements ( 1 - 4 %) , Calculate attribute statistics (1 - 4%), Graph heat maps (1 - 4%) , Graph bar charts (1 - 4 %) and Calculate waiting time (1 - 4%)

On the other hand, the activities that are most often done after Representing the process map are: Identify bottlenecks ( 6 - 2 4 % ), Calculate cycle time ( 7 - 2 8 % ), Calculate waiting time (2 - 8 % ), Represent graphically histograms (1 - 4% ) , Filter events by activities (1 - 4% ) , Filter traces (1 - 4% ) , Filter activities (1 - 4 %) , and Represent process map (1 - 4%) .

Additionally, let's apply two Attribute filters to obtain the process maps of the two specific versions of cycle time and frequency (figure 4) :

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Figure 4: Comparison of the filter by process maps Represent process map with frequency ( left , 100% most frequent activities and 100% paths ) and with cycle time (right , 17.6% most frequent activities and 11.1% paths )

In the previous maps it is observed that in the case of representing a process map with a cycle, it is usually detected to identify more bottlenecks.

In conclusion, it represent process map is usually done r specifically adding details of the cycle time to study aspects of the cycle time. In addition, when it is carried out, it is more frequent that it is the startpoint of the process rather than the endpoint , although in both cases it is frequent. P osteriormente to that activity is often identify bottlenecks or calculate cycle time.

* Filter traces ( 2 9 - 32.22 % )
  + This activity consists of obtaining a subset of traces filtering by some criteria. It can be done by following these specific criteria:
    - Filter traces by activities ( 22 - 75 .86 % ) : It consists of obtaining a subset of traces depending on the existence or absence of one or more activities.
    - Filter traces by attributes ( 8 - 27. 58 % ) : It consists of obtaining a subset of traces depending on the values ​​of their attributes.
    - Filter traces depending on the order of activities (2 - 6.90%): It consists of obtaining a subset of traces in which one or more activities occur in a certain order.
    - Filter traces by frequency (1 - 3.45%): It consists of obtaining a subset of traces that meet some condition regarding cycle time.
    - Filter traces by cycle time (1 - 3.45 % ) : It consists of obtaining a subset of traces that meet some condition regarding cycle time.

* + Disco attribute filter has been applied using the mandatory mode for the “Filter traces” activity, in order to study when said activity is carried out . It is common for the Filter traces activity to be the startpoint of the trace , which occurs 16 times ( 5 5.17 %).

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Figure 5 : Process map resulting from filtering by “ Filter traces ” ( 15 % most frequent activities and 0 % paths).

* + However, there are other activities that are carried out before Filtering traces infrequently , and these are: Calculate cycle time ( 3 - 10.34 % ) , Calculate number of elements (2 - 6.90%) , Calculate percentages (2 - 6.90%) , Calculate attribute statistics (2 - 6.90%) , Filter traces (2 - 6.90%) , Calculate waiting time (2 - 6.90%), Compare cycle time (1 - 3.45%) , Identify bottlenecks (1 - 3.45%), Calculate date of completion of resource activities (1 - 3.45%) Calculate processing time (1 - 3.45%), Identify bottlenecks (1 - 5.26%), Group traces (1 - 3.45%), Represent process map (1 - 3.45 %), Calculate throughput (1 - 3.45%), Graph histograms (1 - 3.45%) .

* + On the other hand, regarding the activities that occur after filtering traces, the most frequent is Calculate cycle time ( 10 - 34.48 %) , although there are other activities that occur before but are very rare : Calculate number of elements ( 6 - 20.69 %), Calculate percentages ( 4 - 13.79 %) , Represent process map (2 - 6.90 %), Filter traces (2 - 6.90%), Group traces (2 - 6.90%), Calculate waiting time (2 - 6.90 %) , Graphing histogra more (1 - 3.45 % ) , Graphing bar charts (1 - 3.45%), represent scatterplot (1 - 3.45%), compare cycle time (1 - 3.45 % ), Preprocessing trace logs (1 - 3.45 % ) , and it is also an endpoint of the trace on one occasion (1 - 3.45 % ) .
  + In conclusion, the most common is to filter traces by activities and this activity is usually carried out before the C alcular cycle time , in order to perform said calculation on a specific subset of traces of interest. In addition, in most cases , Filter traces is the startpoint of the trace , so it is common to start the analysis by filtering.

* Compare cycle time (1 9 - 2 1.11 % )
  + This activity consists of comparing groups of traces or activities through cycle time calculations . There are no specific ways to do it.

* + To observe the process of how " Compare cycle time " is carried out, an Attribute filter with mandatory mode can be applied for said activity (figure 6):

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Figure 6: Map resulting from filtering by Compare cycle time ( 22.8% most frequent activities and 11.1% paths).

The above figure shows that compare cycle time usually performed after calculating cycle time ( October - 5 2 . 63 %). Alternatively other activities performed prior to compare cycle time are Graphing histograms ( 4 - 2 1.05 %) , traces Filter ( 1 - 5. 26 %) , calculate the number of elements ( 1 - 5. 26 %), identify bottlenecks ( 1 - 5. 26 %) , Group traces (1 - 5. 26 %) , or Represent graphically bar diagram ( 2 - 10.52 %), Represent box diagram of cycle time ( 1 - 5.2 6% )

On the other hand , it should be noted that it is often the endpoint of the process ( 1 0 - 5 5.55 %). The activities which are usually made after comparing cycle time are : identify bottlenecks ( 3 - 1 5 . 78 %) , calculate cycle time (2 to 1 .52 %) or trace Group (2 - 1 0.52 %) . Others that tend to be done less frequently are: Filter activities (1 - 5. 26 %) , Analyze cycle time based on events (1 - 5. 26% ) and Identify specific threads (1 - 5. 26%) .

In conclusion, Compare cycle time is usually done after Calculate cycle time . In addition, it is often the endpoint of the process , so it is the result of the process rather than an intermediate step .

* Represent graphically histograms (1 8 - 2 0 % )
  + E sta activity c onsiste to plot the distribution of a variable using histograms. E n analyzes studied this activity is carried out in the following specific ways:
    - Represent graphically histograms of the cycle time   (1 6 - 8 8.89 % ): It consists of showing the distribution of the cycle time (average, median ... etc) of traces or activities in a figure.
    - Graphically represent histograms of waiting time (2 - 1 1.11 % ): It consists of showing the distribution of the waiting time (average, median ... etc) of traces or activities in a figure.
    - Graphically represent histograms of attributes (1 - 5.56 % ): It consists of showing the distribution of numerical attributes of traces or activities by means of a figure.

* + To discover the objective with which this activity is carried out, using Disco has been filtered with Activity filter and Mandatory mode to obtain only the traces in which there is at least one activity "Graph histograms ". The process map obtained is shown below (figure 7). As can be seen, it is common to graphically represent histograms of temporal performance measures, specifically the most frequent is to use cycle time.

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Figure 7: Map resulting from filtering represent graphically histograms ( 2 0% activities frequently and 0% paths).

* + Representing histograms graphically is carried out after various activities , the most frequent being carried out after Calculating cycle time ( 6 - 33.33 %), which corresponds to the specific activity most used in analyzes (Graphing cycle time histograms). Other activities are performed very infrequently before Graphing histograms, such as: Grouping traces (2 - 1 1.1 1 1 % ), Calculate frequency (1 - 5.56 % ), Calculate processing time (1 - 5.56 % ), Identify roles (1 - 5.56 % ), Graph bar charts (1 - 5.56 % ), Filter traces (1 - 5.56 % ), Filter events by cycle time (1 - 5.56 % ), Identify bottlenecks (1 - 5.56 % ), Represent process map (1 - 5.56 % ), Filter variants depending on frequency (1 - 5.56 % ), and on one occasion it is the startpoint of the trace ( 1 - 6.67 % ) , Apply machine learning techniques (1 - 5.56%) .

* + On the other hand, This activity is usually carried out before: Compare cycle time (4 - 2 2.22 %), Identify bottlenecks (2 - 1 1.11 %), Calculate waiting time (2 - 1 1.11 %), Calculate cycle time (2 - 1 1.11 %), Identify roles (1 - 5.56 %), Filter traces (1 - 5.56 %), Group traces (1 - 5.56 %), Graph bar diagrams (1 - 5.56 %) , Graph box plot (1 - 5.56%) , Discover the happy path of the process (1 - 5.56%) . In addition, on 4 occasions ( 22.22 %) it is the endpoint of the trace.

* + In conclusion, when it comes to representing histograms , graphically representing cycle time histograms predominates , and for this purpose, in some cases , Calculate cycle time is performed , which, although it is the most frequent activity , its frequency is relatively low. In addition, after the representation of histograms , different activities are carried out, although the most frequent is to Compare cycle time from the represented histograms .

* Calculate waiting time ( 1 4 - 1 5.56 % )
  + This activity consists of calculating the median, average, maximum or minimum of the waiting time of traces or activities of a process .

* + E l 100% of the analysis in which this activity is used, responding to question 1 of the BPI Challenge 2017. This challenge log offered has an attribute called 'lifecycle: transition' indicating the stage or condition in the one that each event is found . They can be in seven states: schedule, start, suspend, resume, withdraw, complete, and abort. Figure 8 helps to illustrate the transitions between states. From this attribute ('lifecycle: transition'), it is possible to calculate waiting time taking into account the events that are in the 'suspend' state.

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Figure 8: Transitions between states

* + On the other hand, it has been applied at t ribute Disc filter using the mandatory mode "Calculate waiting time" , and the map obtained is shown in Figure 9.

* + As seen on the map, before calculate waiting time various activities are performed , com or Calculate processing time ( 3-2 1.43 %), Filter traces ( 2 - 1 4.29 %) represent process map (2 - 1 4.29 %), Calculate number of elements (2 - 1 4.29 %) , Graph histograms (2 - 1 4.29 % ) , Calculate cycle time (2 - 1 4.29 % ) , Graph bar diagrams ( 1 - 7. 14 % ) , Calculate percentages (1 - 7. 14 % ) , Identify bottlenecks (1 - 7. 14 % ) , Group activities (1 - 7. 14 % ) , Calculate frequency (1 - 7. 14 % ) , Compare waiting time with processing time (1 - 7. 14 % ) , Identify activity with the highest backlog (1 - 7.14%) . On several occasions it is the s tart point of the trace (2 - 1 4.29 % ) .

* + However, after calculating waiting time more often the activity identify bottlenecks (5 - 35.71 %), specifically studying this activity, it has noted that it is in 80% of cases of Identify activities as bottlenecks applying criteria time yield ( 4 - 80%). To a lesser extent, the following activities are also carried out : Filter traces (2 - 1 4.29 % ) , Compare waiting time with processing time (2 - 1 4.29 %), Calculate processing time (2 - 1 4.29 %), Calculate cycle time (1 - 7.14%), Represent process map ( 1 - 7.14% ) , Group traces ( 1 - 7. 14% ) , Represent graphically bar diagrams ( 1 - 7. 14% ) , Group activities (1 - 7. 14% ) , Calculate frequency (1 - 7. 14% ) , Identify resources (1 - 7. 14 % ) , Assign resource to each activity (1 - 7. 14% ) . It is also an endpoint of the trace 3 times (2 1.43 %).

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Figure 9: Map resultant filter by "Calculate waiting time" ( 4 0% more frequent activities and 0% paths).

* In conclusion, there is no activity that is carried out in most cases before Calculate waiting time , but it could be said that its calculation is related to the processing time since it is carried out on several occasions before or after said activity. In addition, after calculating waiting time, it is usually carried out to Identify bottlenecks by applying temporal performance criteria , to detect in which activities more time is invested and therefore identify which activities involve delays in the process .

* Graphing bar charts ( 13 - 1 4.45 %)
* It consists of representing the values ​​associated with a discrete variable using a bar diagram. In these analyzes it is carried out in various ways:
  + Graphically represent cycle time bar diagrams ( 9 - 69.23 %): It consists of showing a measure of the cycle time (median, average ... etc) for each activity in the form of a bar whose height is equal to its cycle time value.
  + Graph bar charts of the trace ( 3 - 23.08 % ): Consists show the percentage or number of traces containing some specific activity by a bar chart.
  + Graphically represent waiting time bar diagrams ( 2 - 1 5.38 % ): It consists of showing a measure of waiting time (median, average ... etc) for each activity.
  + Graphically represent attribute bar diagrams (2 - 15.38%): It consists of showing the numerical values of an attribute with respect to another measure (activities, resources ... etc) .

* In the same way as in the previous cases, it has been used at t ribute filter Drive for traces in which is done the least once activity " Graphing bar charts " .

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Figure 10 : Map resulting from filtering by " Graphing bar diagrams " (40% most frequent activities and 0% paths).

* From the map obtained, it is observed that it is frequent to graphically represent bar diagrams of temporary performance measures, specifically the most frequent is to use cycle time. In 4 6.15 % of the analyzes, before R epresenting graphically bar diagrams, Calculate cycle time is performed ( 6 - 46.15 %) . In other cases, various activities are performed with low frequency (1 - 7.69 %) , as are statistics Calculate attribute, traces Group, calculate waiting time , Filter activities , Graphing histograms , traces Filter , identify bottlenecks , represent process map , Filter activities , Identify resources , Identify attribute values , Represent time series of threads, and Calculate r throughput . On 1 occasion it is the startpoint of the trace (1 - 7.69%) .

* Furthermore, in the 30 77 % of s analysis is carried identify bottlenecks (4 - 30.77 %) after Graphing bar charts to show a measure of the time cycle (median, average , ... etc) for each activity and from from this representation obtain those activities that involve delays in the process. On other occasions , Group traces (2 - 15.38%) and Compare cycle time (2 - 15.38%) are performed. And to a lesser extent ( 1 - 7.69 %), another series of activities is also carried out following Graphing bar charts : Calculate attribute statistics, Compare cycle time , Graph histograms , Represent process map, Calculate throughput , Calculate waiting time , Identify Resources , Identify Attribute Values, and Represent Thread Time Series . Furthermore, two occasion ones is endpoint trace ( 2 - 1 5.38 %).

* In conclusion, when it comes to graphically representing bar diagrams, graphically representing cycle time bar diagrams predominates , and for this in some cases , Calculate cycle time is previously carried out . In addition, after the representation of histograms, different activities are carried out, although the most frequent is Identify bottlenecks.

* Group traces (1 7 - 1 8.88 % )
  + The ac tivity Group traces is one of the most common activities to analyze the cycle time, c onsiste trace group to from of some criterion . Specifically, it will be carried out in the following specific ways:
    - Group traces depending on attributes (6 - 35.29%). It consists of creating subsets of traces depending on the values ​​of their attributes.
    - Group traces by activities (5 - 29.41 %). It consists of creating more than one subset of traces based on the existence or absence of an activity or several activities.
    - Group traces by cycle time (3 - 17.64 %). It consists of creating subsets of traces based on their cycle time value .
    - Group traces by year (2 - 1 1.76 % ). It consists of creating subsets of traces based on the year to which they belong.
    - Group traces by waiting time (1 - 5.88 % ). It consists of creating subsets of traces based on their waiting time value .
    - Group traces by organizational units (1 - 5.88 %) . It is to create subsets of traces depending on the organizational units.
    - Group traces by role (1 - 5.88 %). It consists of creating more than one subset depending on the existence or absence of roles in the traces.
  + If an Attribute filter with mandatory mode is carried out to "Group traces", the process map to carry out said activity is obtained ( figure 11):

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Figure 11: Fragment of the process map of Group traces (31.8% most frequent activities and 18.6% paths).

* + In the previous figure it is observed that there is not an activity that is usually performed frequently before Grouping traces, but that there are many activities that occur before but infrequently : Compare cycle time (2 - 1 1.76 %), Calculate cycle time (2 - 1 1.76 %), Calculate waiting time ( 2 - 13.33 % ) , Represent bar charts (2 - 11.76%) or Filter traces (2 - 11.76%) . Alternatively, other activities that occur earlier less frequently are: Preprocess log traces (1 - 5.88 %) , Calculate average activities per trace (1 - 5.88 %) , Calculate attribute statistics (1 - 5.88 % ), Identify roles ( 1 - 5.88 %) , Group traces (1 - 5.88% ) , Graph histograms (1 - 5.88 %), and Identify bottlenecks (1 - 5.88 )

* + If activities are generalized pre traces Group, we can see that almost half of them ( 6 - 3 5 . 29 %) are related to temporary measures performance (compare cycle time, calculate cycle time, calculate waiting time) .

* + On the other hand, the activities most often performed after Grouping traces are Calculate cycle time ( 4 - 23.52 %), Calculate percentages ( 3 - 17.64 %) and Calculate number of elements ( 5 - 2 9.41 %). Other less frequent are: Graphing histograms (2 - 1 1.76 %), Filter traces (1 - 5.88 %) , Group traces ( 2 - 11.76 %) , Compare cycle time (1 - 5.88 %), Apply decision trees (1 - 5.88 %) , and Represent graphically bar charts ( 1 - 5.88%).

* + By Finally , we must mention that it is only traces Group starpoint of the process in a case ( 4 - 23.52 %) and is never the endpoint.

* + In conclusion, in the context of performing cycle time analysis, the Group traces activity is mostly performed by grouping by activities or by attributes. Before this activity, some activity related to temporal performance measures usually occurs , and after this activity, percentages , the number of elements in the groups or Calculate cycle time are usually calculated .

* Calculate number of elements ( 2 4 - 2 6 . 66 % )
  + This activity consists of determining how many activities / traces / events are part of a set of activities / traces / events . For analysis related to cycle time, this activity is carried out in the following specific ways:
    - Calculate number of traces (1 5 - 62 .5 %). It consists of determining how many traces are part of a set or a subset of traces.
    - Calculate number of activities ( 11 - 4 5 .8 3 %). It consists of determining how many activities are part of a set or a subset of traces.
    - Calculate number of events (5 - 20.83 %). It consists of determining how many events are part of a set or a subset of events.
    - Calculate number of variants ( 4 - 1 6.67 %) . It consists of determining how many activity patterns exist in a set of traces.
    - Calculate the number of different organizational units (1 - 4.16 %) . It consists of determining how many different organizational units exist in a group of traces .
    - Calculate number of values ​​of an attribute ( 1 - 4.16%) . It consists of determining how many values ​​an attribute can take .

* + To observe the process of how " Calculate number of elements " is carried out, an Attribute filter with mandatory mode can be applied for said activity (figure 12):

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Figure 12 : Map resulting filtered by Calculate number of elements ( 18. 2 % most frequent activities and 1 4 . 2 % of paths).

In the above map is observed that there is an activity that sole make frequent mind prior to Calculate number of elements, but there are many options within which include : Calculate number of elements ( 7 - 29.16 %), calculate cycle time ( 5 - 2 0.83 %), Filter traces (6-25%) and Group traces ( 5 - 2 0 . 83 %) . Alternatively, other activities that tend to occur infrequently are: Identify bottlenecks ( 1 - 7.14 % ) , Preprocess log traces ( 1 - 4.16 %) , Group activities (1 - 4.16 %) , Group organizational units ( 1 - 4.16 %) ), Calculate percentages (1 - 7.14 % ) , Identify bottlenecks (2 - 8.33%), Calculate frequency (1 - 4.16 %), Calculate dates of completion of activities (1 - 4.16%) or Analyze cycle time based on events ( 1 - 4.16 % ).

On the other hand, the activities that are most often done after Calculate number of elements are: Calculate number of elements ( 7 - 28 % ) , or Calculate cycle time ( 9 - 36 % ) . Lesser extent are performed subsequently activities as compare cycle time ( 4 - 17.39%) , calculate statistics attributes (2-8%) Calculate percentages ( 3 - 1 2 %), calculate waiting time ( 2 - 8 % ) Calculate Average activities per trace ( 2 - 8 %), Calculate percentages (2 - 14.28%) , Represent process map (1 - 4 %) , Calculate throughput (2 - 8%), %), Filter traces (2 - 8 %), Represent a dotted diagram (1-4%) , Identify activity with the highest backlog (1-4%) or Compare cycle time (1 - 4 %) .

Finally, it should be noted the fact that it is carried out several times in a row, which indicates that on those occasions it is possibly carried out and is applied with several different specific criteria. Specifically, the specific pattern that is repeated the most is Calculate number of traces -> Calculate number of activities (3 - 42.85 %).

In conclusion, Calculate number of elements is usually applied as Calculate number of traces or as Calculate number of activities to analyze aspects related to cycle time , in addition to that it is not usually startpoirt or endpoint . With respect to such activity suel and perform previously Calculate cycle or group traces and then is usually calculated cycle time. In the case that it is carried out more than once in a row, the number of traces and the number of activities are usually calculated.

* Calculate percentages ( 14 - 15.56 %)
  + It consists of determining the proportion of certain elements (roles, traces, resources) of sets of traces or activities . Most often in these analyzes it is c alculate the percentage of traces, though , and one of them calculates the percentage of events.
    - Calculate percentage of traces ( 11 - 78.57 % ) : It consists of calculating the percentage of traces that a subset of traces represents.
    - Calculate percentage of events ( 3 - 21.43 5 % ) : It consists of calculating the percentage of events that a subset of events represents.

* + Applying the Disco attribute filter with the mandatory mode to "Calculate percentages" the following process map has been obtained (figure 13):

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Figure 13: Map resulting from filtering by " Calculate percentages" ( 2 0 % most frequent activities and 15 % of paths)

* A from the map of FIG 13 can be seen that before Calculate percentages, can perform various activities as Filter traces ( 4 - 28.57 %), calculate cycle time ( 3 - 21.43 % ) Calculate number of elements ( 3 - 21.43%), Group traces ( 3 - 21.43 % ), Calculate average activities per trace ( 2 - 1 4.29 % ), Identify bottlenecks (1 - 7.14 % ), Calculate frequency (1 - 7.14 % ) .

* Furthermore, calculate percentages in several occasions is endpoint trace (2 - 14.29 %) . Although also after carrying out this activity , in some analyzes, Calculate cycle time ( 4 - 28.57 %), Filter traces ( 2 - 1 4.29 % ) , Graphically represent a circular diagram of attributes (2 - 14.29%), Calculate number of elements ( 2 - 1 4.29 % ) , Identify attribute values ​​(2 - 14.29%), C when calculating attribute statistics (1 - 1 2.5 % ) , Calculate waiting time (1 - 12.5%), Identify bottlenecks (1 - 7.14%), Filter events by activities (1 - 7.14%) .

* In conclusion, the most frequent thing for this activity is Calculate percentage of traces and it is usually done mostly after Grouping traces or Calculate number of elements to know the percentage of traces grouped in each subset or to know the percentage of traces that a number of traces represents. that has been previously told .