IBM Cloud Pak for Business Automation Demos and Labs

IBM Process Mining

Use Process Mining to Improve Procure to Pay Process

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1 Introduction

1.1 About Process Mining

Process mining is a family of techniques in process management that support the analysis of actual business processes based on event logs. During process mining, specialized data mining algorithms are applied to identify trends, patterns, and details in event logs recorded by an information system. Process mining aims to improve process efficiency and understanding of processes.

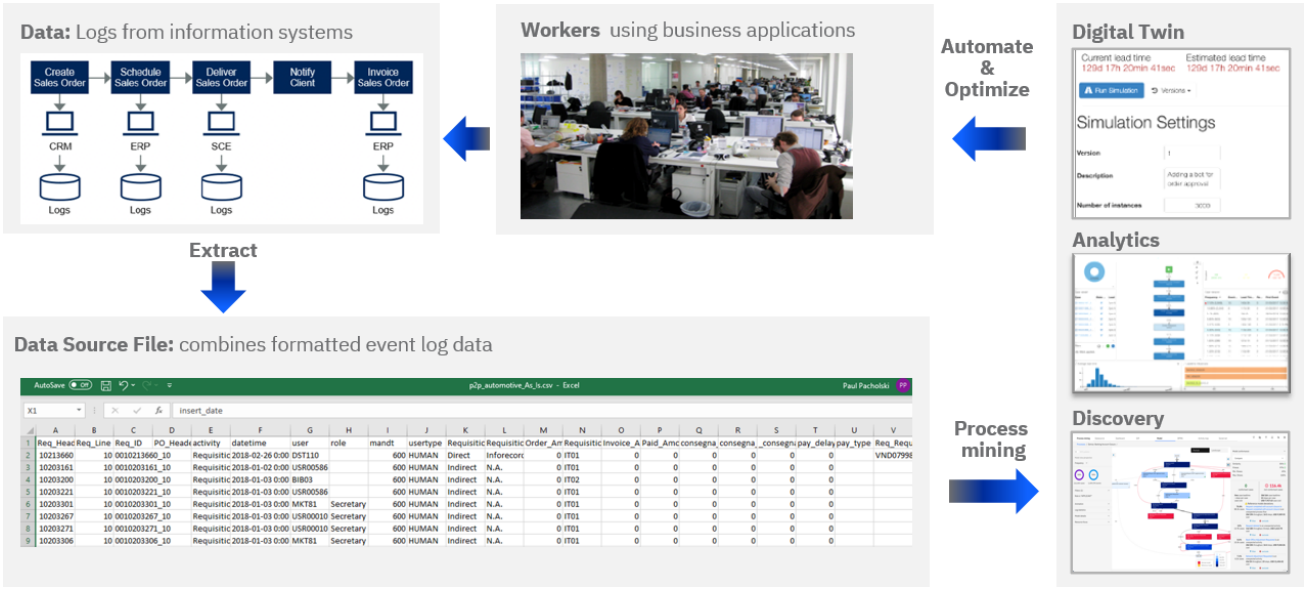


Figure 1. Process Mining

1.2 Process Mining Use Case Used in this Lab

1.2.1 Procure to Pay (P2P) Process

The Procure to Pay process connects the procurement and entire supply chain processes within a company through the goods receipt process and finally to the payment issued to the vendor.

In recent years, companies have carefully looked at their Procure to Pay processes to:

- Reduce overall supply chain and inventory costs
- Free up needed cash
- Improve operational performance
- Make improved financial decisions

In addition to reducing overall supply chain and inventory costs, improving the Procure to Pay Process can add visibility that allows management to have better communication with the vendor as to where the items are in the delivery process, and payment to the vendor.

1.2.2 P2P Process – Process Improvement Areas

In this lab we assume the role of an automotive manufacturer (JK Auto Inc.). JK Auto Inc.'s process improvement team wants to analyze their Procure to Pay Process using IBM Process Mining to identify process improvement opportunities.

There are five areas of P2P processes where process analyses can derive the greatest value. The figure below shows a high-level P2P process and highlights the key process improvement areas we will tackle in this lab. Note the potential cost savings or that can be achieved and losses avoided!

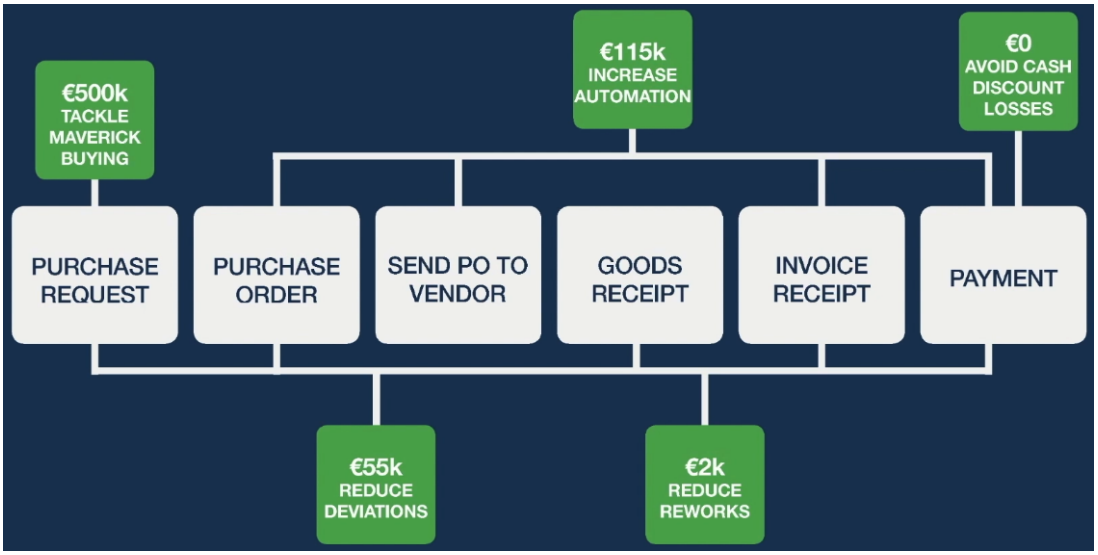


Figure 2. P2P Process Improvement and Automation Opportunities

1.2.3 P2P Process – Multilevel Process Mining

The P2P Process is SAP-based. The data came from SAP transaction logs and was gathered over 12 months. The four critical P2P processes and a typical set of SAP transactions required to complete them are shown in the figure below.

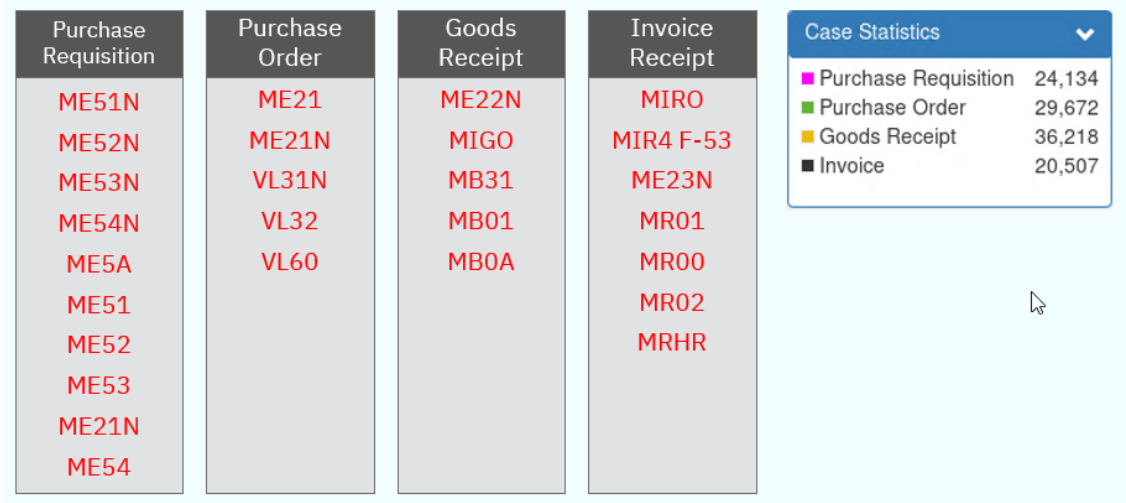
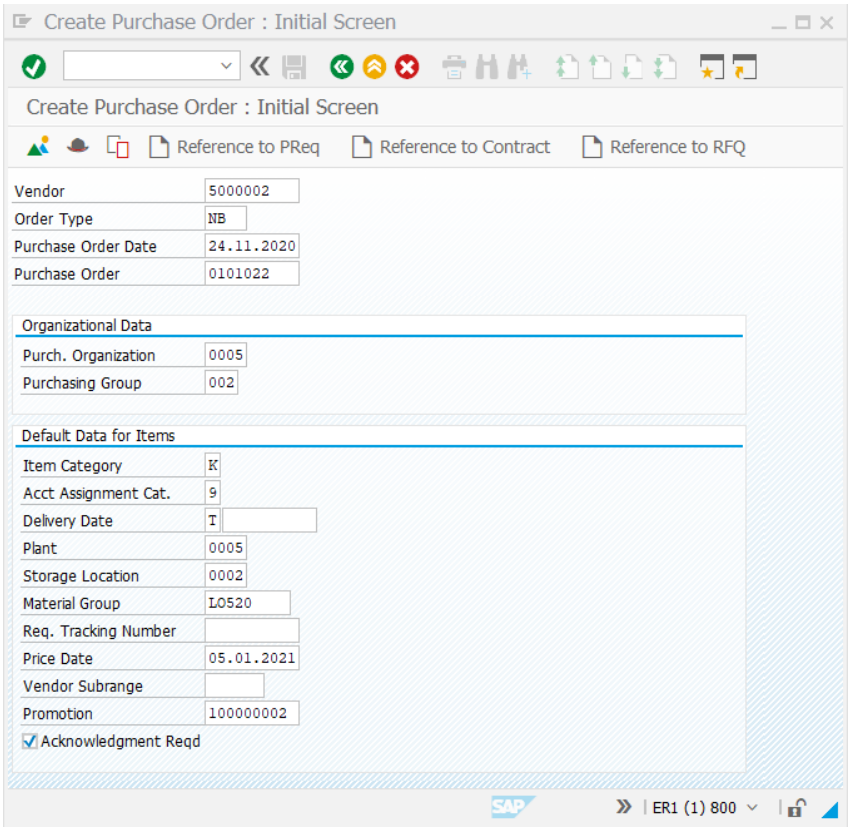


Figure 3. Multilevel P2P Processes Shown as Case Statistic in Process Mining Model View

Typically each distinct Process is completed by executing a set of related SAP transactions in varying Order including Rework. For example Purchase Order process typically involves execution of ME21, ME21N, VL31N, VL32, and VL60.

Here is an example SAP GUI screen of ME21 (Create Purchase Order) transaction:



1.3 Lab Objectives

The purpose of this lab is to enable you to demo (or just to explore and learn) how IBM Process Mining can be applied to improve and gain insights into JK Auto Inc.'s P2P Process.

After completion of this lab you will be able to deliver a live demo recorded in this video: https://ibm.box.com/v/Lab2ProcessMiningVideo. Note that the video may not depict the Process exactly as you will see it in this lab.

2 Lab Setup

2.1 Import Lab Files

_1. Download the following files. You will use them in this lab:

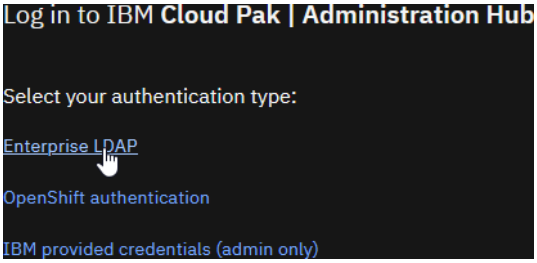
File	Link
P2P.zip	https://ibm.box.com/v/PM-LAB-2-DATASET
P2P_2021-10-28_074505.idp	https://ibm.box.com/v/PM-LAB-2-IDPFILE

2.2 Open IBM Process Mining Application

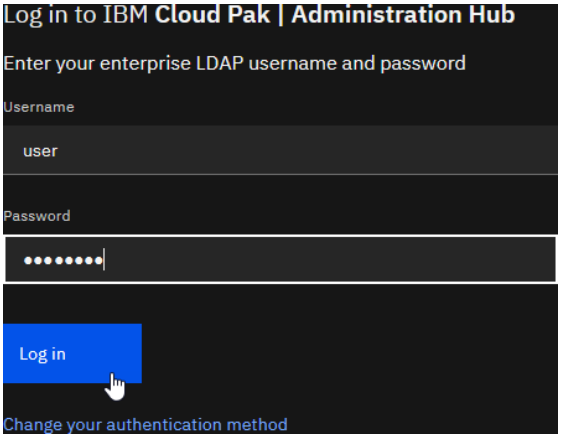
If you are performing this lab as a part of an IBM event, access the document that lists the available systems and URLs along with login instructions. For this lab, you will need to access **IBM Process Mining**.

_2. Start your browser and use the **IBM Business Automation Studio** link

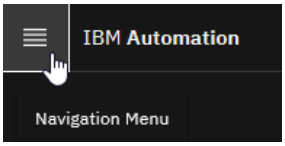
_3. Click **Enterprise LDAP**



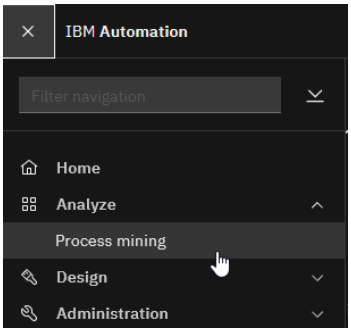
_4. Enter your username and password and then click **Log in**



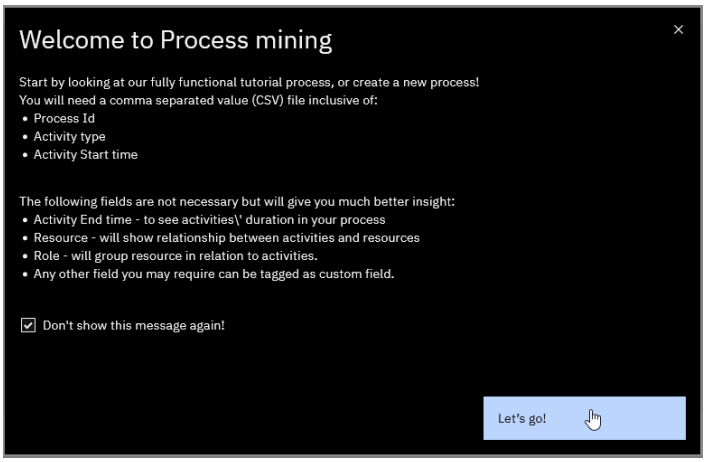
_5. Click **Navigation Menu**



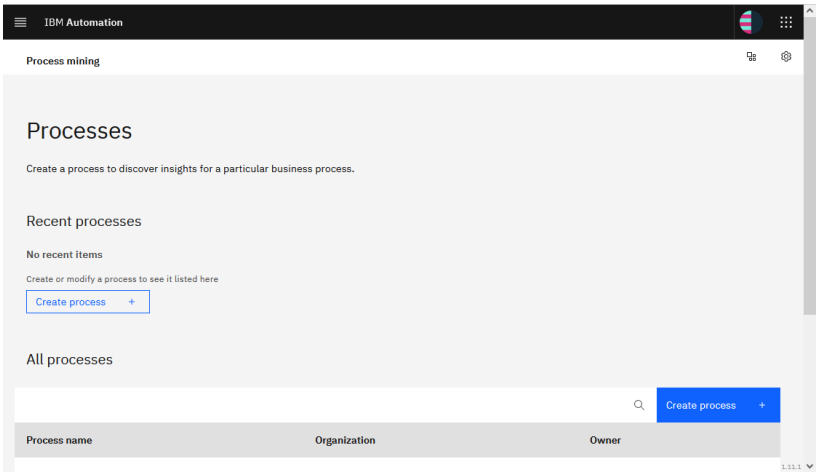
_6. Select **Process mining**



_7. If you see the Welcome window, check **Don't show this message again** check box and click **Let's go!**



You should now see IBM Process Mining web UI



3 Lab Instructions

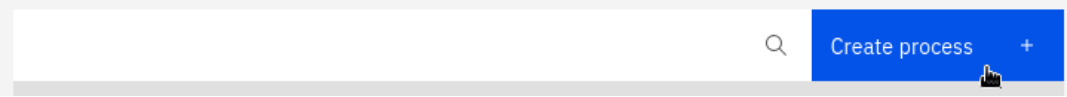
This lab will show you how to identify process improvement and business improvement opportunities by analyzing the data captured from JK Auto Inc.'s SAP-based processes. IBM Process Mining uses standard SAP BAPI-based scripts to extract business and process data that can then be imported as CSV files for process analysis.

3.1 Create a New Process

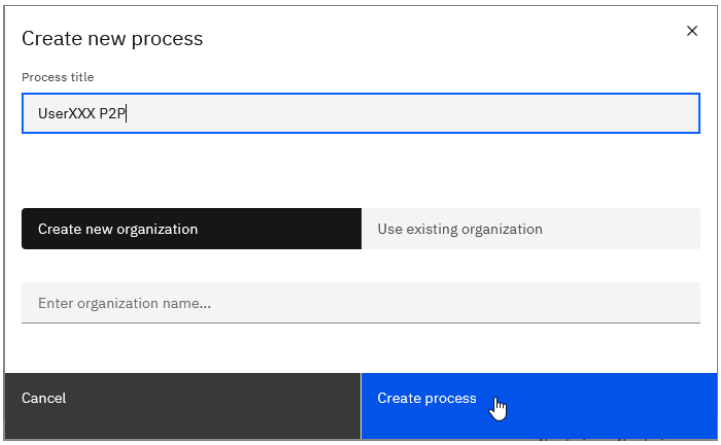
When you open a workspace, you can create a Process and Organization or a New Process in an Exiting Organization (in our case, you should see an organization called Tutorials).

Note: if you are using a shared environment, please use your user name prefix in the process name when creating a new process.

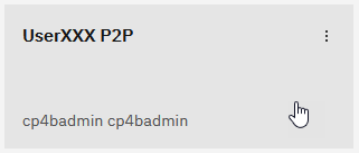
_1. Click in **Create process +**



_2. For *Process Title* enter **<Your User id> P2P** and click **Create process**



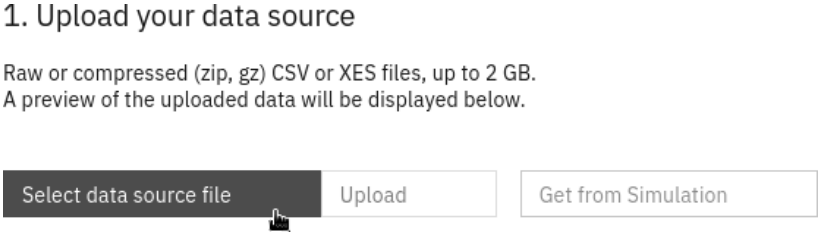
_3. Click **<Your User id> P2P**



3.1.1 Upload Process Data

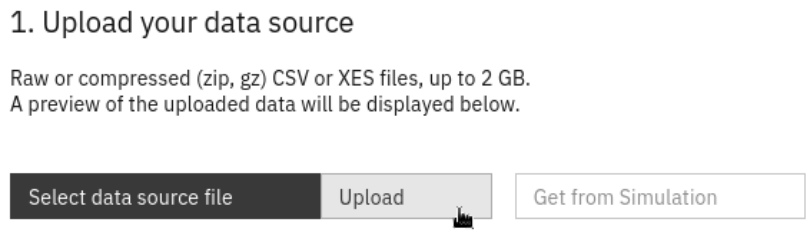
You will need to upload a log file (.CSV or .XES) containing mined process data into the Data Source to analyze the Process.

_1. Click **Select data source file** to upload a CSV data which was captured from an existing Oder Processing process



_2. Select **P2P.zip** then click **Open**

_3. Click **Upload**

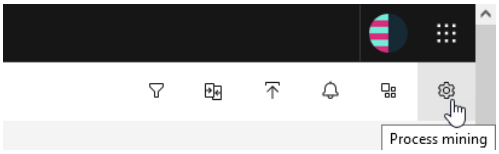


3.1.2 Import Project Settings

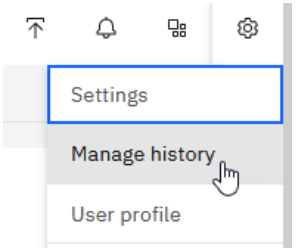
You will now import project settings that include the reference model.

Note: The reference model of a process describes its expected standard behavior in terms of activities and workflow. The reference model is usually designed in BPMN language by a process owner and can be imported to a Process Mining project.

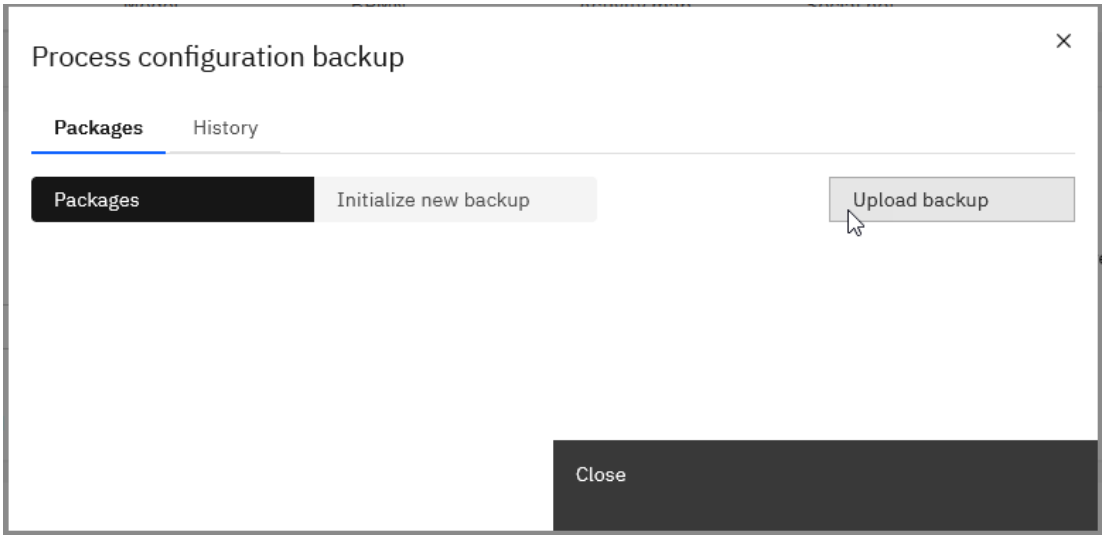
_1. Click **Process mining** icon on the toolbar



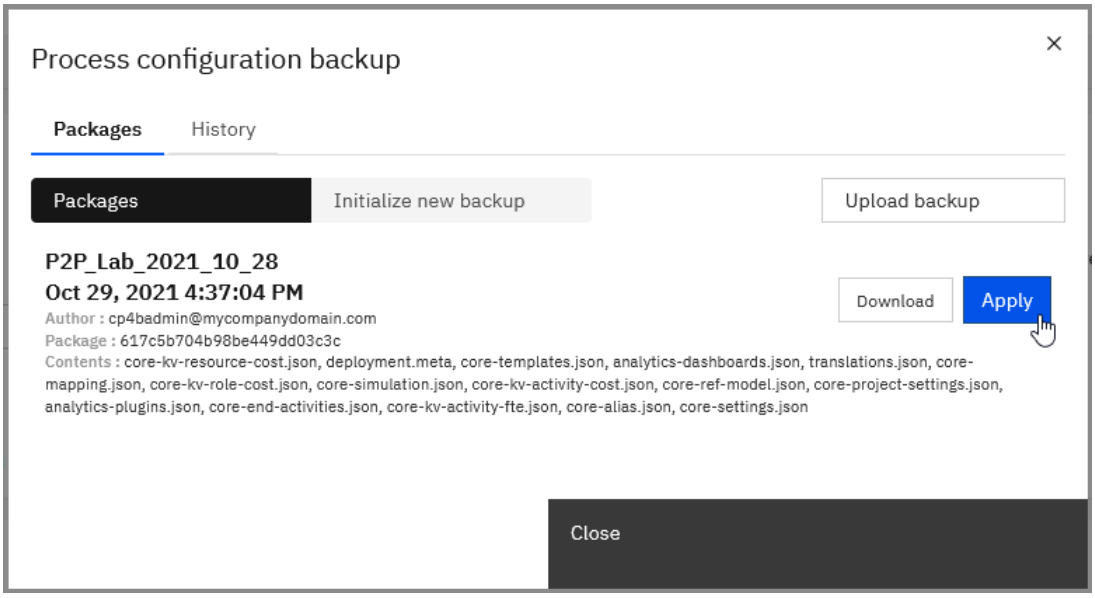
_2. Select **Manage history**



_3. Select **Upload backup**



_4. Select **P2P_2021-10-28_074505.idp** file and click **Apply**

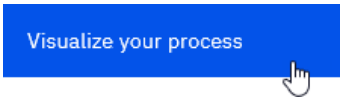


_5. Click **Close**

3.1.3 Visualize Process

This action will use the CSV file data to create the process model!

_1. Click in **Visualize your process** box



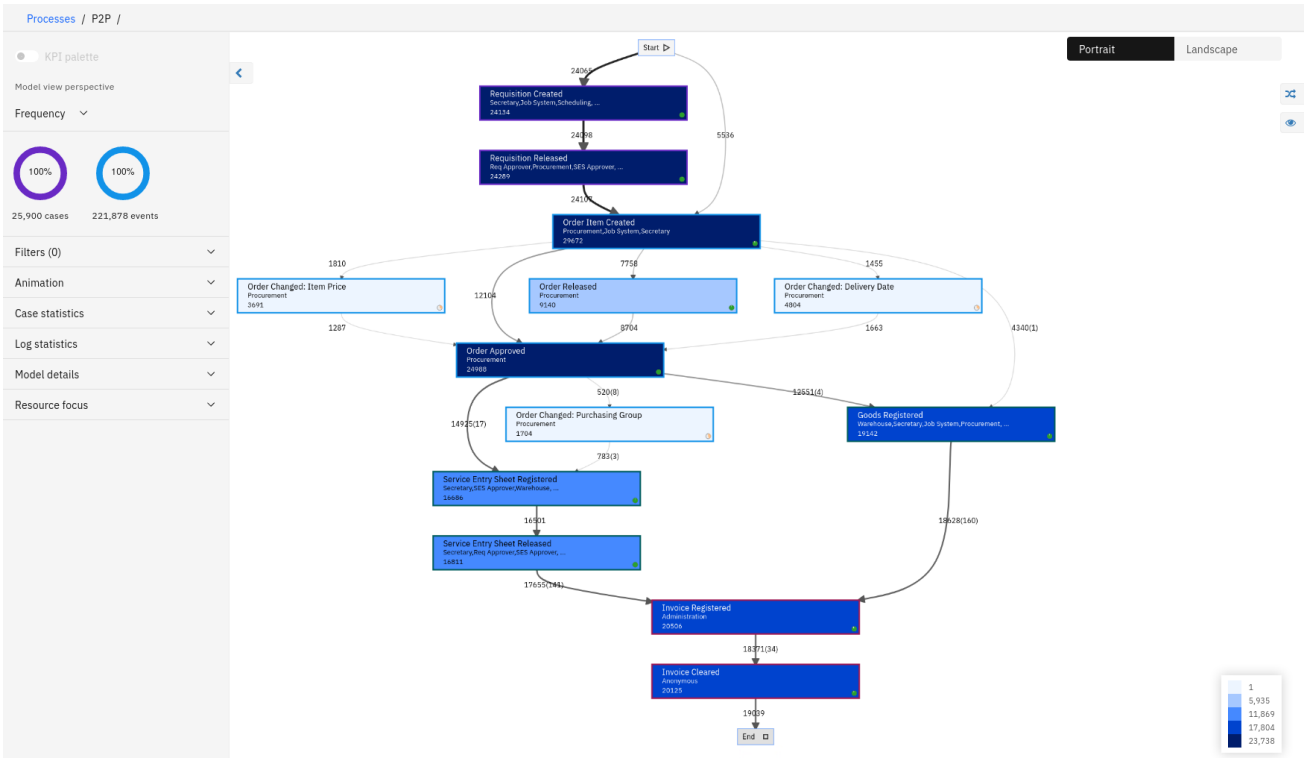
_2. **Wait** for the message box below to close.

3.2 Gain Process Improvement Insights

You can instantly gain process improvement insights by analyzing the multilevel P2P processes in a single view.

3.2.1 Model View

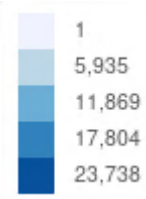
You should now see the default Model View which is the Frequency view.



Hint: Use the mouse wheel to zoom and the mouse right button to move the Process diagram. The Model automatically displays the frequency analysis. The dark blue color highlights the most frequent activities, while the bold arrows highlight the most frequent transitions. In this way, the most frequent paths between activities of the Process can be identified.

- The numbers next to the lines show how often that specific process flow has been followed.
- The numbers within the rectangles show the number of times that the Activity is performed
- The description in the rectangles indicates the name of the Activity and the roles by which the Activity is carried out. They could be more than one role (multiple roles followed by dots are displayed).

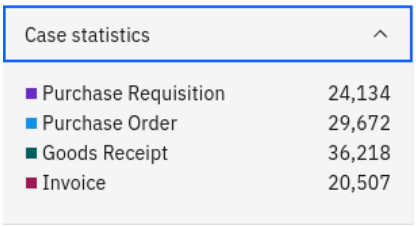
- The green circle at the bottom right corner of the activity rectangle indicates the Model coverage (100% indicates that the Model details cover all the possible relationships of that Activity. The percentage indicates how many possible relationships you are currently visualizing. The level of relations is adjustable)
- The color saturation of Activity reflects how often an activity was invoked (the frequency). The legend gives you the frequency coloring detail



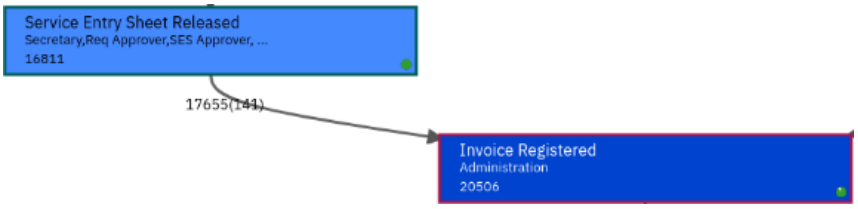
3.2.2 Multilevel Process View

Traditional process mining techniques analyze multilevel processes separately. Unique to IBM Process Mining, multilevel process mining provides a holistic view of the entire P2P Process allowing to discover and correlate sub-processes and their dependencies in a single tool.

_1. Open the **Case Statistics** legend to decipher the color scheme.

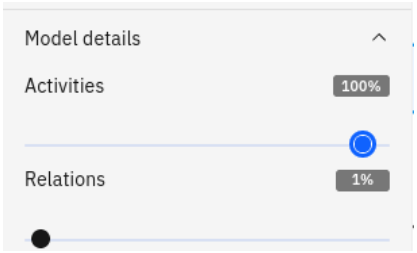


The colors of the Activity borders reflect the multilevel nature of the Process. For example, the first two activities correspond to the Purchase Requisition process, which represents potentially several SAP transactions!

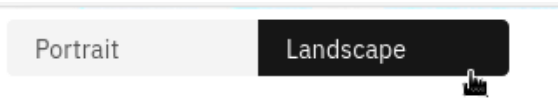


The visualization does not show all the captured data relationships and activity instances by default. This is to reduce any unnecessary complexity that may impair visualizing and exploring the Process.

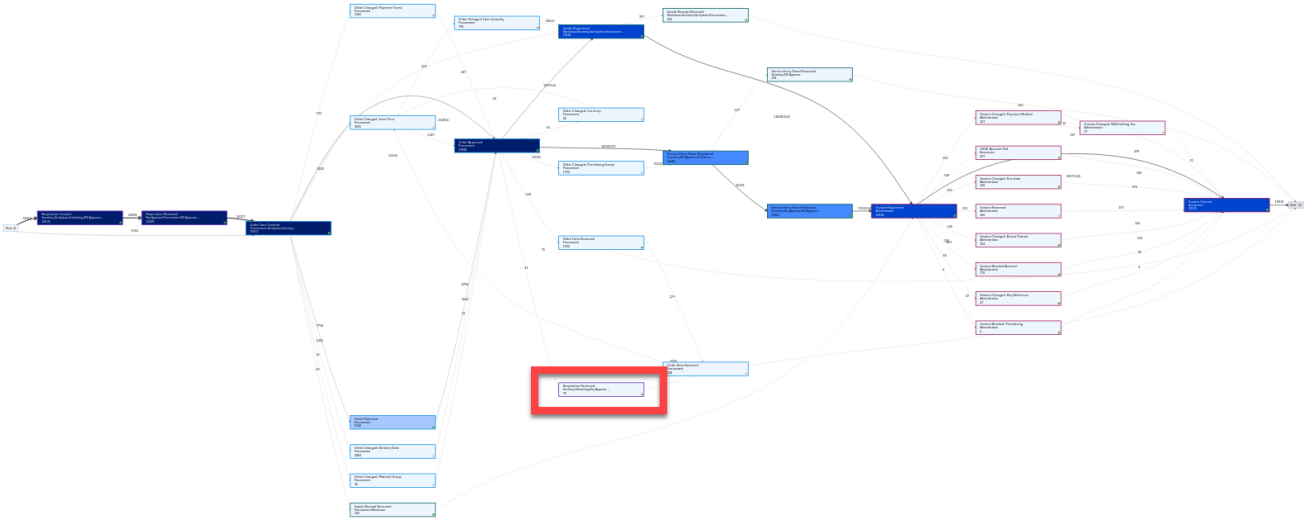
_2. To see all the activities that are part of the Purchase Requisition process, select **100%** for Activities in Model details



_3. Click **Landscape**

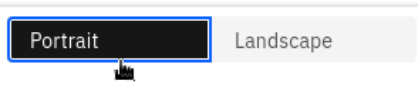


Note that now another Purchase Requisition process activity called *Requisition Reversed Activity* appears.

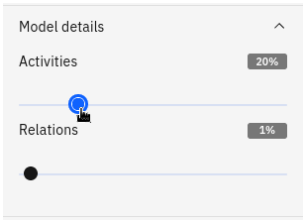


This is telling us that the Requisition Reversal step is rarely invoked in the Purchase Requisition process!

_4. Click **Portrait**



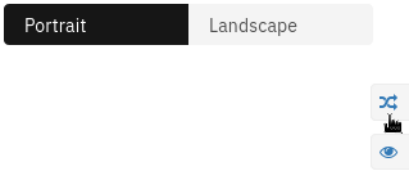
_5. Set the Activities frequency back to **20%**



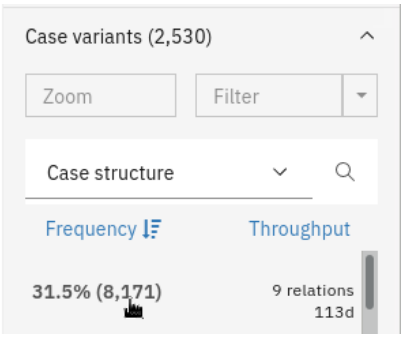
Similarly, if you set the Relations to 100%, you will see a bewildering spider web of connections that show all the transitions between process activities! Do not forget to reset Relations back to 1%.

3.2.3 Process Paths (Case Variants)

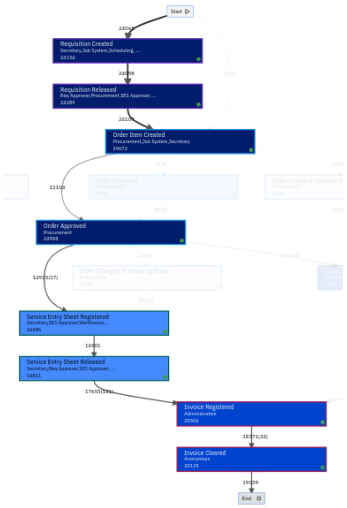
_1. Click the **tangled-arrows icon** in the top right corner.



_2. The Case variants view enables you to select what is shown in the Model. To select process paths by their frequency, click the top variant: **31.5% (8,171)**

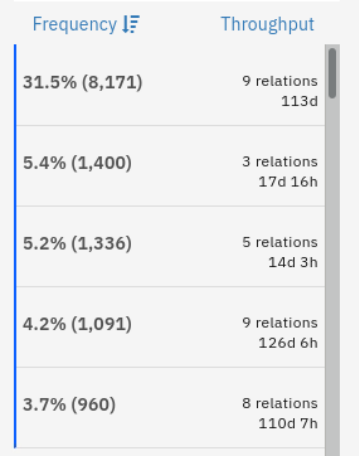


Note that now the Model shows only the selected process variant (process path).

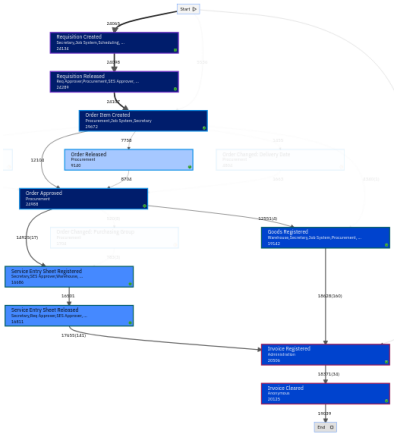


_3. Use **Ctrl key** to select the **first five** variants

If you are using Mac use the **Cmd** key instead



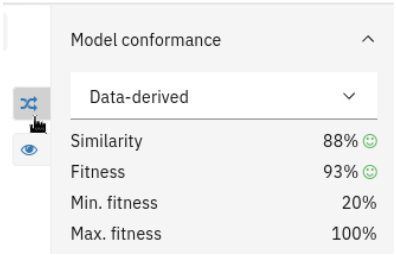
Notice now that you see fewer process paths in the Model. This is useful when you want to enhance the model readability or focus only on the process paths you want to optimize.



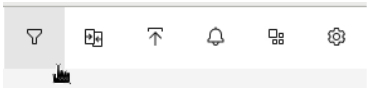
As you will see in the next step, it is possible to create a "top-five variants" Filter for some later use

_4. **De-select** all the variants.

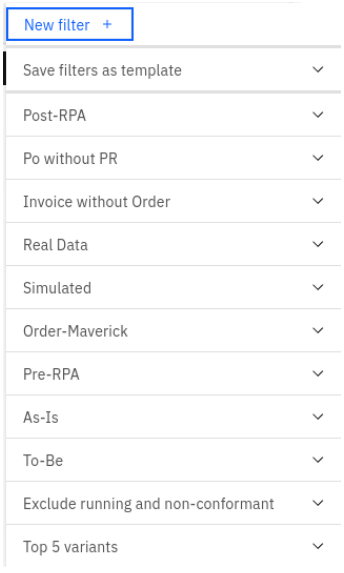
_5. Click the **tangled-arrows icon** to close the Variants view



_6. Click **Filters**



Let's examine the Filters feature...

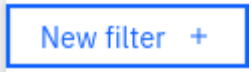


When working on Process and business improvements, you typically want to only work with the top 3-5 most frequent process variants or exclude running and non-conformant cases. To do this, you can create and save filters that satisfy these or any other requirements you may have.

We have already created some filters for you, including the top-5 variants Filter.

We have already done this for you in this lab. You will be using this Filter later in this lab.

If you like, click the **New Filter +** button to create your filters!

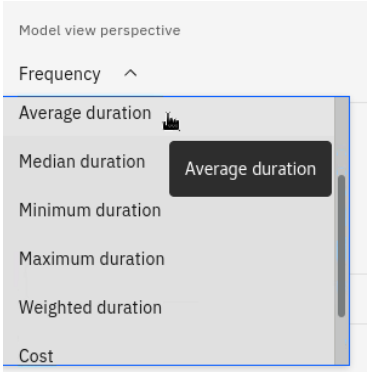


3.2.4 Process Performance -Bottlenecks

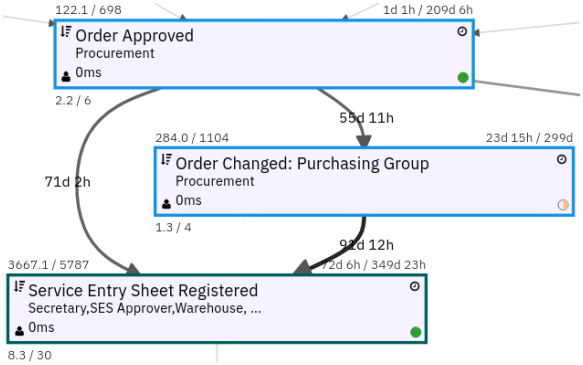
You can use the Duration View to determine which activities and tasks are creating critical bottlenecks and whose automation will lead to the most significant overall process time improvement.

Let's find bottlenecks in our P2P Process!

_1. Change the View from Frequency to **Average duration**



_2. **Zoom and center** on **Order Changed: Purchasing Group** activity



Since we are looking for process bottlenecks, we have selected the activities with the "thickest" transition arrows, which indicate the longest wait times.

The arrows connecting the activities include Wait Time values. Note that the longer the waiting time, the thicker the line. For example, the longest wait time in our example is 91d 12h to start the Service Entry Sheet Registered Activity after completing the Order Changed Activity.

The wait times between the activities shown above is significant and can be considered process bottlenecks worthy of further investigation. One possible root cause for the excessive wait time could be the lack of sufficient human resources to start working on the Service Entry Sheet Registered Activity.

_3. Change the View back to **Frequency**

3.3 Tackle Maverick Buying

Maverick buying is a term describing are purchase orders without a requisition or invoices without a purchase order. This includes off-contact methods of procurement or non-authorized purchases. Maverick buying makes the agreement with the supplier more expensive because the volume of the framework agreement decreases or goods are purchased at a higher price.

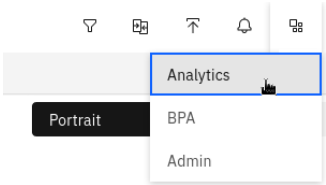
In our P2P Process, we can use process mining to help business analysts identify maverick buying by looking for:

1) Orders without a purchase requisition
2) Invoices without an order

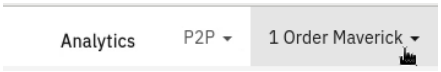
3.3.1 Orders without a Purchase Requisition

We will now examine some of the prebuilt dashboards specifically designed to tackle the Maverick Buying problem.

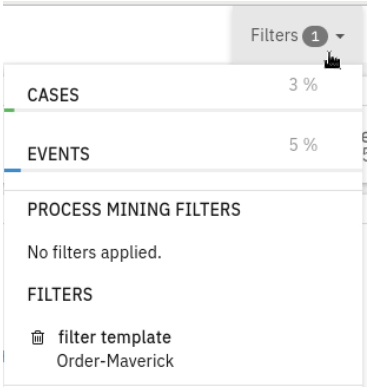
_1. Click the **chess-board icon** and then click **Analytics**



_2. If not already selected, select **1 Order Maverick** dashboard



_3. Click **Filters**



Note that this dashboard has the "Order-Maverick" filter applied. This Filter includes only the Cases that fulfill the following criteria:

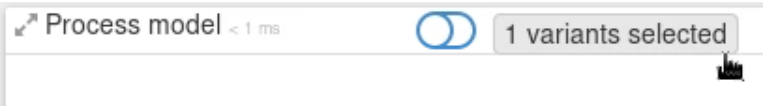
- ☐ Activity is not "Requisition Created"
- ☐ Exclude running cases
- ☐ Activity is "Order Item Created"

The Filter includes only the Cases where Order was created without a requisition!

3.3.1.1 **Variants**

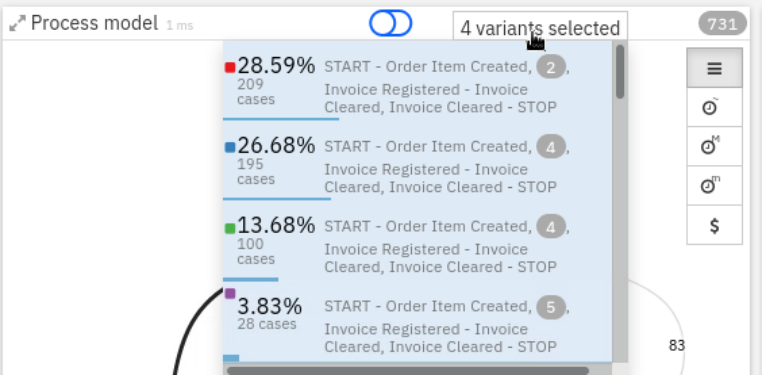
This View shows all the variants of the Cases that have the Maverick Buying problem.

_1. Click **1 variants selected**

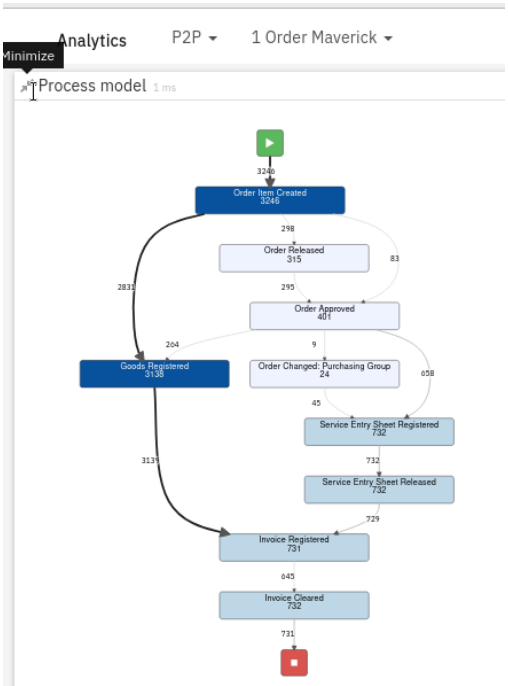


_2. Use **Ctrl** key to multiply select first 4 variants

> If are using Mac use the **Cmd** key instead

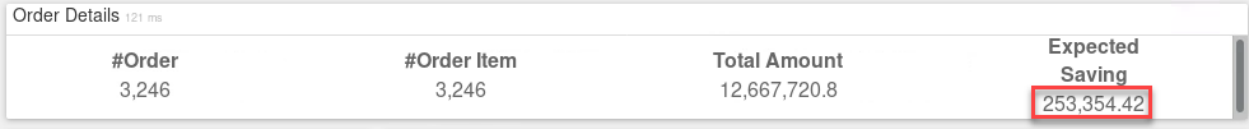


You should now see a more complex Process model view. Note that you can use the "expand icon" to maximize the Process model view

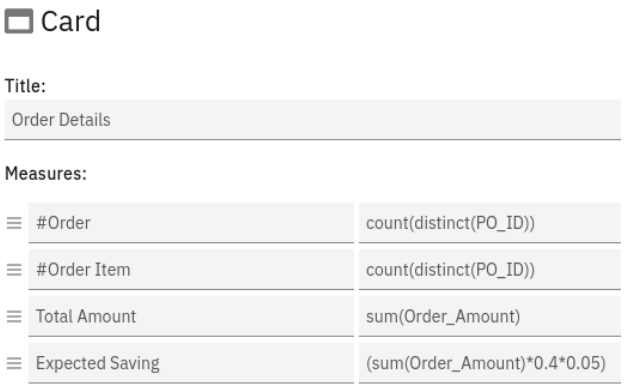


3.3.1.2 **Order details**

This Chart shows the expected savings.



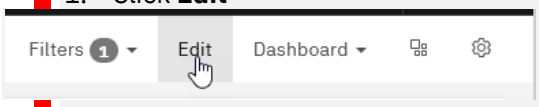
Note that the Order Details chart was created using these calculations:



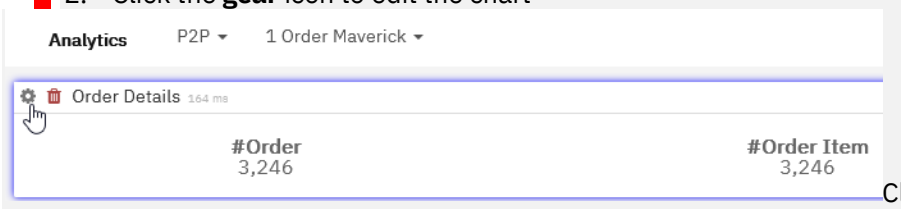
The "Expect Savings" are calculated as the missed discounts.

Note to see the calculations used to build the Other Details Chart you could follow these steps

1. Click **Edit**



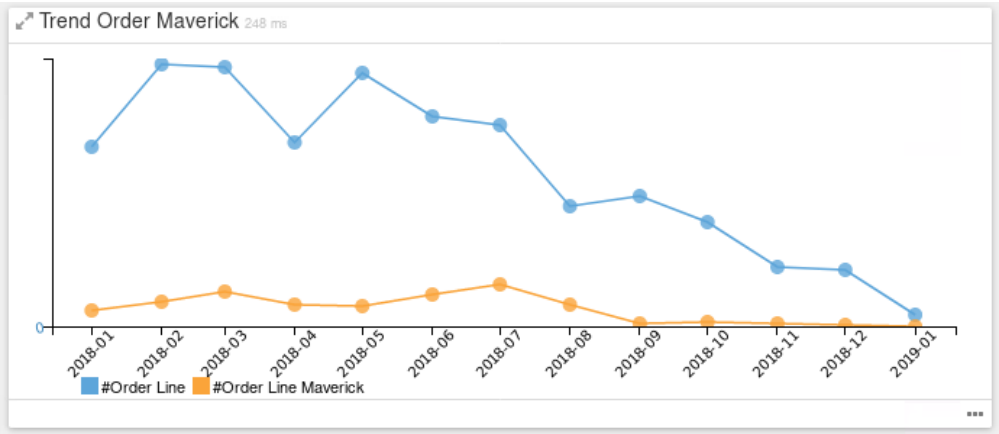
2. Click the **gear** icon to edit the chart



Click

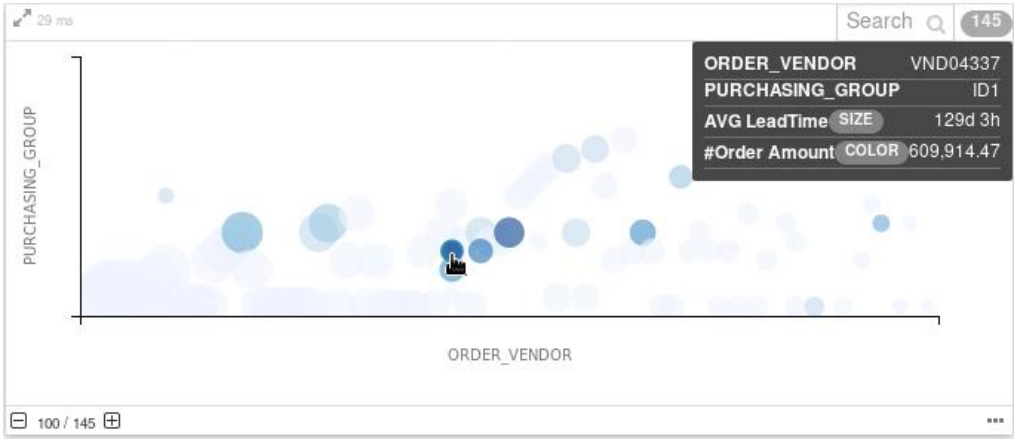
3.3.1.3 **Trend Order Maverick**

Shows volumes and dates of Maverick orders versus compliant orders.



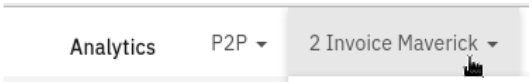
3.3.1.4 **Maverick Orders by Purchasing Group**

Shows order amount (the darker the color, the more significant the amount), vendor, and purchasing group.

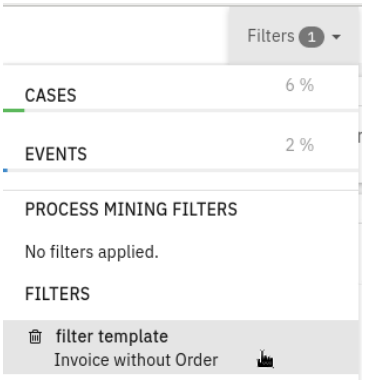


3.3.2 Invoice without an Order

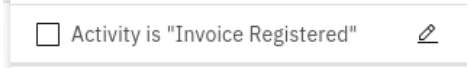
_1. For the dashboard, select **2 Invoice Maverick**



Note that the Filter has changed,

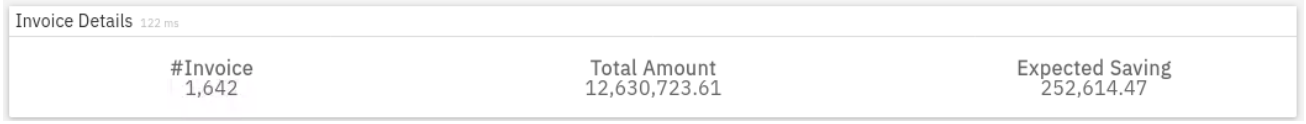


We are now showing only Cases that include "Invoice Registered" Activity which is only required when an Invoice without an Order is received!



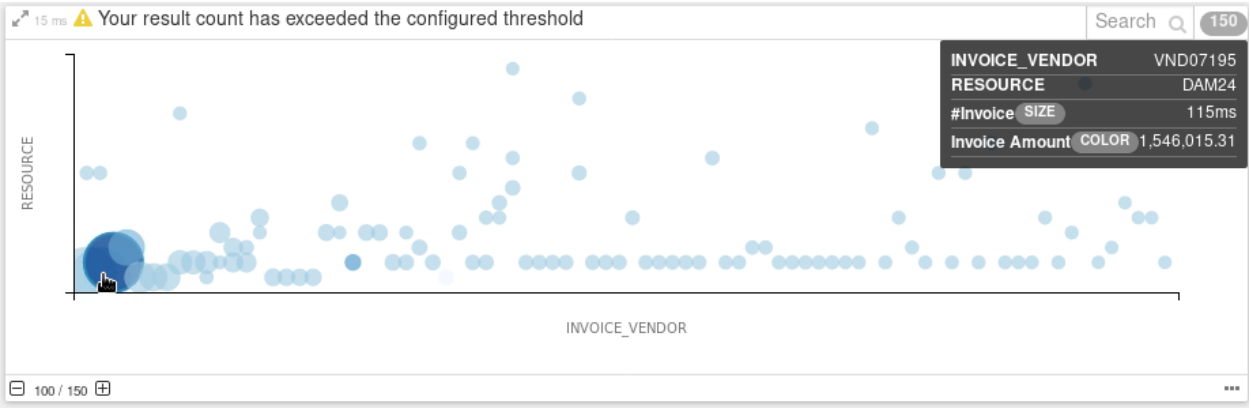
3.3.2.1 **Invoice Details**

This Chart shows the expected savings.



3.3.2.2 **RESOURCE vs INVOICE-VENDOR dashboard**

_1. In the **RESOURCE vs INVOICE-VENDOR** dashboard, select **the darkest dot**.



Note the total Invoice Amount of User DAM24 buying from vendor VND07195 without an invoice!

3.3.2.3 **Order Details**

Shows the vendors (Vendors) and, most notably, the users (Resource) who process invoices without orders!

Order Details 14 ms Your result count has exceeded the configured threshold

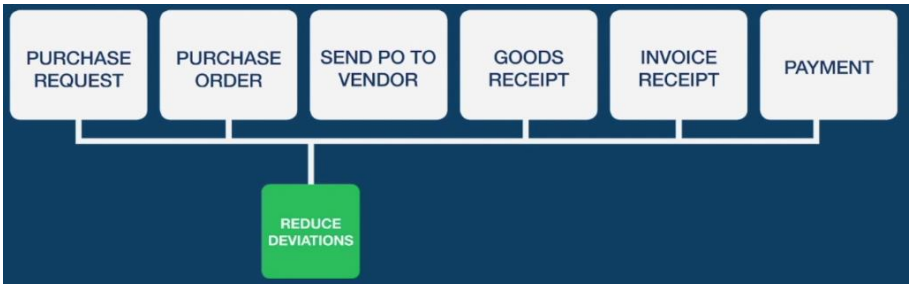
Search 150

INVOICE_ID	Vendor	Resource	Registration Date
2017030262_2017_IT10	VND05820	USR00953	01/02/2018
3017005717_2017_IT10	VND07630	USR00084	01/03/2018
3017005722_2017_IT10	VND07630	USR00084	01/03/2018
2018012689_2018_IT10	VND05120	DAM24	07/06/2018
2017030542_2017_IT10	VND04728	CONS0120	01/04/2018
3017005739_2017_IT10	VND03950	DAM78	01/04/2018
2018012707_2018_IT10	VND07910	DAM24	07/06/2018

3.4 Reduce Deviations

We can use process mining to identify process path deviations and discover the root causes and the impact of those deviations, such as a cost associated with extra resources and process delays.

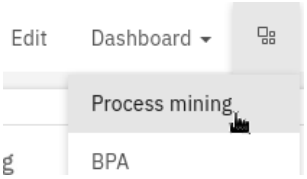
Process deviations are discovered by comparing the model discovered from process mining data with a reference model from Blueworks live or other BPM tools.



3.4.1 General Insights

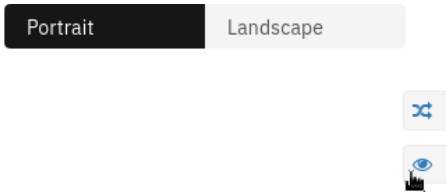
First, let's examine the cost of non-conformance and how pervasive the non-conformance is in the P2P Process.

_1. Click the chess-board icon and select **Process Mining** to get back to Model view.



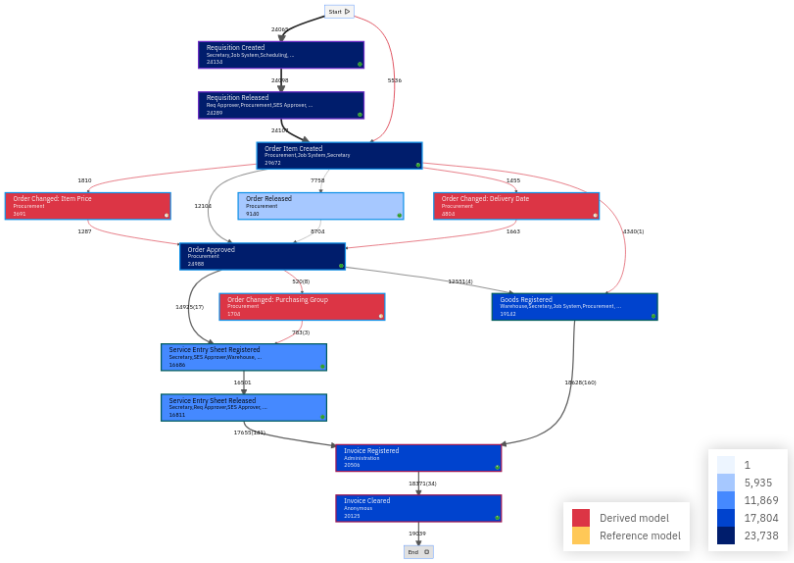
_2. Click the **left arrow** icon to hide the Model palette

_3. Click the **eye icon**

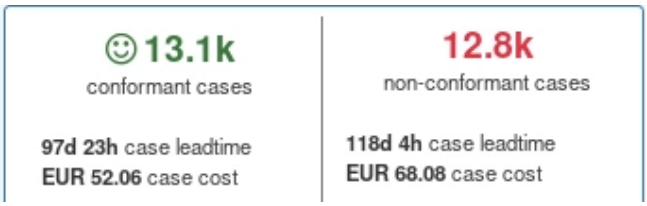


_4. It is easy to identify how pervasive the non-conformance in the P2P Process is:

- the red background color can identify the non-conformant activities
- the non-conformant transitions are also set to red



_5. Let's look at the Model conformance summary view to see the negative impact of the P2P process non-conformance on business.



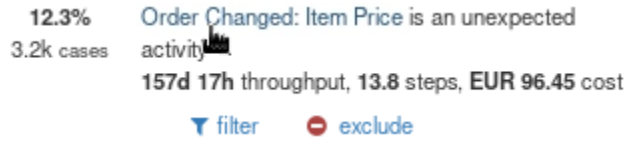
Note the following:

- 12800 instances (Cases) were not conforming to the reference model
- The average lead time (Lead Time is the amount of time between process initiation and completion) of non-conformant processes is about 21 days longer (subtract 97 from 118).
- The average cost of a non-conformant Process is about EUR 16 higher per case (subtract 52 from 68).

3.4.2 Root Cause Analysis

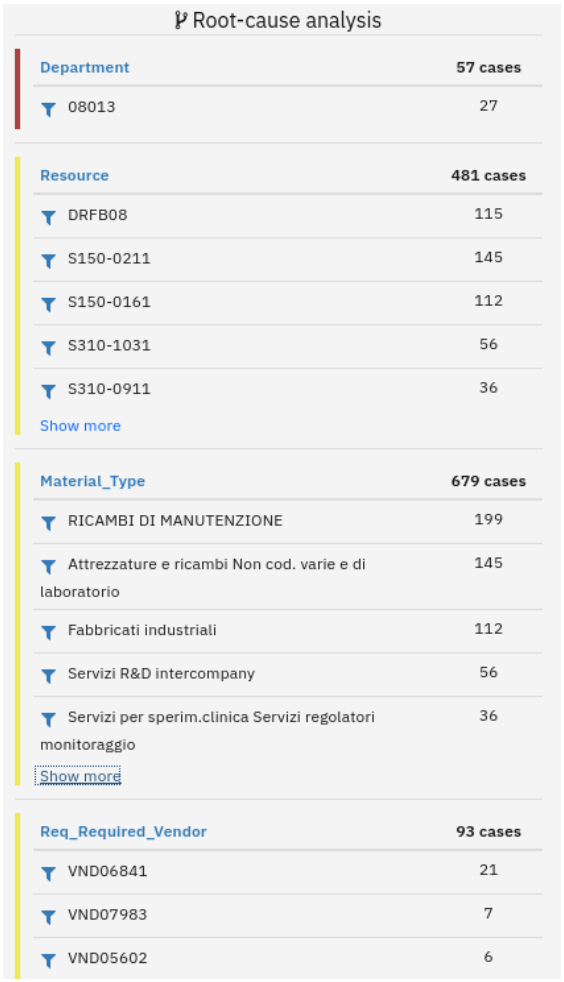
Once we identify non-conformant activities or transitions, we can use the Root Cause Analysis feature to obtain information derived from the custom fields in the dataset. For example, we can determine if a non-conformance involves a particular resource, role, supplier, product, company, etc.

_1. Click **Order Changed: Item Price** – the most frequent non-conformant deviated Activity.



_2. Let's examine this View.

In the root-cause analysis section, there is information about how many cases (where the deviation is present) involve a specific resource, role, supplier, product, company, etc. Depending on the criticality of the root cause, it may be colored red, yellow or grey.



Note the rich details available to determine the root cause of the Order Changed: Item Price activity being executed as part of the P2P Process.

You can see the specific Department, Resource, Material Type, and Vendor

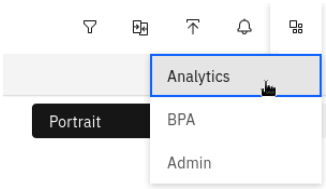
Depending on the criticality of the root cause, it may be colored red, yellow, or grey.

_3. Click the eye icon Click the **eye icon**

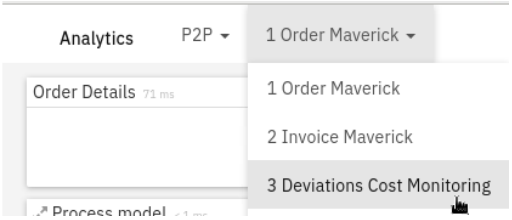
3.4.3 Cost of Deviations

We will now examine some of the prebuilt dashboards specifically designed to tackle the Cost of Deviations problem.

_1. Click the **chess-board icon** and then click **Analytics**



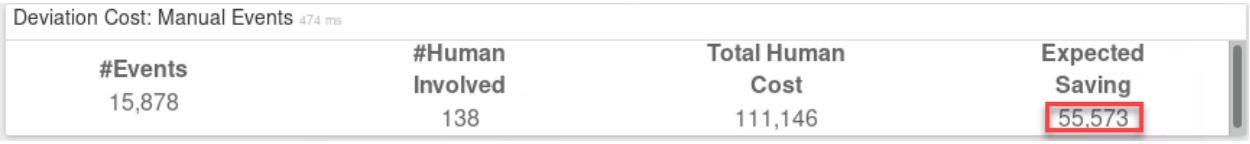
_2. Select **3 Deviation Cost Monitoring** dashboard



_3. Let's examine three charts in the Deviation Cost Monitoring dashboard

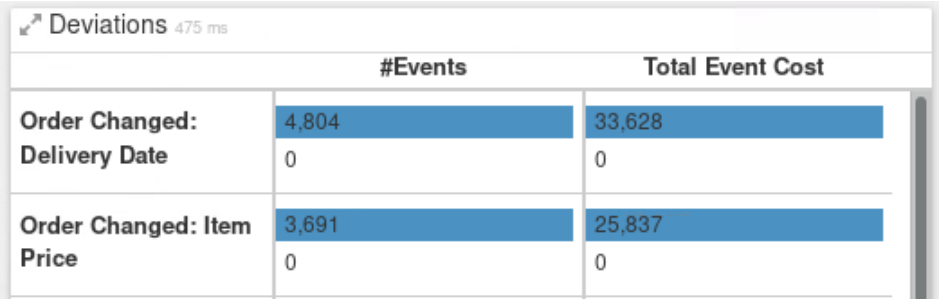
3.4.3.1 **Deviation Cost: Manual Events**

Shows the expected savings that can be achieved if the deviations were to be eliminated.



3.4.3.2 **Deviations**

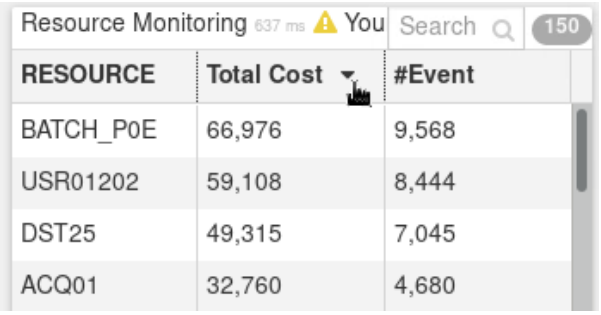
This Chart shows the activities identified as deviations from the reference model, including frequency and incurred costs. For example, the *Order Changed: Delivery Date* activity and *Order Changed: Item Price* activities are most frequent and costly.



3.4.3.3 **Resource Monitoring**

This Chart shows what users completed activities that were identified as deviations, including frequency and the associated costs.

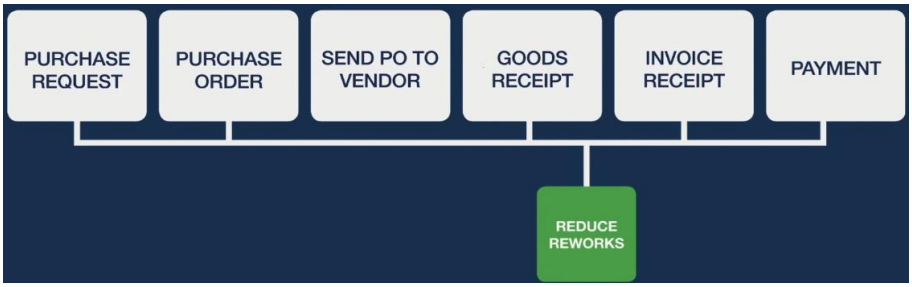
Note: Click the Total Cost or #Event column to sort in descending order



This View allows you to identify the users (RESOURCE column) who performed activities in the process paths that deviated from the reference model. The other columns show the total costs and the frequency. The first step to eliminate the deviations would be to investigate why the users felt it necessary not to follow the process paths defined by the reference model.

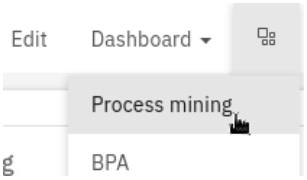
3.5 Reduce Rework

Activities that are repeated more than once in the same process instance are defined as Rework. Activities with reworks typically reveal errors when filling-out forms and can become candidates for automation by RPA.

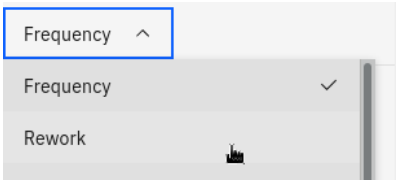


3.5.1 Rework View

_1. Click the **chess-board** icon and then **Process mining** to get back to Model view.



_2. Select **Rework** to change from Frequency to Rework view

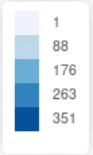


There are two kinds of Rework:

- if you can see an arrow that goes out and falls into the same Activity, it is called a **self-loop**;
- when, in the same process instance, the Activity is repeated several times, this is also called a **rework**.

3.5.1.1 **Rework**

Activities with Rework are marked according to the legend. The darker the activity color, the more time a rework occurred in the same process instance.

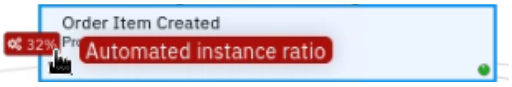


_1. Let's examine the Activity with the highest rework ratio in **Order changed: Delivery Date** Activity

- 438 instances included Rework
- On average, the Activity is repeated during each case 4.2 times.
- This Activity has 0% automation and considering the Rework possibly due to errors, and it may be a good candidate for RPA automation!

_2. Note that the red badge on the **Order Item Create** Activity.

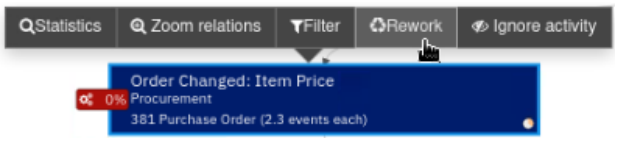
It shows the automation ratio for the Activity. In 32% of the instances (cases) in the P2P Process, a robot completed this Activity. Also, not the light background color, which indicates a lower level of Rework. Could this be the effect of a higher automation ratio?



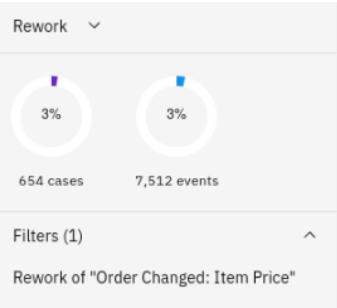
3.5.1.2 **Self-loop**

_1. Click **Order Changed: Item Price** activity. This is another Activity with a high rework ratio,

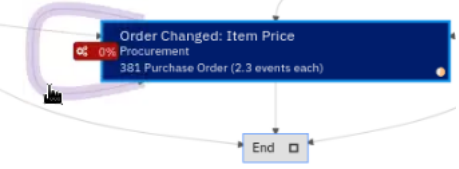
_2. Click **Rework**



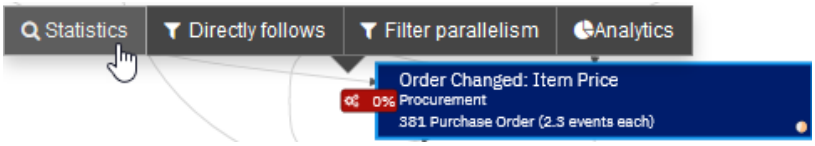
This action creates a Filter. Note that 3% or 654 instances (Cases) include this Rework.



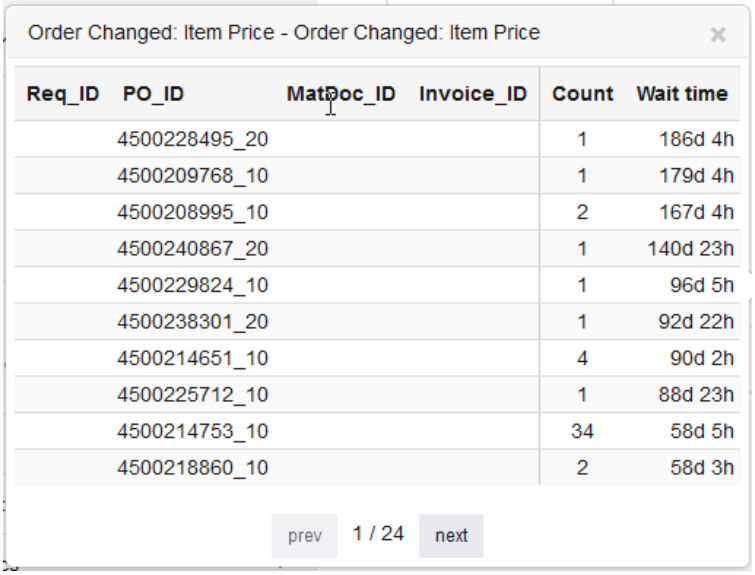
_3. Click the **self-loop link** on the **Order Changed: Item Price** activity



_4. Click **Statistics**

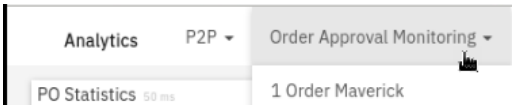


You should now see the details of the Cases that were involved in self-loop Rework.

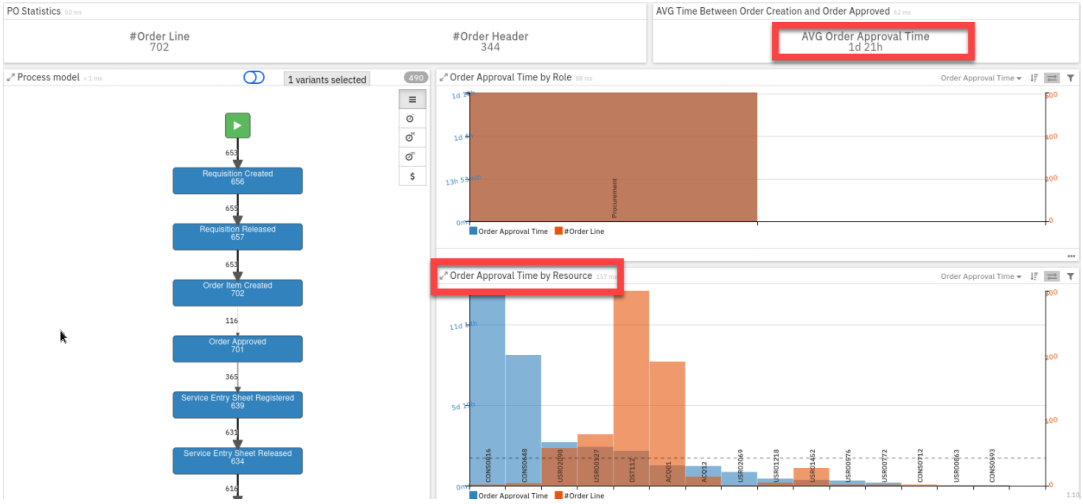


_5. Click **X** to close above the window.

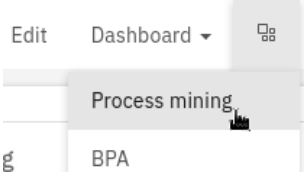
_6. Select **Order Approval Monitoring** dashboard



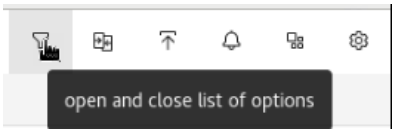
Note that you can examine the impact of the reworks in this Activity on the Order Approval KPI such as AVG Order Approval Time or identify what resources (people) were involved in reworks of this Activity.



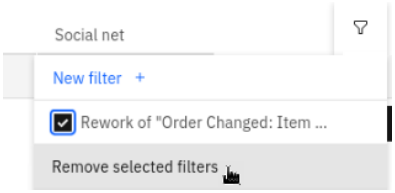
_7. Click the **chess-board** icon and then **Process mining** to get back to Model view.



_8. To remove the Filter, click **Filter icon**



_9. Select **Rework of Order Changed: Item ...** and then click **Remove selected filters**

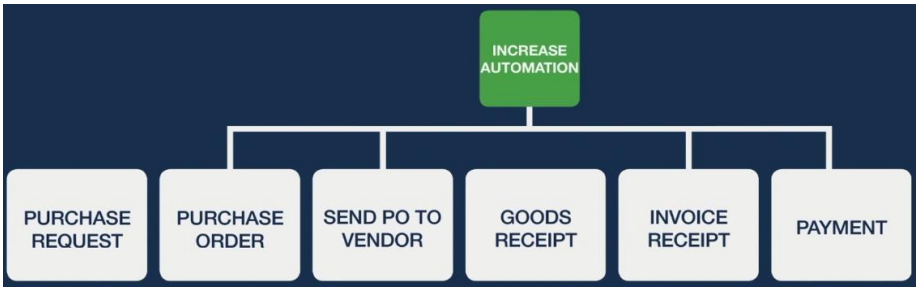


_10. Select **Yes** on *Remove project filters* Window.

3.6 Increase Automation

We will explore two ways to use process mining insights to automate JK Auto Inc.'s P2P Process:

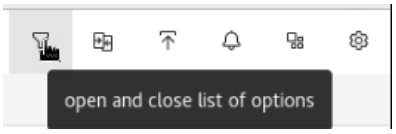
- Automation of Activities
- Understanding and optimizing process paths



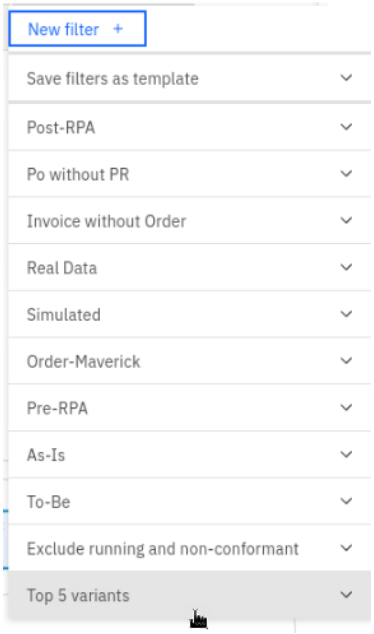
3.6.1 Increase Automation Analysis Setup

In our automation opportunity analysis, let's focus only on the top 5 variants and exclude the outliers (less frequently executed process paths.

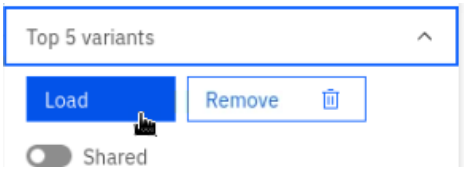
_1. Click **Filter icon**



_2. Select **Top 5 variants**



_1. Click **Load**



3.6.2 Automation of Activities

In this part of the lab, you will explore two IBM Process Mining capabilities:

- **Ability to identify automating candidates.**

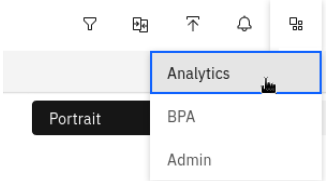
  First, we will identify the most impactful automation opportunities for the process KPI, such as Costs reduction or Lead Time reduction.

- **Simulation**.

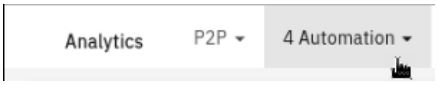
  Once the candidates for automation are identified, we will use **the what-if simulation capabilities** to understand the impact of the automation by comparing the simulation data to the original data captured from the logs. This will enable process owners to determine the ROI before implementing any process improvement initiative, such as Robotic Process Automation.

3.6.2.1 **Identify Automation Candidates**

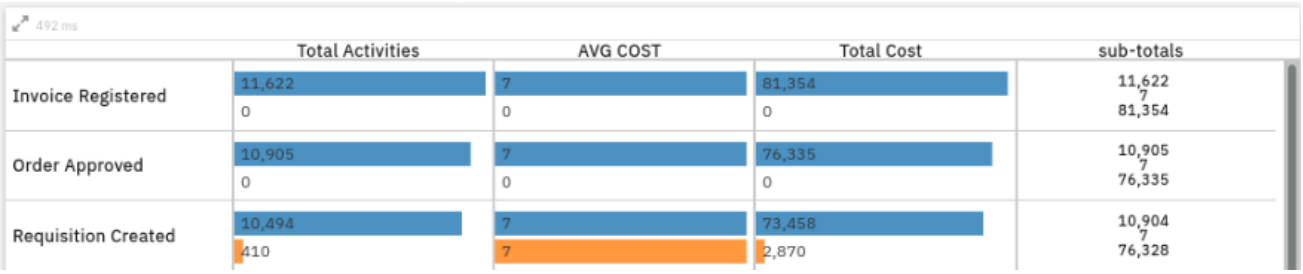
_1. Click the **chess-board icon** and then click **Analytics**



_2. Select **4 Automation** dashboard



Note the three most costly activities.



The first two Activities have not been automated. The third Activity has been automated using RPA, but not entirely. It could benefit from increased automation by investing in more RPA bot licenses.

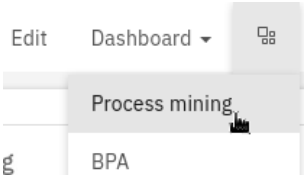
In the next step, we will perform a simulation to see the ROI and the benefits of the three most costly activities.

3.6.2.2 **Use Simulation Results to Determine ROI**

Let's create and configure a simulation.

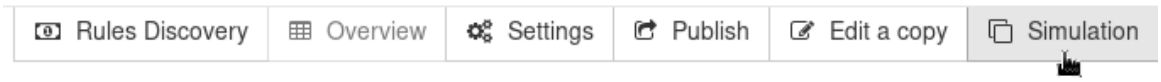
3.6.2.2.1 Create Simulation

_1. Click the **chess-board** icon and then **Process mining** to get back to Model view.

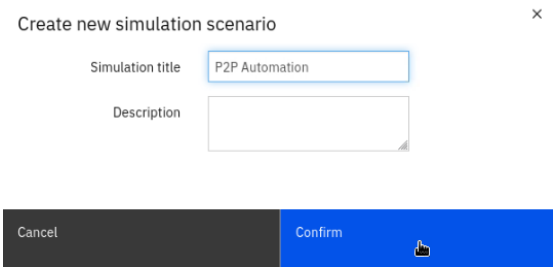


_1. Click **BPMN** tab

_2. Click **Simulation**

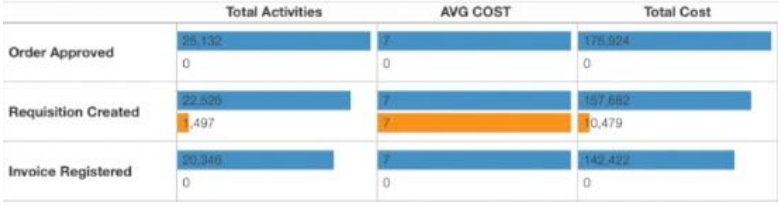


_3. For Simulation Title enter **P2P Automation** and click **Confirm**



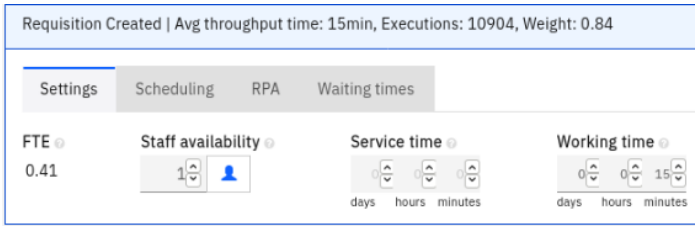
3.6.2.2.2 Configure Simulation

Recall that we discovered automation opportunities for the three activities shown below with the highest total cost:

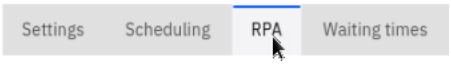


_1. Set Number of instances to **12,958** (to match the number of instances we have after applying the Filter)

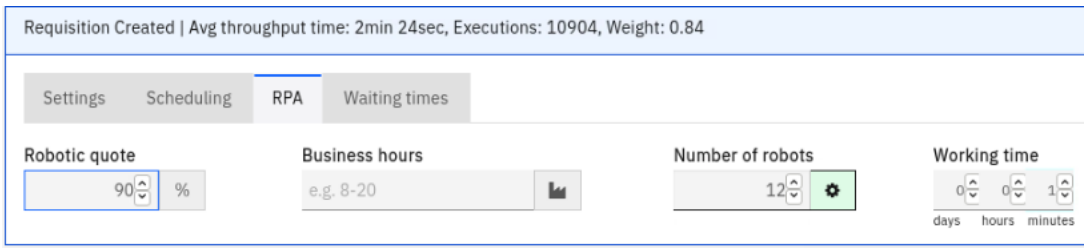
_2. In the Settings section of the **Requisition Created** Activity. Reduce Staff availability from 14 to **1**



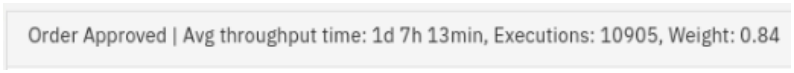
_3. Click **RPA** tab



_4. Set Robotic quote to **90**, Number of robots to **12,** and Working time to **1** minute



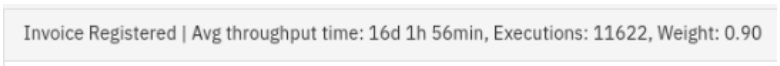
_5. Locate *Order Approved* activity



_6. Change the following settings:

- Settings > Staff availability: **1**
- RPA > Robotic quote: **90**
- RPA > Number of robots: **12**
- RPA > Working time: **1**

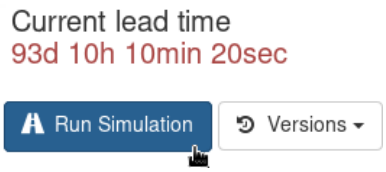
_7. Locate *Invoice Registered* activity



_8. Change the following settings:

- Settings > Staff availability: **1**
- RPA > Robotic quote: **90**
- RPA > Number of robots: **12**
- RPA > Working time: **1**

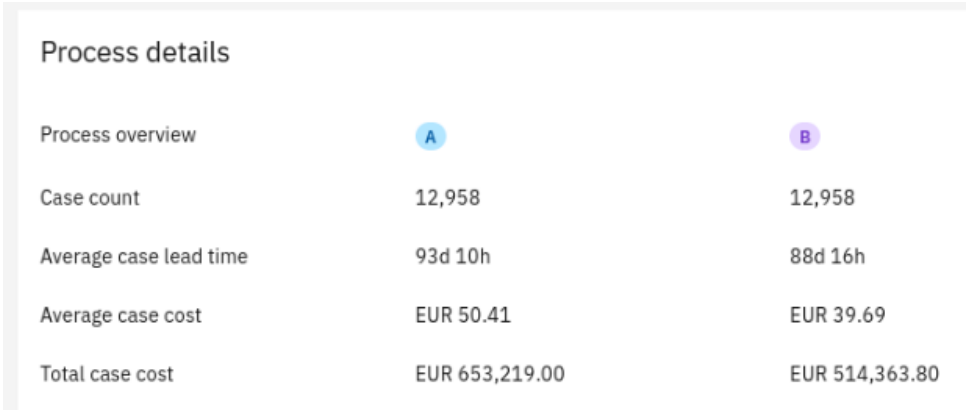
_9. Click **Run Simulation**



_10. Wait for the Simulation in progress to close

3.6.2.2.3 Examine Simulation Results

The Process overview table provides a summary of key metrics. **A** represents the as-is Process, and column **B** represents the simulation results



Notice that decrease in *Average case lead time*, decrease in *Average case cost,* and finally decrease in *Total case cost*!

3.6.3 Optimization of Process Paths

There are two ways the decision logic information gained through process mining can be used to increase automation:

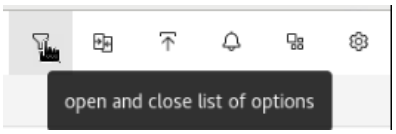
- Leveraging DMN data to implement decision automation
- Changing decision gateway settings in IBM Process Mining simulation future

3.6.3.1 **Leveraging DMN Data to Implement Decision Automation**

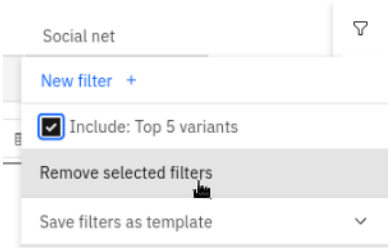
Decision gateways in a BPMN process diagram control process paths. The Decision Rules Mining (DRM) capability can automatically discover the correlations within the uploaded and mapped data onto IBM Process Mining. This DRM capability enables IBM Process Mining to detect the decision rules that govern the process automatically.

_1. Click **BPMN**

_2. Click **Filter icon**

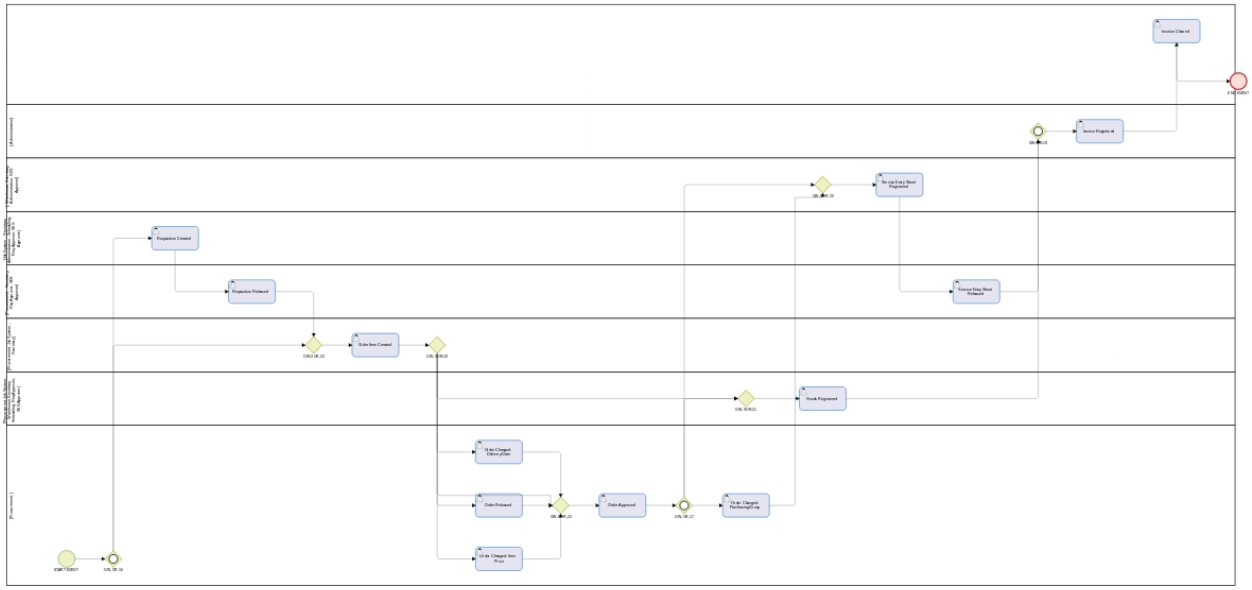


_3. Select **Top 5 variants** and then click **Remove selected filters**

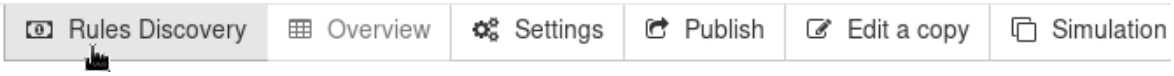


_4. Select **Yes** on *Remove project filters* Window.

You should now see a more complex BPMN diagram than includes all process paths.



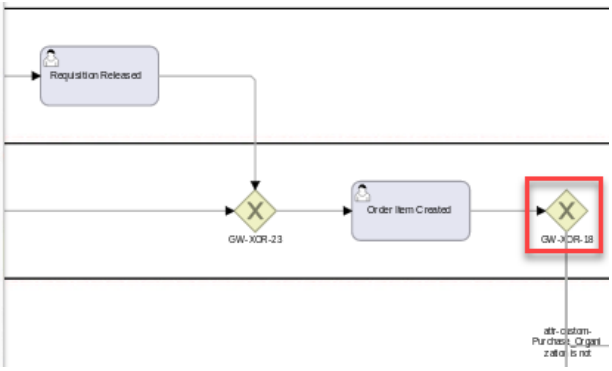
_5. Click **Rules Discovery**



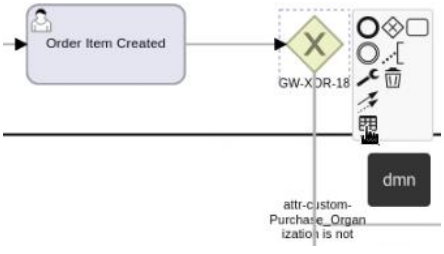
_6. Wait for the *Loading* message to clear, this may take few minutes.

_7. Click **Edit a copy**

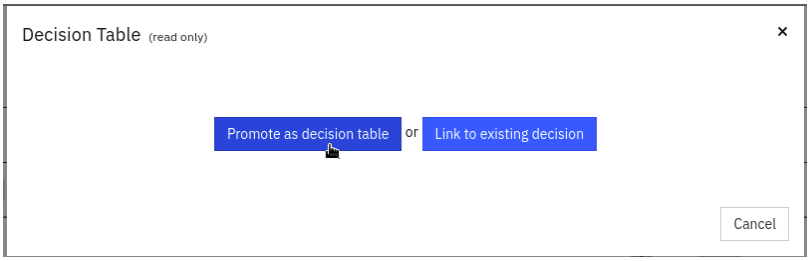
_8. Find Gateway **GW-XOR-18**, use the mouse wheel to zoom.



_9. Click Gateway **GW-XOR-18** and select **DMN**



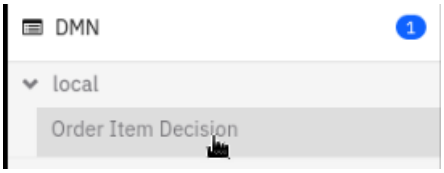
_10. Click **Promote as a decision table**



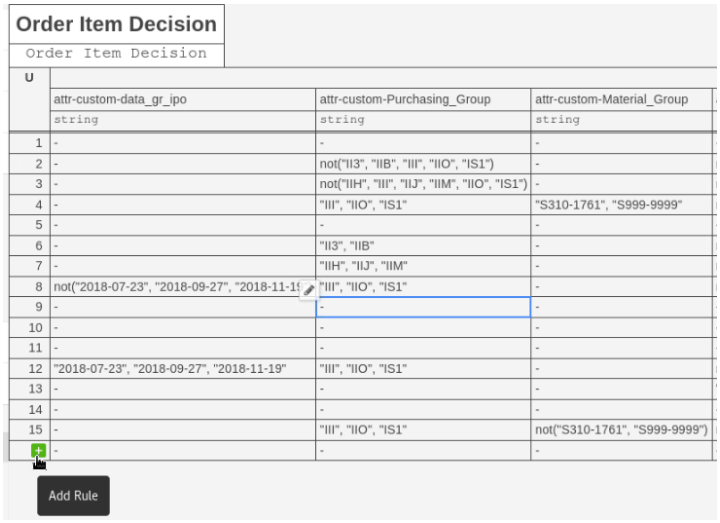
_11. For Decision name enter **Order Item Decision**, for Output variable name enter **order_item_decsions** and click **Next**

_12. Click **X** to close the decision table

_13. Select and click **DMN > local > Order Item Decision**



Note that this DMN decision table is fully editable, including adding or changing the rules (rows in the DMN table). Also, note that the columns correspond to the custom variable defined for this process model in the input CVS file.

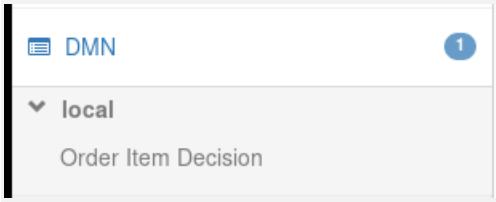


_14. **Scroll to the right** to see the last table column

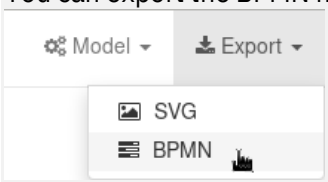
Output + order item decsion	Annotation
Order Changed: Delivery Date	-
Order Approved	-
Order Approved	-
Order Approved	-
Order Released	-
Order Released	-
Order Released	-
Order Released	-
Order Changed: Item Price	-
Order Changed: Item Price	-
Order Changed: Item Price	-
Order Changed: Item Price	-
Goods Registered	-
Goods Registered	-
Goods Registered	-

According to the BPMN process diagram, the last column represents the DMN output variable is the name of Activity to execute next.

Note:
You can export the BPMN process to orchestrate the activities captured by process mining and then use the DMN decision table definition to implement decisions directly in the BPMN process or externally using IBM Automation Decision Services.



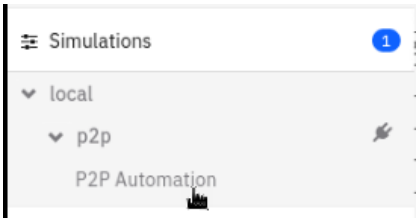
You can export the BPMN model from this View:



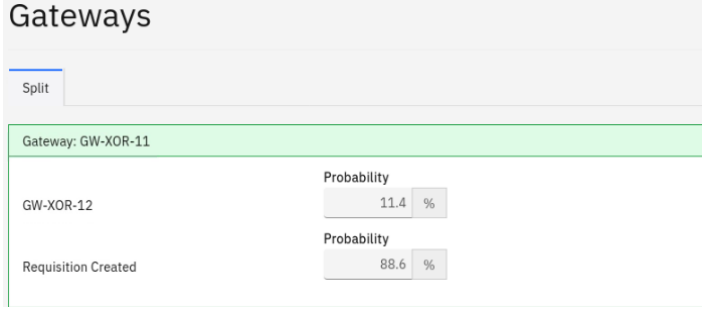
The exported BPMN model will include the DMN decision table information. It is not a DMN export.

3.6.3.2 **Changing decision gateway settings in IBM Process Mining simulation future**

_1. Select **Simulations > local > p2p** and click **P2P Automation**



_2. **Scroll to the end** of the Simulation page



The Gateways simulation configuration section in Simulation configuration allows changing the distribution of the Gateway outputs. Note that Simulation does not consider the actual values of the business data.

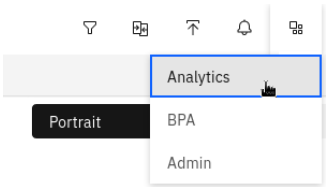
3.7 Avoid Cash Discount Losses

To support JK Auto Inc.'s Spend Under Management (SUM) initiative, process mining can be used to improve the purchasing process's transparency. We will now explore using process mining to monitor and better manage payments to suppliers.

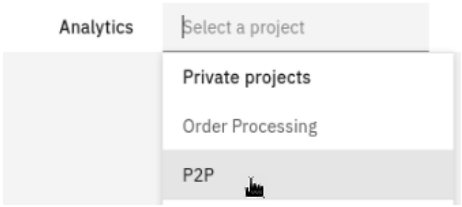
There are two aspects of SUM that JK Auto Inc. wants to focus on:

- Late Payments of Supplier Invoices. A costly inefficiency with significant business impacts:
  - Detrimental to organization's valuable supplier relationships.
  - Poor relationships and missed opportunities for preferable terms on critical goods and services in the future.
  - Additional interest payments
- Early payments. Another costly inefficiency with significant business impacts:
  - Paying early can yield substantial benefits in situations where suppliers offer discounts or rebates for early payment.
  - Cash discount loses result when early payment option is not exercised

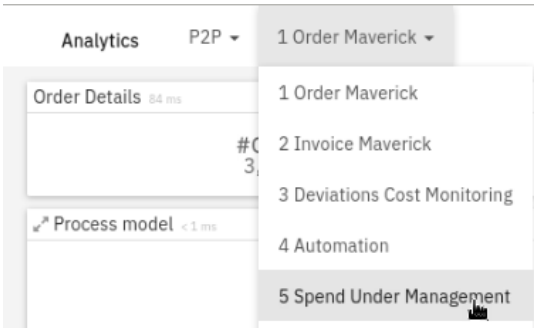
_1. Click the **chess-board icon** and then click **Analytics**



_2. If not already selected, select **P2P** project

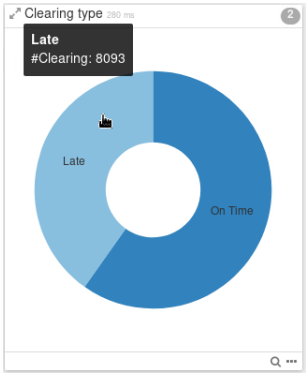


_3. Select **5 Spend Under Management** dashboard

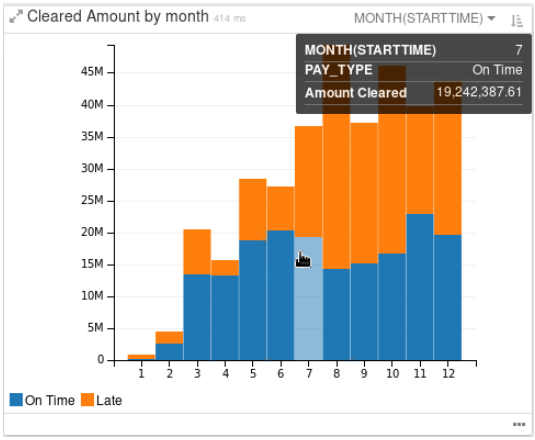


3.7.1 Late Payment

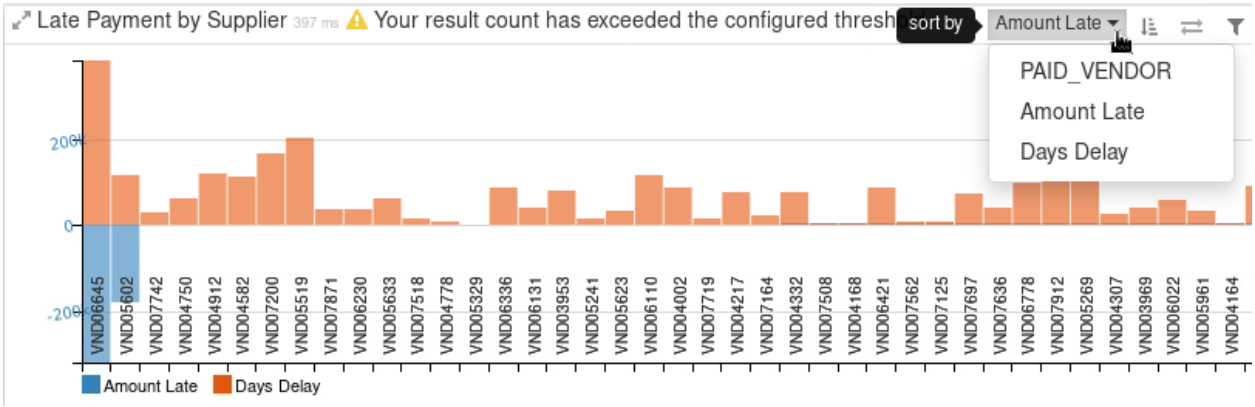
Clearing type – this View shows instances that incurred resulted in late payment of vendor invoices.



Cleared Amount by month – this View shows the payment amounts of late (orange) versus on-time (blue) per month

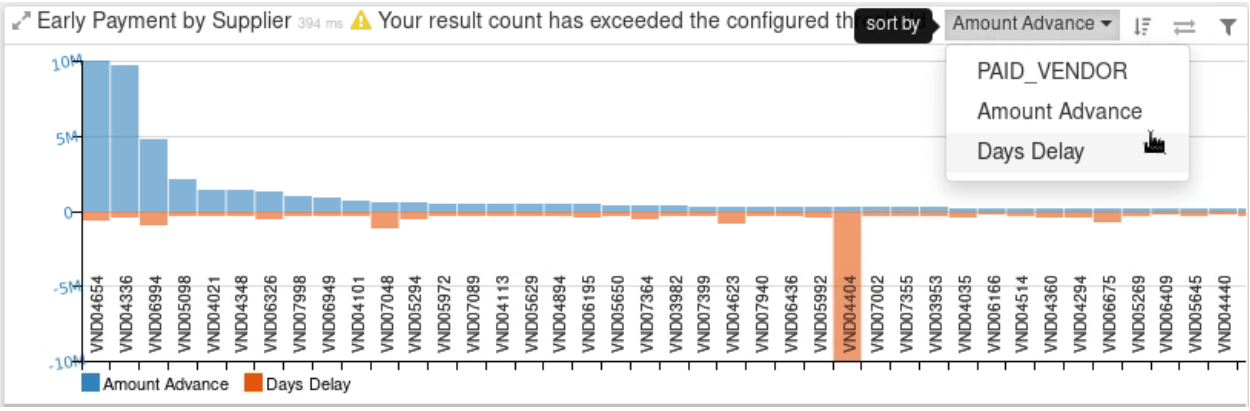


Late Payment by Supplier – this View shows the late payment data. For example, the first suppliers have the most significant late payment proportion.



3.7.2 Early Payment

Early Payment by supplier – this View shows if JK Auto Inc. is taking full advantage of discounts or rebates for early payment offered by suppliers.



3.8 Lab Summary

You have just learned how IBM Process Mining can be applied to improve and gain insights into JK Auto Inc.'s P2P Process.

You should now be able to deliver a live demo recorded in this video: https://ibm.box.com/v/Lab2ProcessMiningVideo.