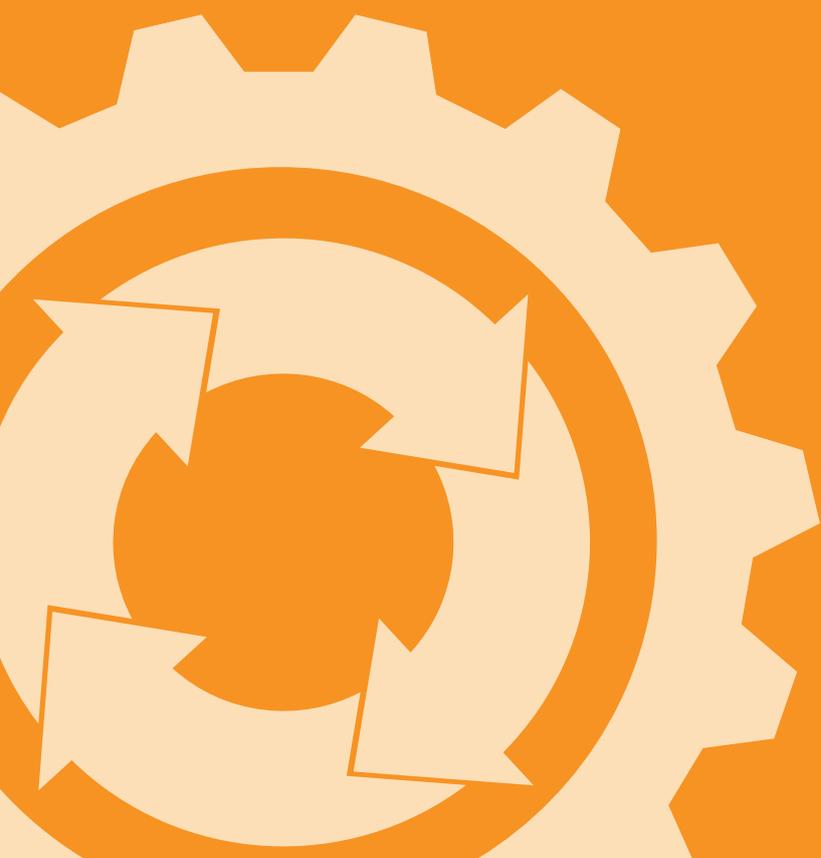


PRAGMADEV
PROCESS

TUTORIAL



PRAGMADEV
modeling and testing tools

Contents

1	Introduction	3
2	The model	4
2.1	Organization	4
2.2	Pools and lanes	6
2.3	Processes	9
3	Execution	15
3.1	Semantic check	15
3.2	Interactive execution	18
3.3	Automatic execution	35
3.3.1	Single-trace execution	35
3.3.2	Multi-trace execution	44
4	Exploration	48
4.1	Complexity check	48
4.2	Reachability	49
4.3	Deadlock check	51
4.4	Property verification	53
5	Simulation	59
5.1	Simulation parameters	59
5.1.1	Bike delivery	59
5.1.1.1	Scenario parameters	59
5.1.1.2	Element parameters	62
	Time, cost, and control parameters	62
	Result requests	67
5.1.2	Car delivery	69
5.1.2.1	Scenario parameters	69
5.1.2.2	Element parameters	71
5.2	Running the simulation	72
5.3	Simulation results	74
5.4	Simulation log	79
5.5	Critical path	81
6	Conclusion	83

1 Introduction

Before starting this tutorial, it is important to understand the basic concepts used in PragmaDev Process. These concepts derive from the language supported by PragmaDev Process, i.e., **BPMN**.

BPMN stands for **Business Process Model and Notation**. BPMN is a graphical language defined by the Object Management Group (OMG). Its primary goal is to provide a notation that is understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes. In doing so, BPMN provides a simple mean of communicating process information to other business users, process implementers, customers, and suppliers.

The following are the most important elements of a BPMN diagram in PragmaDev Process:

- A **Collaboration** is a collection of *Participants* shown as **Pools**, their interactions shown by **Message Flows**, and may include **Processes** within the **Pools**.
- A **Lane** is a sub-partition within a **Pool** that is used to organize and categorize **Activities** of a **Process** within a **Pool**.
- A **Process** describes a sequence or flow of **Activities** in an organization with the objective of carrying out work. In BPMN a **Process** is depicted as a graph of flow elements, which are a set of **Activities**, **Events**, **Gateways**, and **Sequence Flows**.

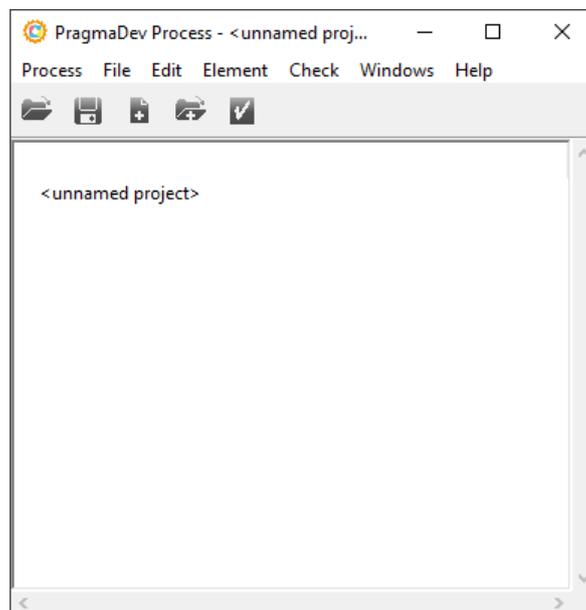
2 The model

The model we have chosen is simple enough to be written from scratch but rich enough to pinpoint the basics of BPMN. It is a pizza delivery model composed of a pizza *Vendor* and a *Customer*. *Vendor's* activities are categorized in activities carried out by the *Clerk*, *Chef*, and *Delivery Boy*. Upon receiving an order from the *Customer*, the *Clerk* will forward such order to the *Chef*. The *Chef* will then bake the pizza and hand it over to the *Delivery Boy*. At last the pizza will be delivered to the *Customer*.

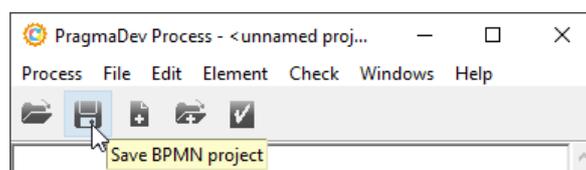
The BPMN model of the pizza delivery used in this tutorial is found in \$PRAGMADEV_PROCESS_HOME/examples/Pizza.

2.1 Organization

Let's get our hands on the tool! Start PragmaDev Process. The window that appears is called the Project Manager:

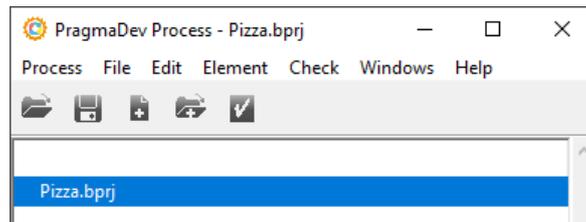


Save the project via the button in the toolbar:

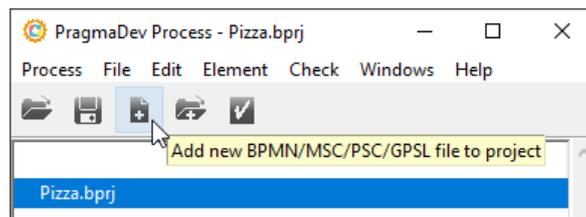


Tutorial

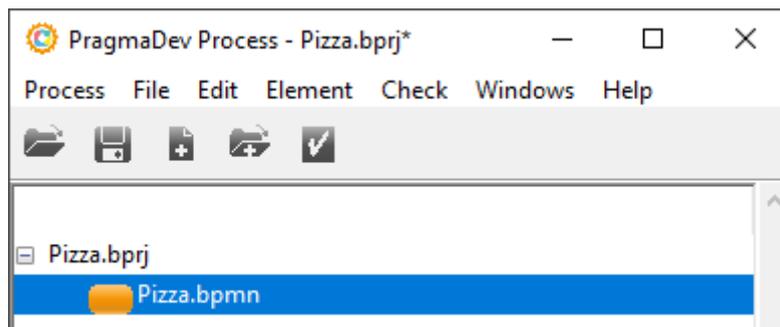
Name the project Pizza:



Create and add a new BPMN file to the project via the button in the toolbar:

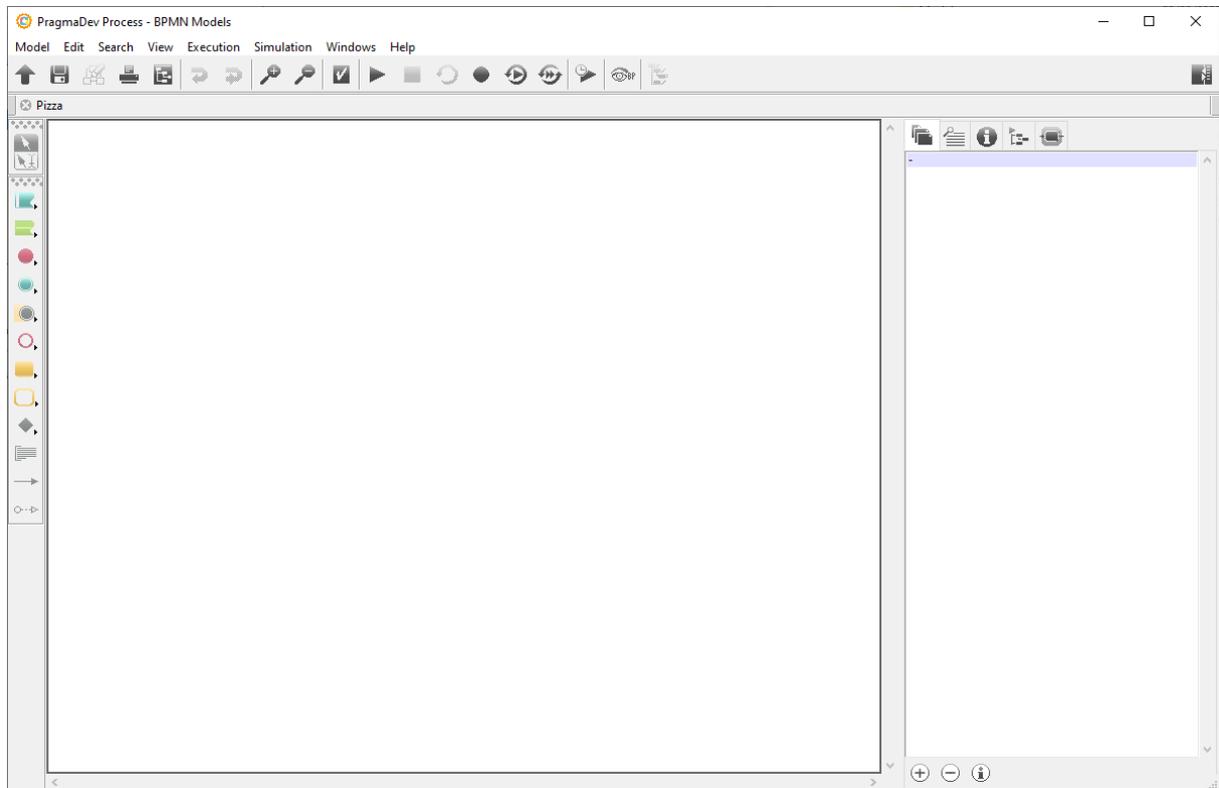


Name it Pizza:



2.2 Pools and lanes

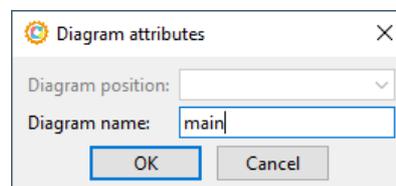
Double click Pizza . bpmn in the Project Manager to open it in the BPMN Editor:



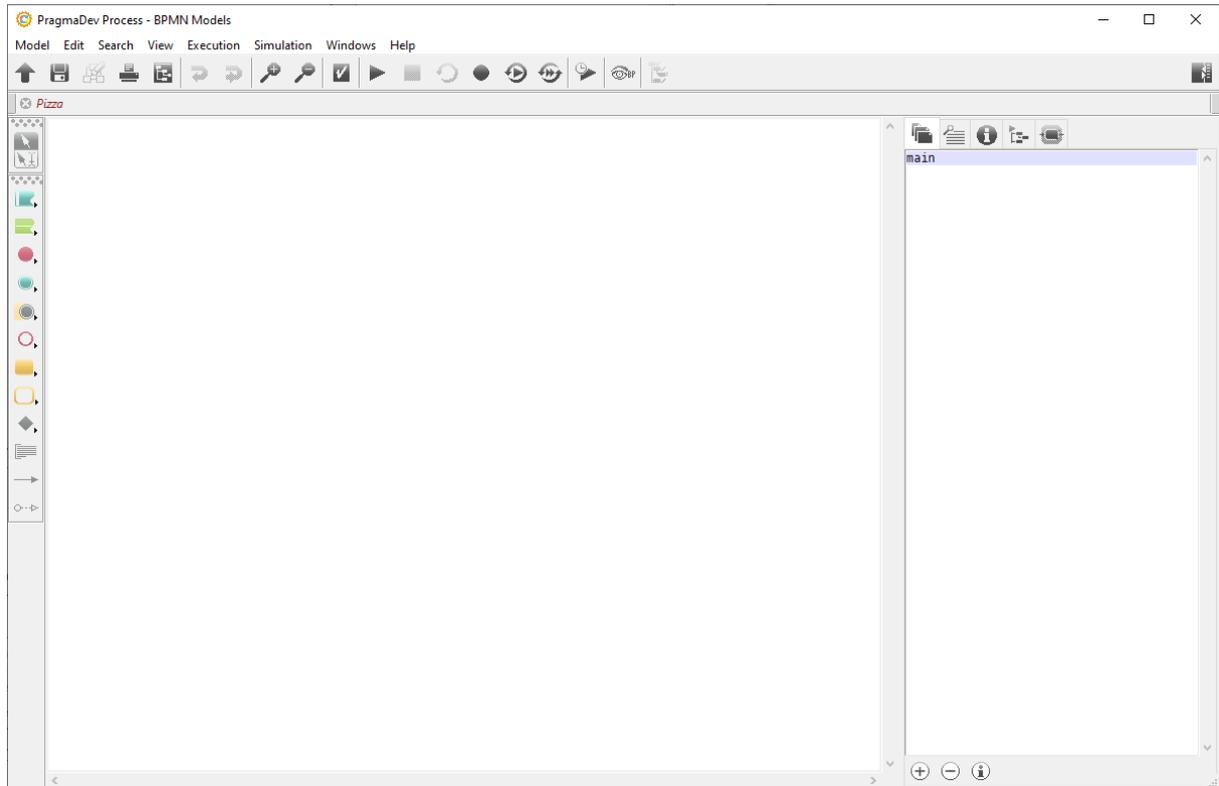
To change the name of the current diagram use the button:



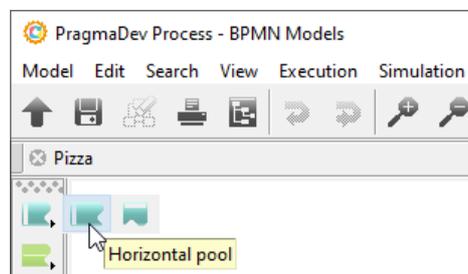
Name it main and hit "OK":



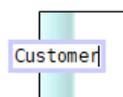
Notice the change in the diagram browser:



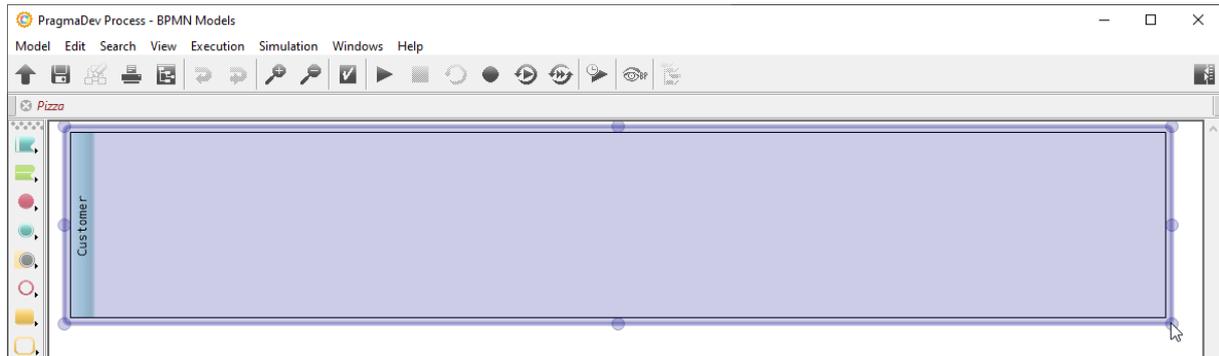
Create a horizontal pool via the tool button:



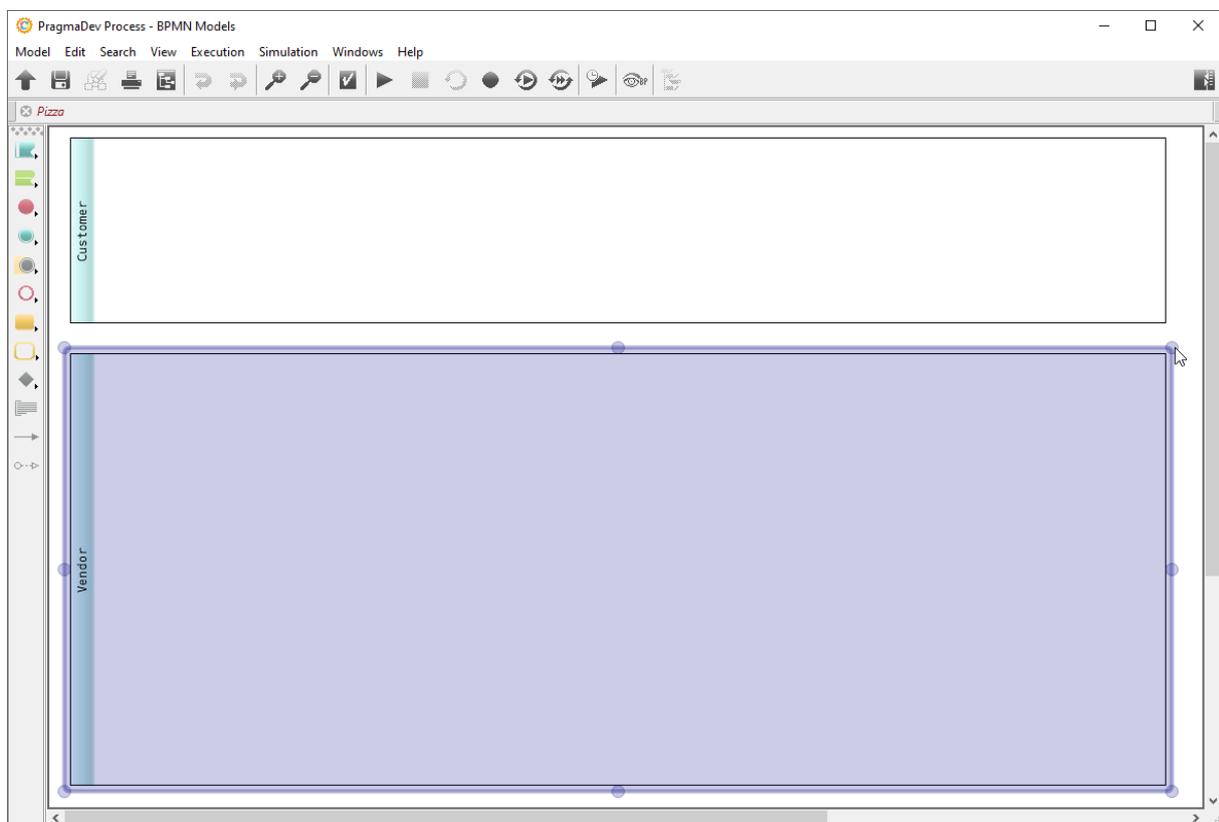
and name it Customer:



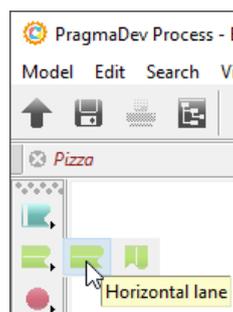
Resize the pool using the points to create space for other elements:



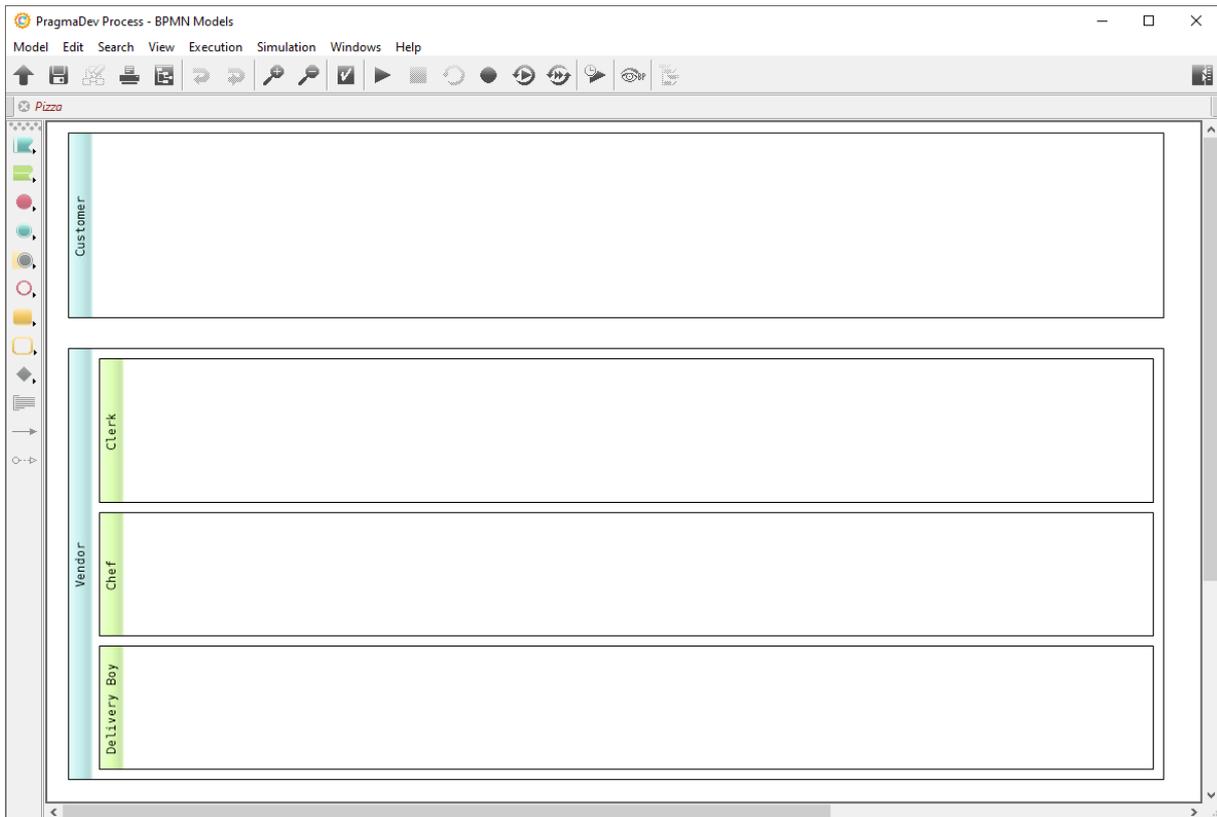
Create another pool named Vendor and resize it:



Create three horizontal lanes inside the Vendor using the tool button:

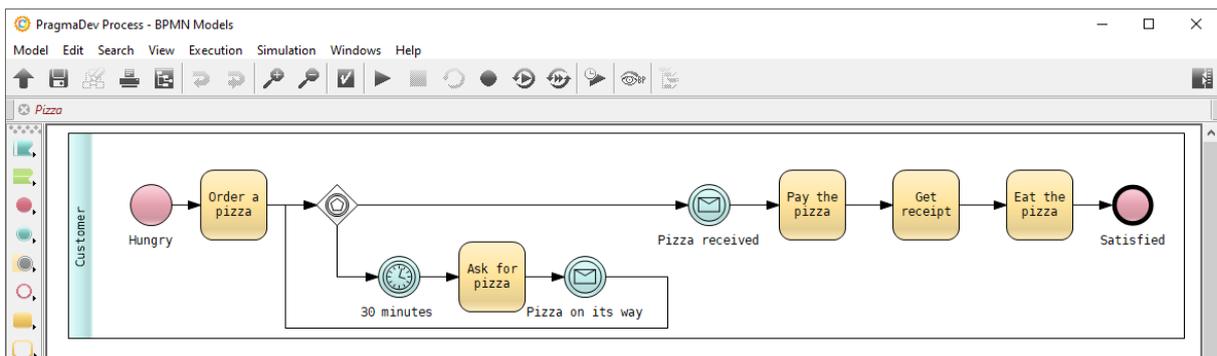


Name them Clerk, Chef, Delivery Boy, and resize them as shown:



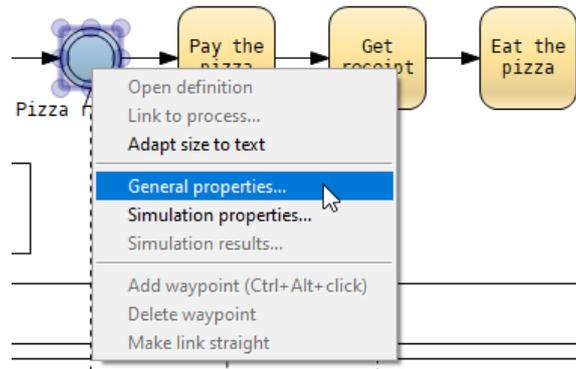
2.3 Processes

Use the tool buttons to draw the Customer process as shown:

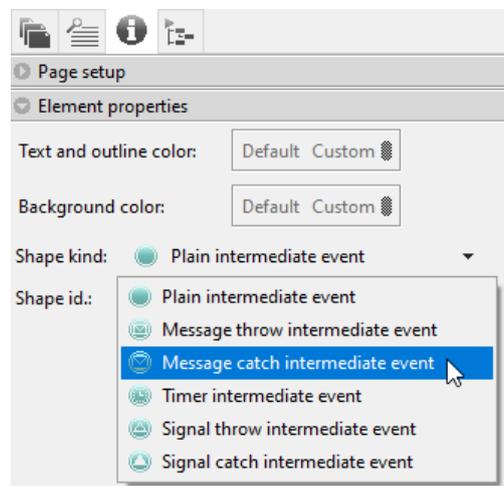


Symbols can either be created with the tools in the toolbar, or via keyboard shortcuts. The insertion shortcuts are all introduced by "Control + Space" (or "Command + Control + Space" on macOS), followed by a letter giving the type of symbol to create. For example, to create a start event, press "Control + Space" followed by "s"; with "t", it creates a task, with "i" an intermediate event, with "g" a gateway, and so on. To see the available letters, you can press "Control + Space", then "?".

Symbols created with the keyboard shortcuts will always be *plain* ones. Their type can however be changed afterwards by opening the symbol properties:

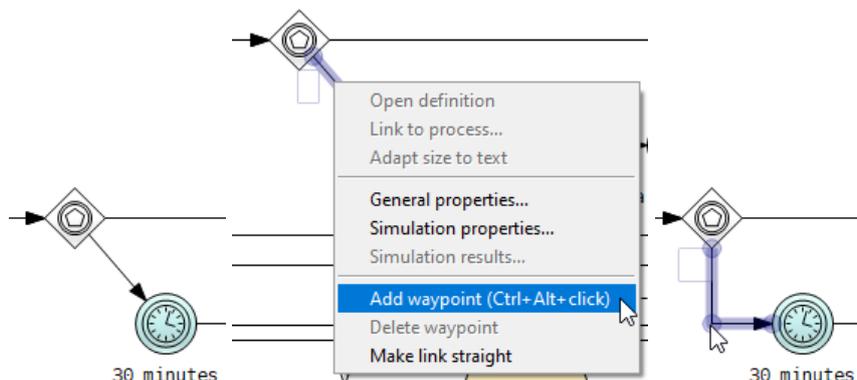


then changing its type in the right-hand side panel in the editor window:



Links can also be created via a "Control + Space" sequence: with "Shift + s", it creates a sequence flow and with "Shift + m" a message flow. Sequence flows can also be created automatically from the previously selected symbol to the newly inserted one if the option "Automatically create sequence flows" is checked in the "Edit" menu.

Sequence (or message) flows are drawn as a straight line by default. To create non-linear paths, right click a flow to "Add waypoint", and move the waypoint to the desired position:



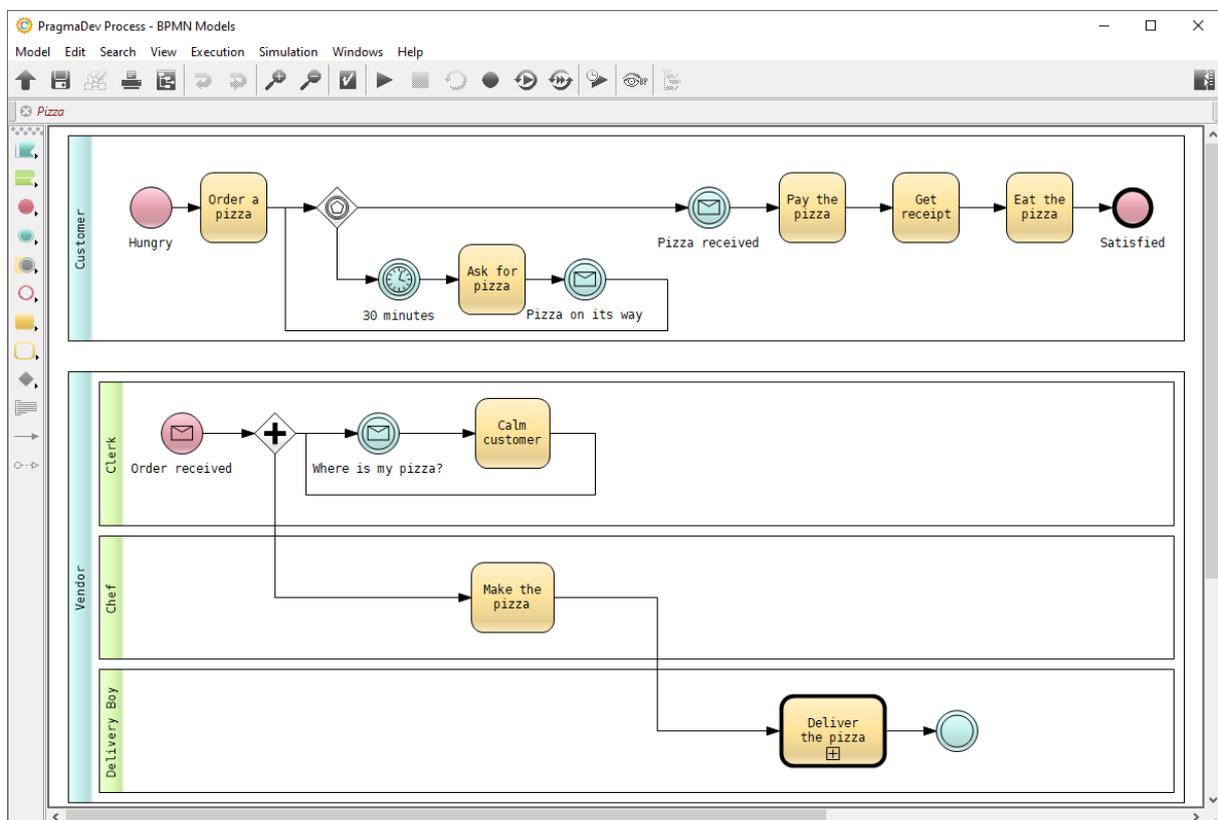
Tutorial

Non-linear paths can be created also by holding "Shift" and clicking to place waypoints while drawing the path from the source to the target symbol.

The Customer process says the following:

- The Customer is Hungry for pizza.
- He/She decides to Order a pizza.
- The Customer will wait until his/her pizza is delivered (Pizza received).
- If the pizza is not delivered within 30 minutes, the Customer will check what's going on with his/her pizza (Ask for pizza).
- Upon receiving the pizza, the Customer will Pay the pizza, Get receipt, and finally Eat the pizza to be Satisfied.

Draw the Vendor process as shown:



The Vendor process says the following:

- Upon receiving an order from the Customer, the Clerk will enter a loop waiting for complaints (Where is my pizza?), and in case of a complaint the Clerk will try to Calm customer.
- The Clerk will also forward the received order to the Chef to Make the pizza.
- When ready, the Chef will hand over the pizza to the Delivery Boy to Deliver the pizza.

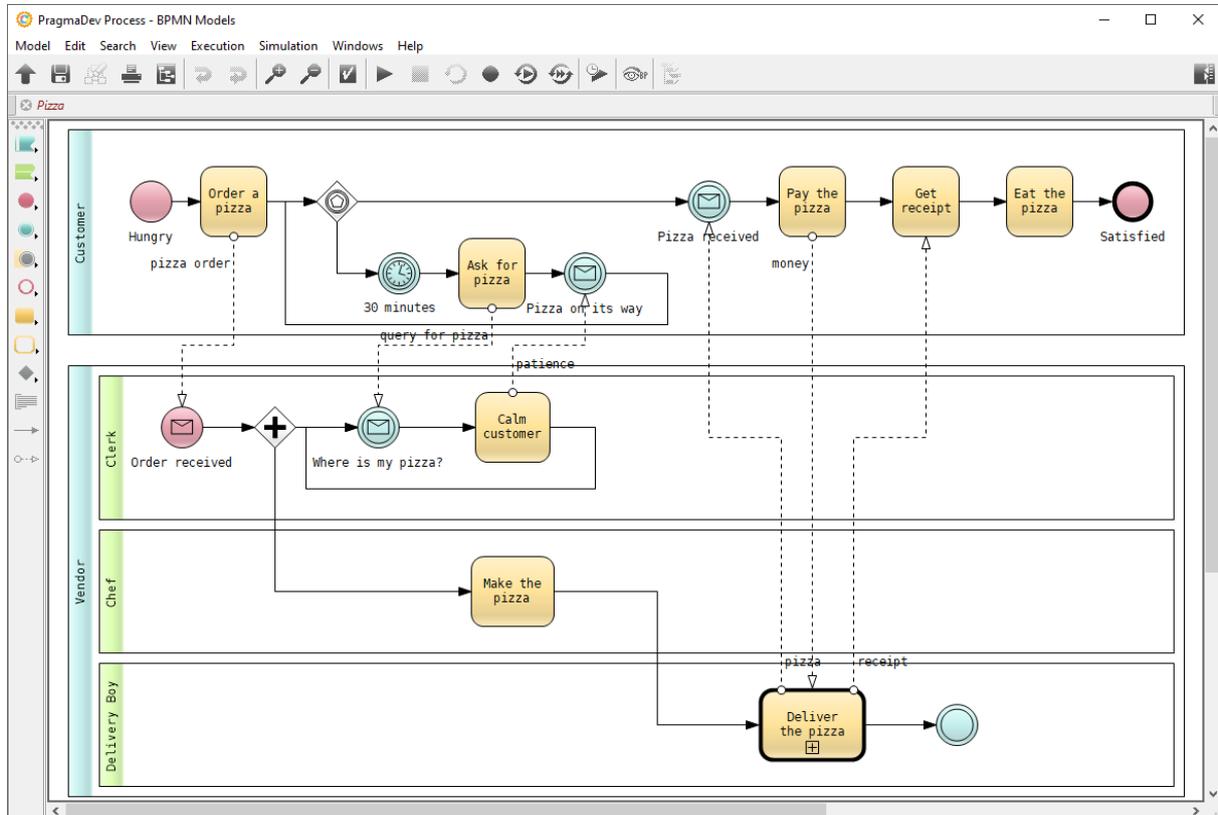
Notes:

- Deliver the pizza is a *process call activity*.

Tutorial

- The process ends with an intermediate event. This error is intentional, and will be corrected later in the tutorial.

To complete the Customer-Vendor *collaboration* draw the following message flows:



Let's define now the call-activity Deliver the pizza. Add a new diagram via the button at the bottom of the diagram browser:



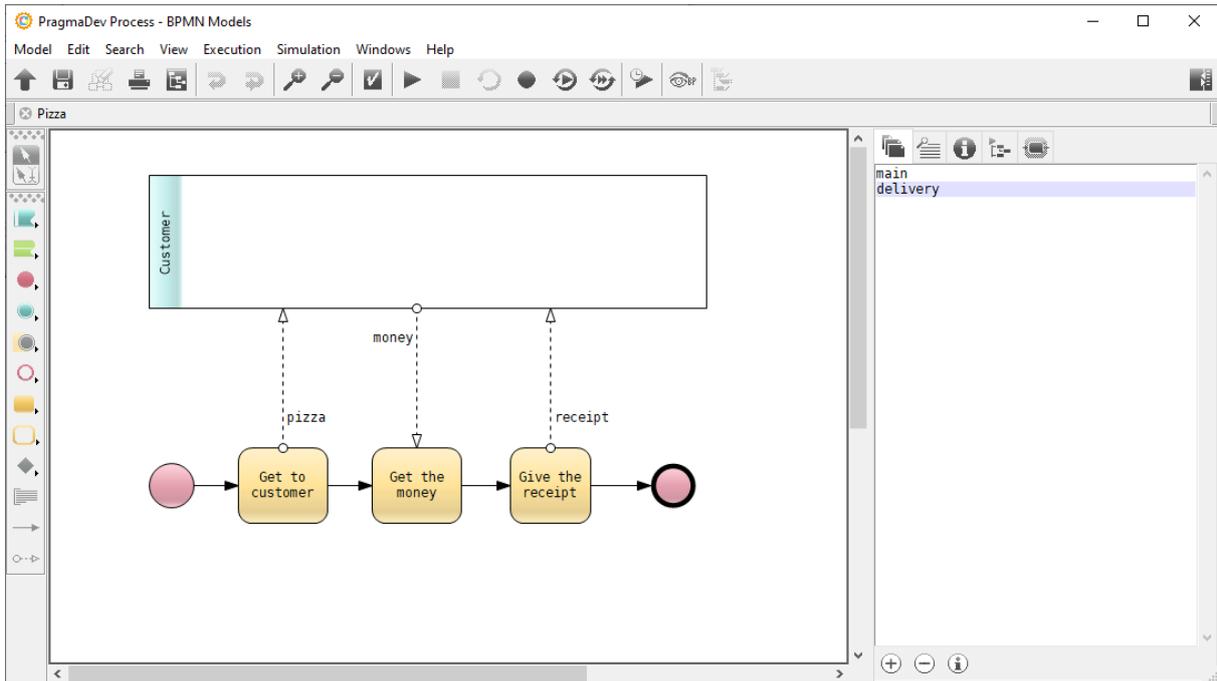
Name it delivery and hit "OK":

Diagram attributes ✕

Diagram position:

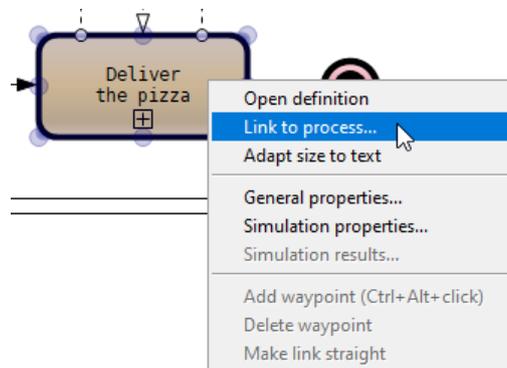
Diagram name:

The new empty diagram will be selected. Draw the following:

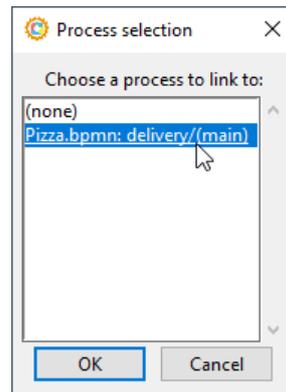


When creating the message flows be sure to draw starting from / ending to either the border or header of the pool Customer.

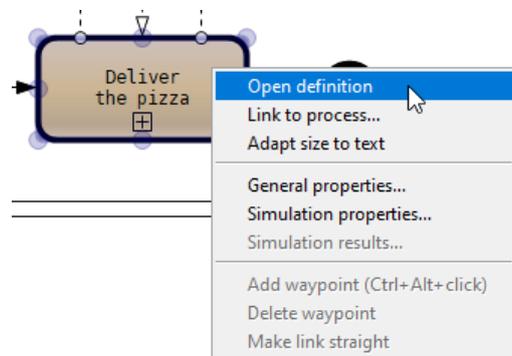
Save the changes and go to the main diagram. Right click the call-activity and then "Link to process...":



Select the single available option (except *none*) in the dialog and hit "OK":



Right click the call-activity and then "Open definition":



This should display the delivery diagram in the editor.

The model of the pizza delivery is now complete. Save everything before closing the editor.

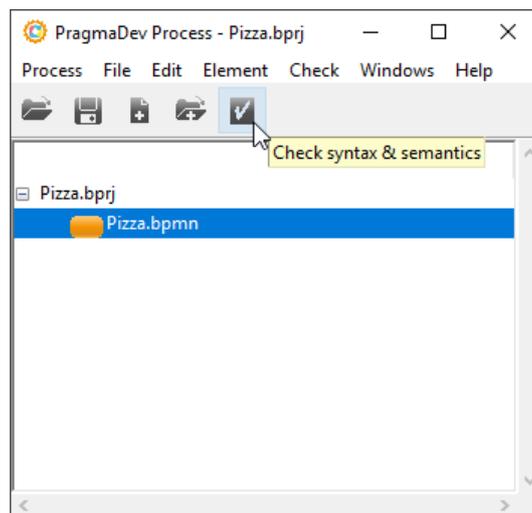
3 Execution

Now we will execute the model using PragmaDev Process BPMN Executor. There are two kinds of execution:

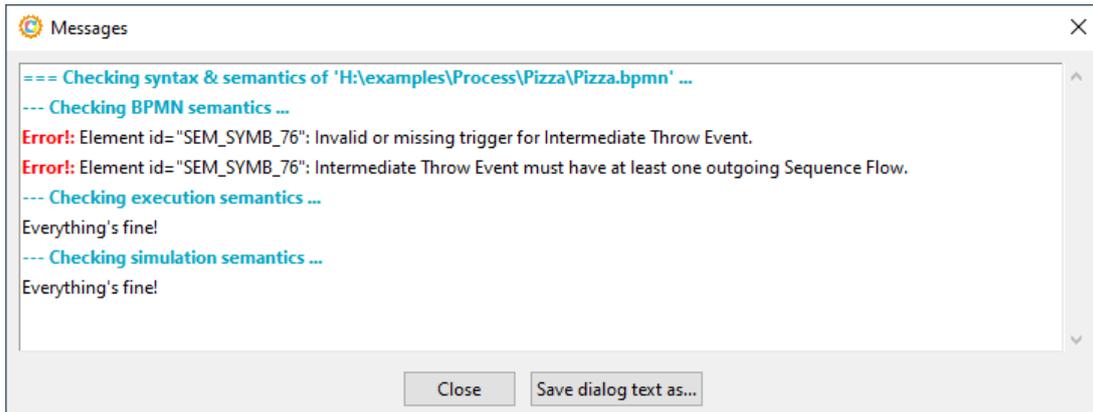
- *Interactive*: allows the user to have full control over the execution. The user interacts with the model at every step of its execution.
- *Automatic*: enables model execution without user input. The execution is guided by MSC traces.

3.1 Semantic check

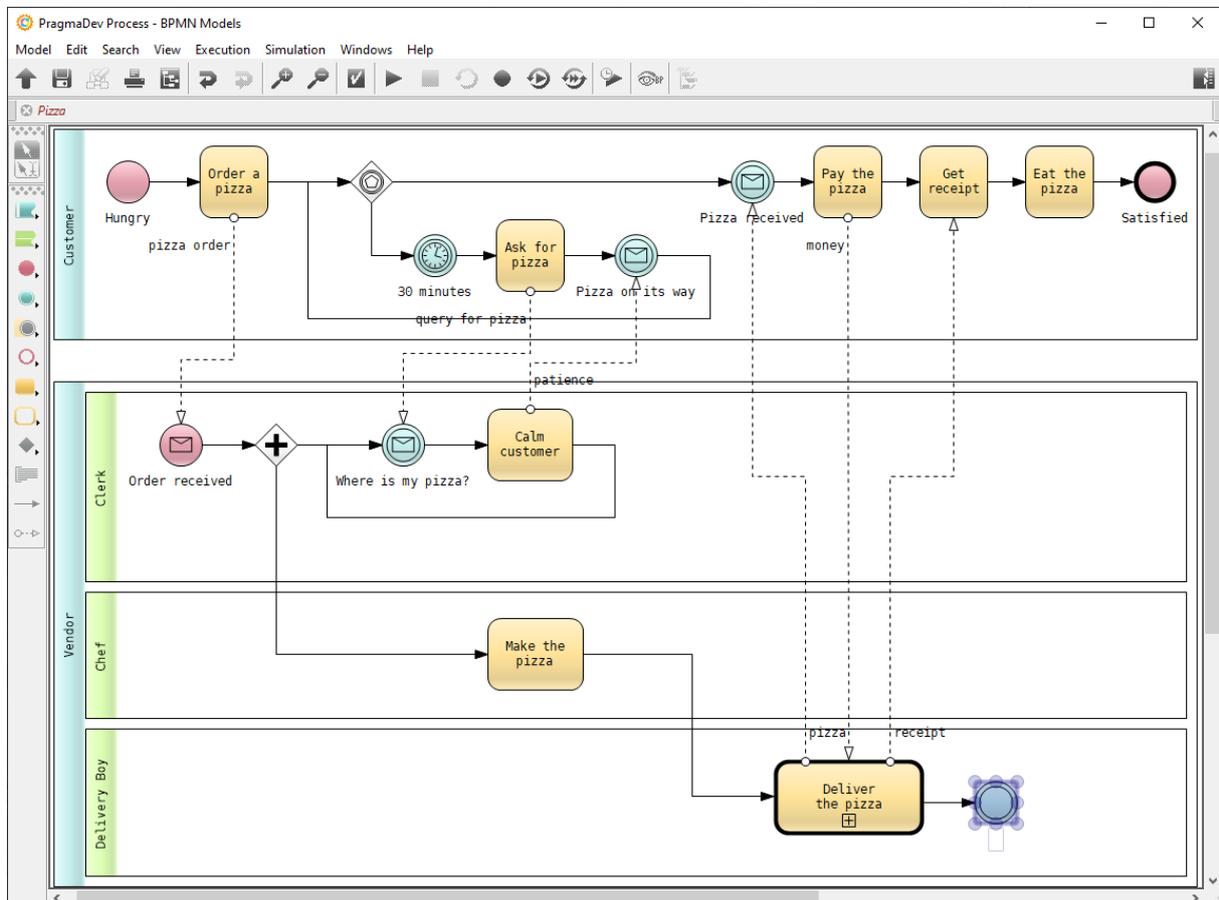
The model can be executed only if it conforms to BPMN 2.0 semantics. To make sure this is true, select `Pizza.bpmn` in the project manager and click the "Check syntax & semantics" button:



A window will pop-up showing the result of the semantic check on the model:

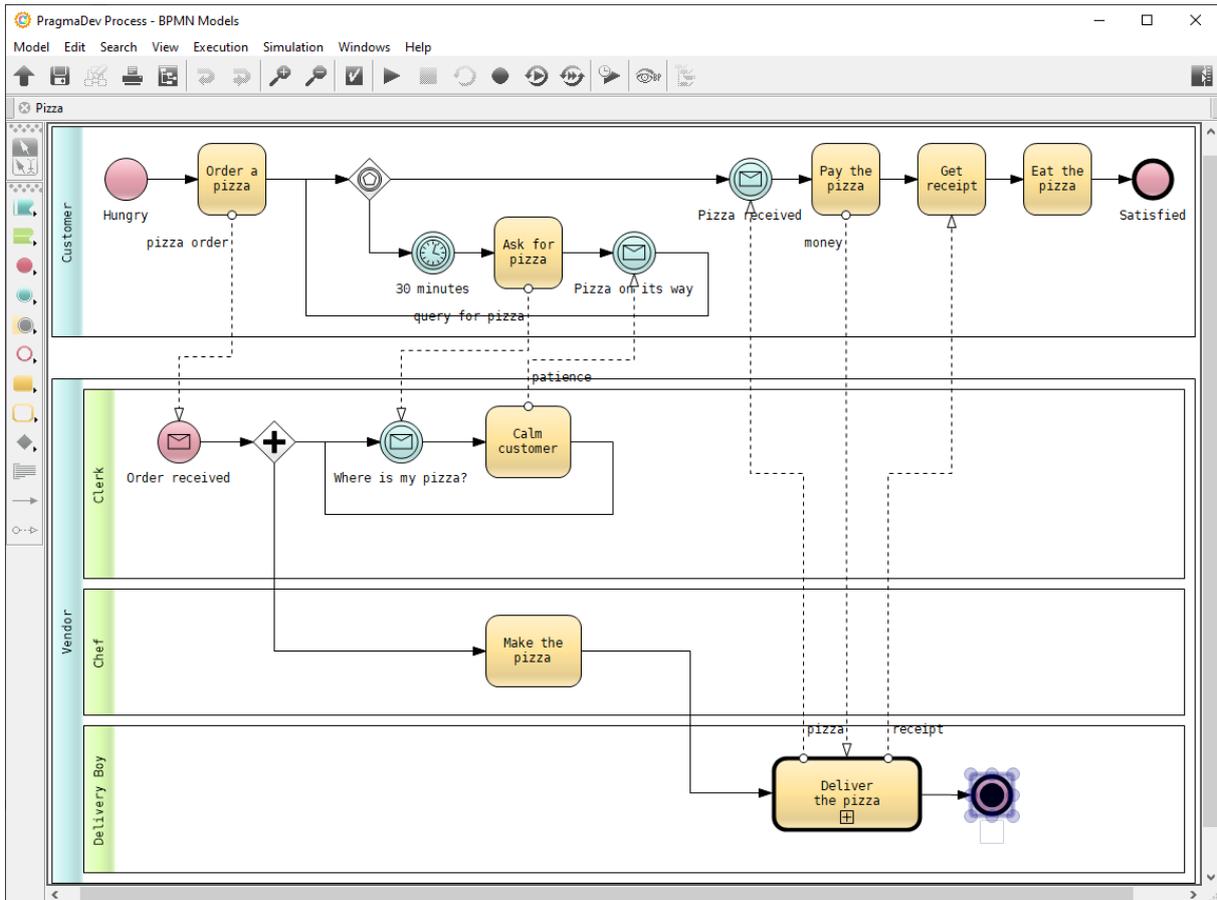


Double-clicking either of the listed errors will open the model in the editor and the concerned element will be selected:

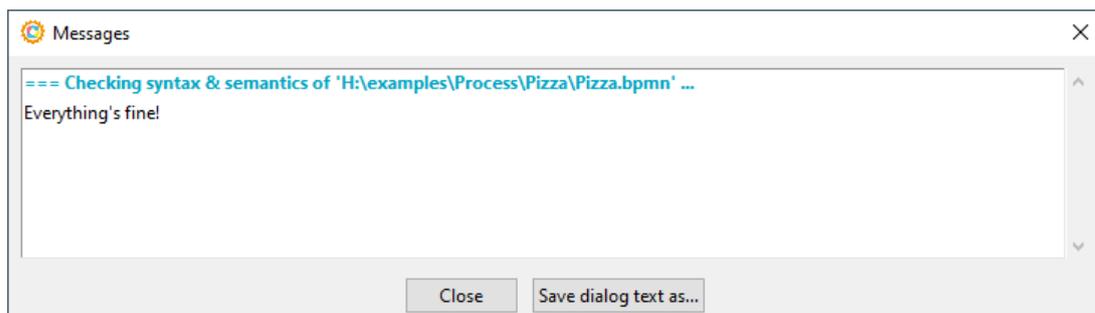


Tutorial

Replace the intermediate event with a terminate end event to correct the errors:

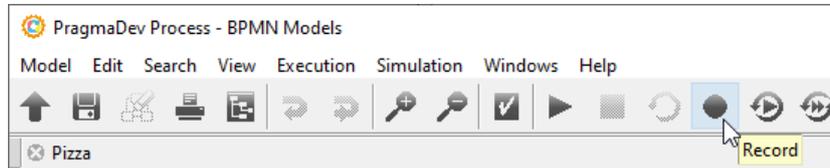


Re-running a semantic check on the model should not list any errors:

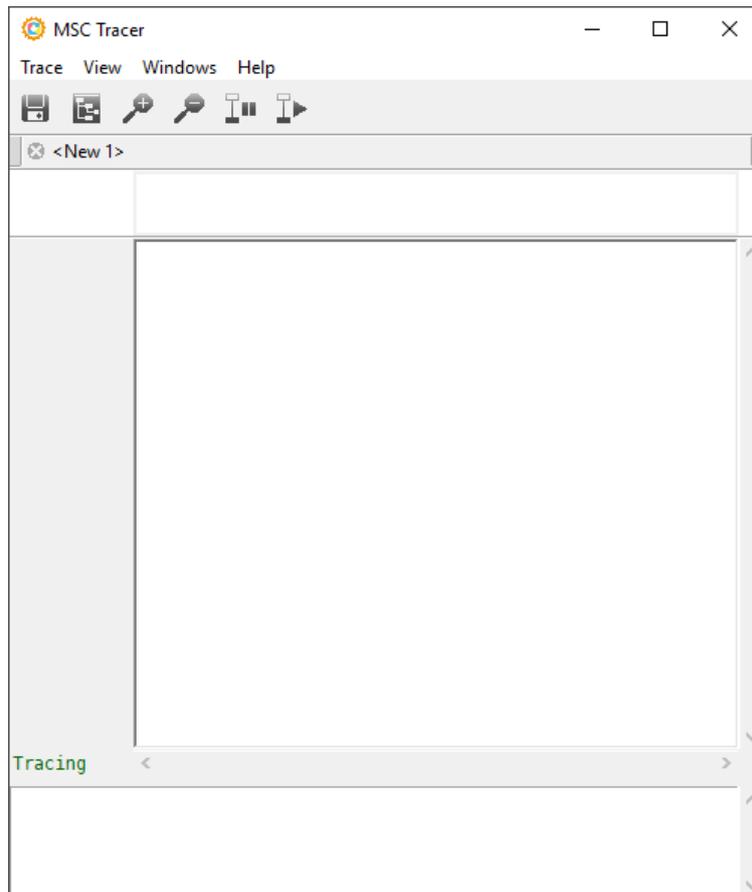


3.2 Interactive execution

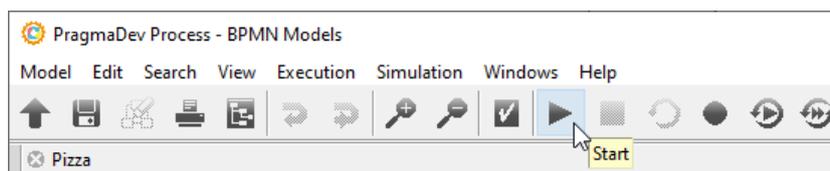
With `Pizza.bpmn` opened in the editor (double-click on it in the project manager), click the "Record" button:



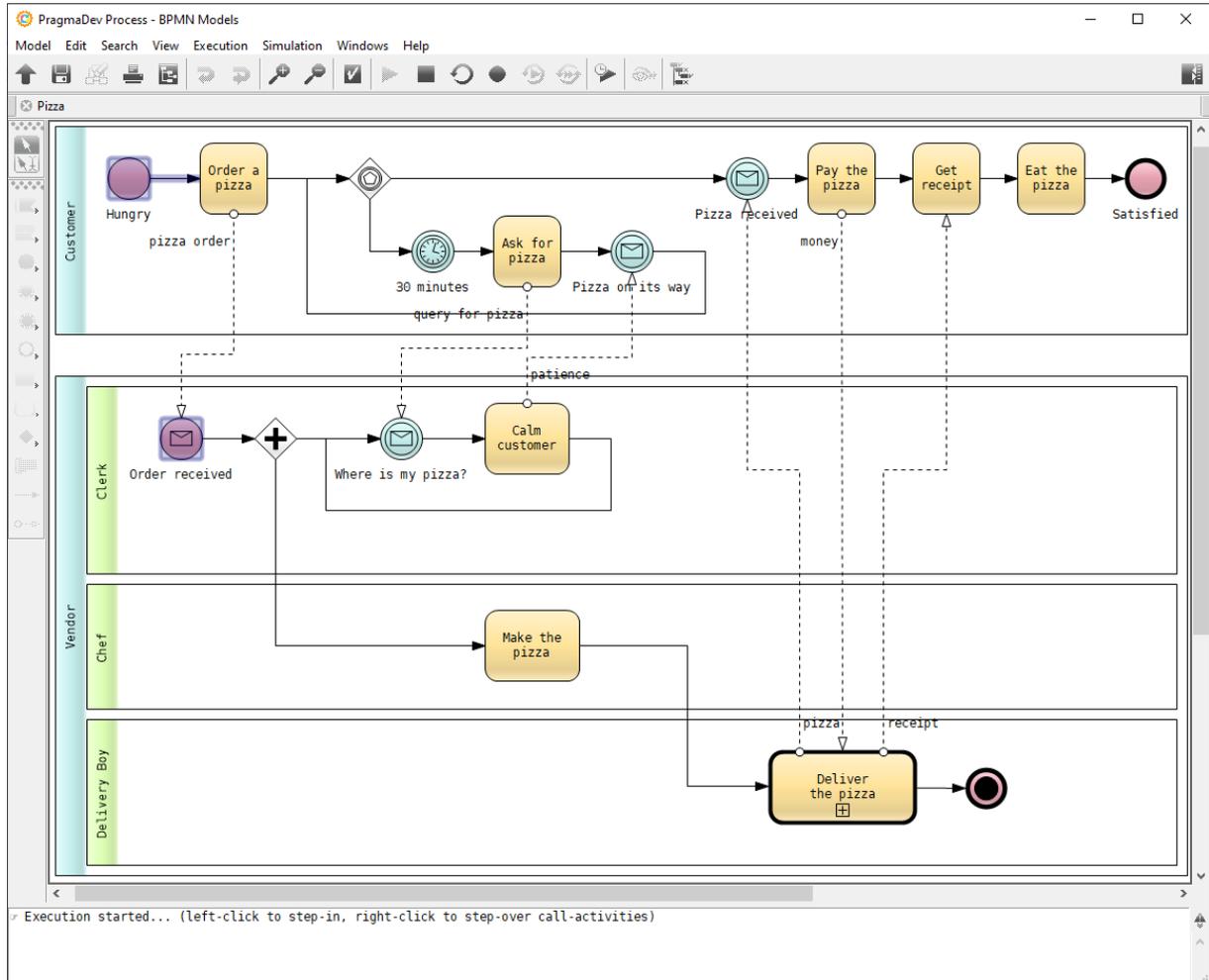
This will allow us to record the execution in the *MSC Tracer*:



We can now start the execution via the "Start" button:

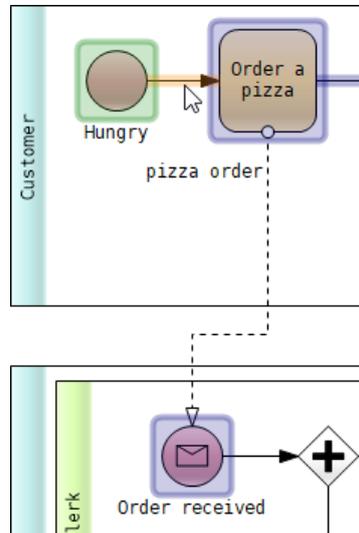


Start events and executable flows will be marked in blue:

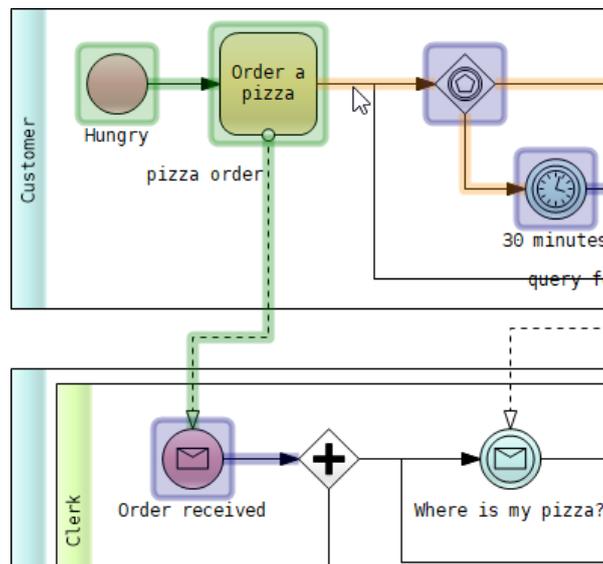


Tutorial

Please note that generally speaking only sequence flows, some message flows, or call-activities can be clicked. No other symbol can be clicked even though they appear in blue. In our example there is a single sequence flow that can be executed. Clicking on it will advance execution, i.e., make the Customer order a pizza:

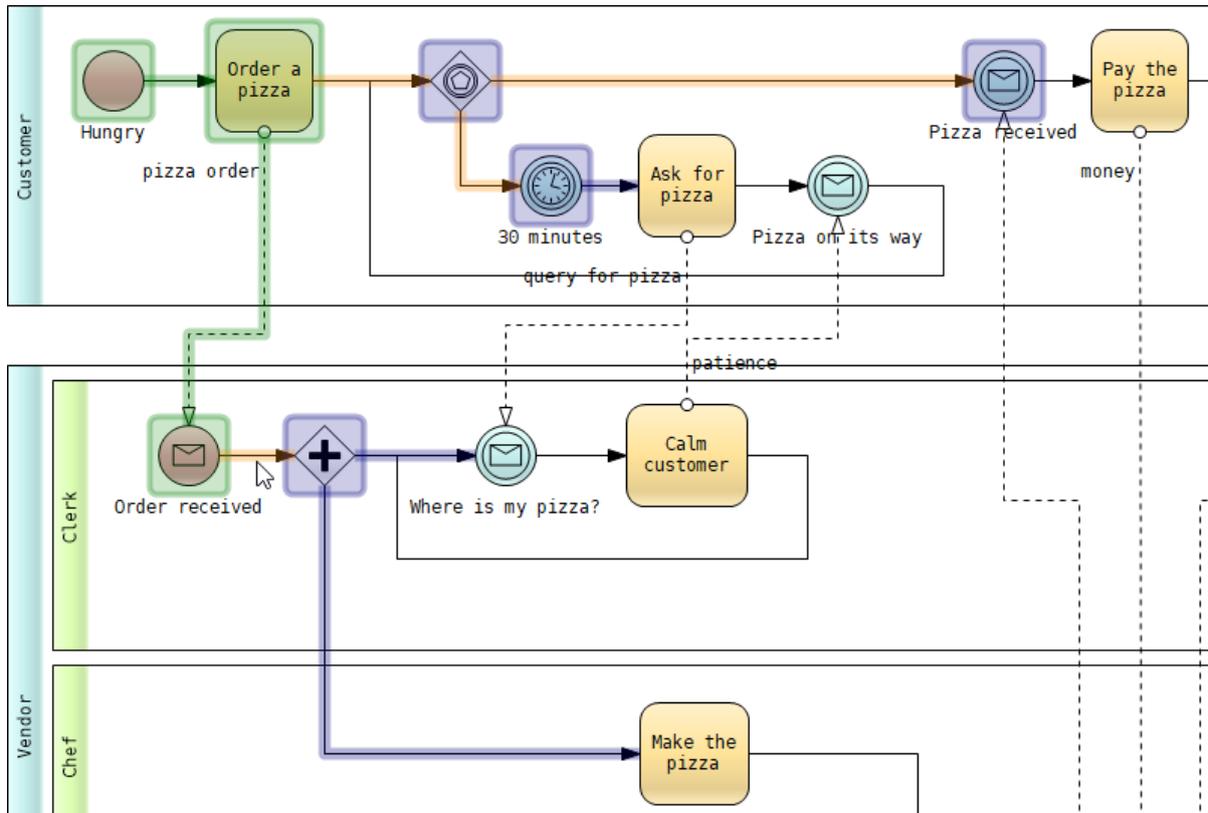


The next (and only) step will be for the Customer to send the pizza order to the Clerk; to continue click the sequence flow:



Tutorial

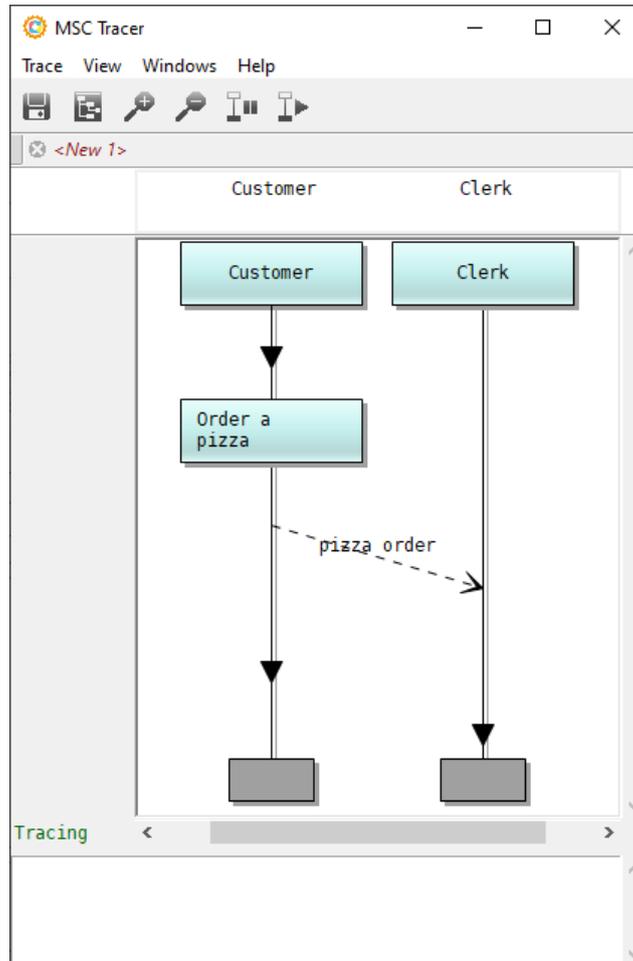
The pizza order will start the Vendor process. Clicking the sequence flow will result in:



Tutorial

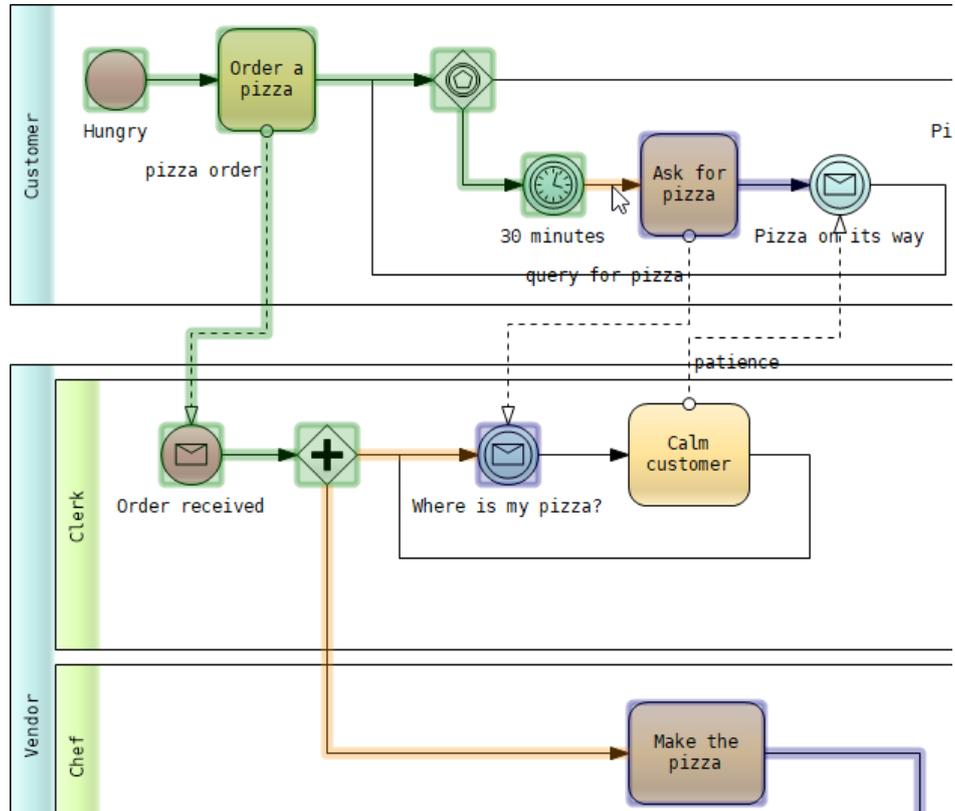
By entering the event gateway, the Customer will wait for its pizza to be delivered (i.e., the Pizza received event) and start a 30 minutes timer. If the timer fires before the pizza is delivered, the Customer will ask the Clerk for the pizza. On the other hand, the parallel gateway in the Vendor process will allow the Clerk to listen to any Customer queries, while the Chef starts baking the pizza.

While execution advances in the editor, all steps are also being recorded in the *MSC Tracer*:



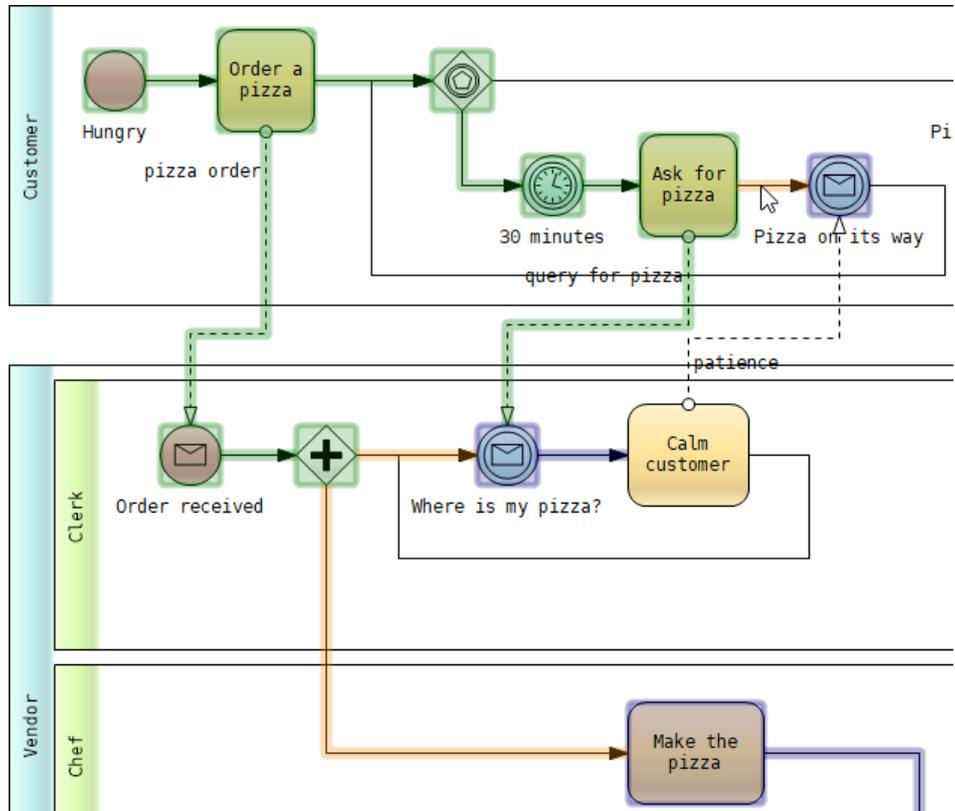
Tutorial

Let's make the timer fire, the Clerk listen for Customer queries, and the Chef start baking the pizza by clicking all three sequence flows:



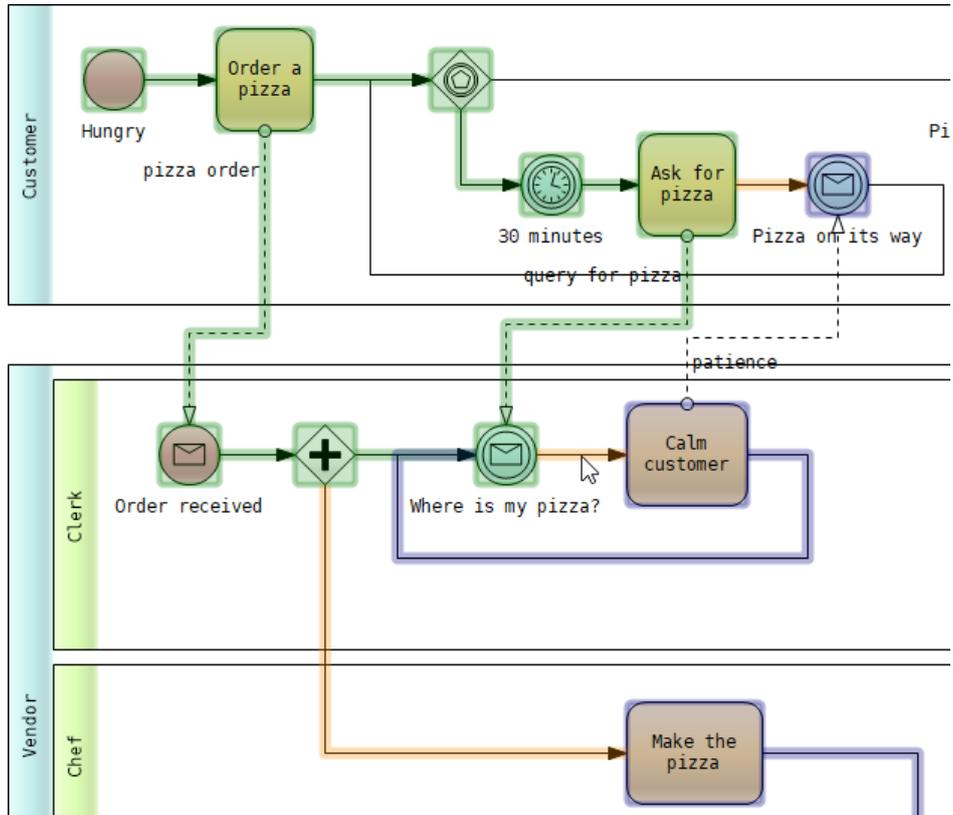
Tutorial

Notice that the Pizza received event is no longer active because the 30 minutes event was triggered. In this situation the Customer is asking the Clerk for the pizza, while the pizza is being prepared by the Chef. If query for pizza is sent:



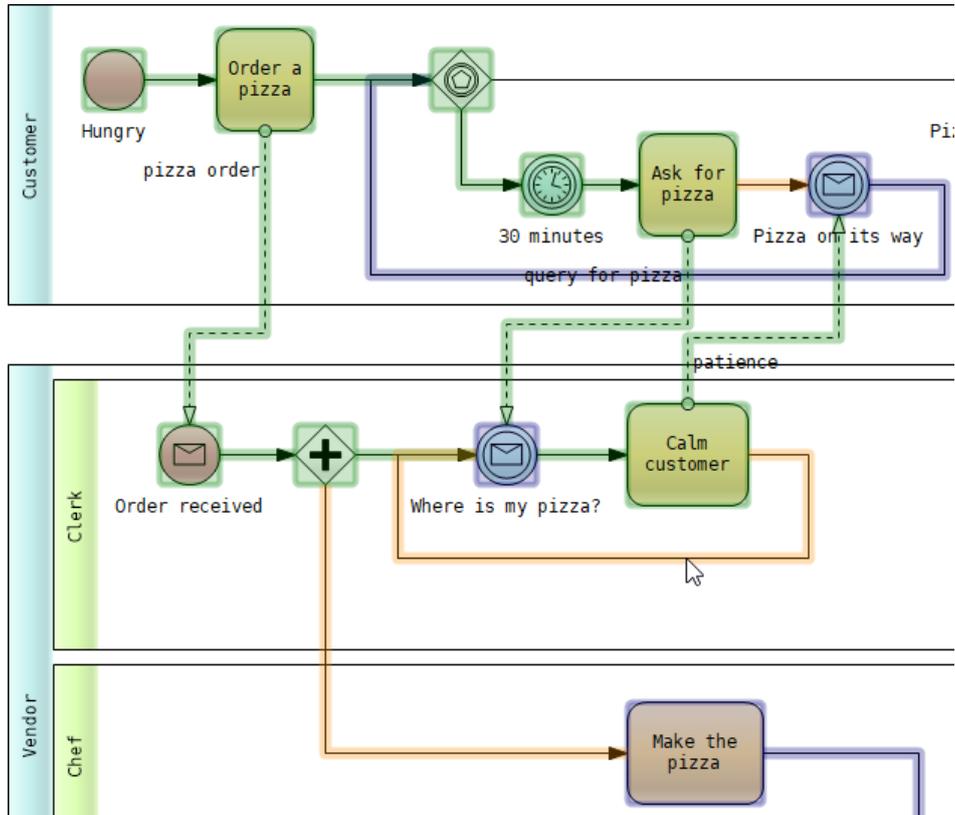
Tutorial

By clicking the sequence flow, the Clerk will Calm customer while the later will be waiting for a feedback (i.e., the Pizza on its way event):

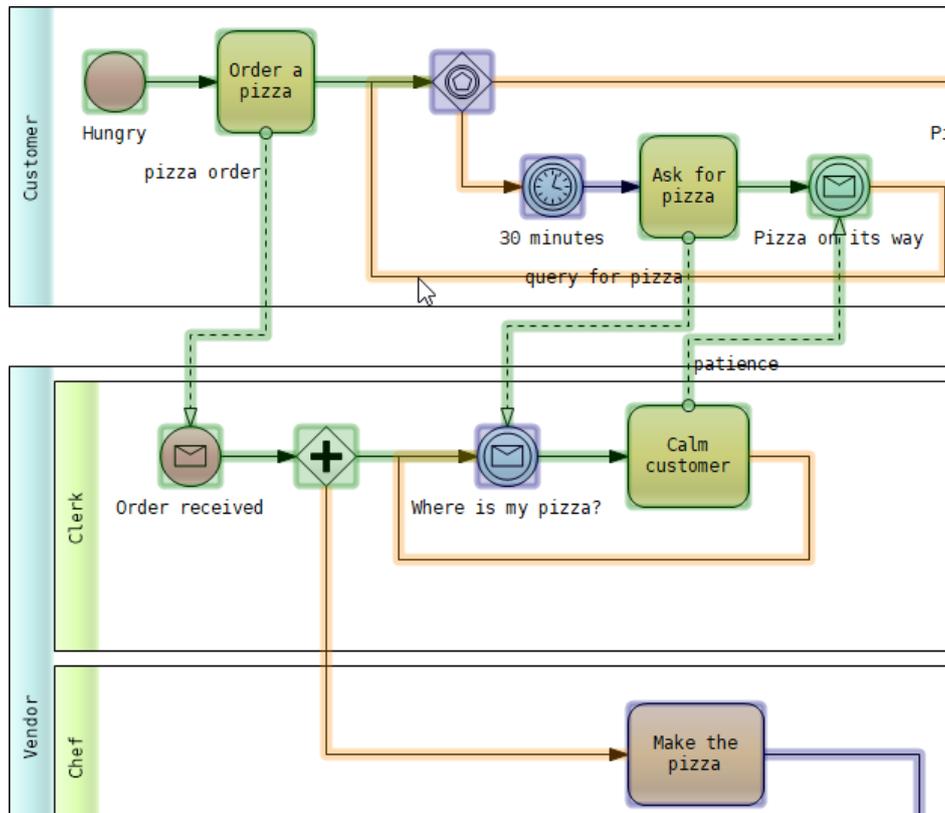


Tutorial

Make the Clerk respond to the Customer's query by clicking the sequence flow which will automatically send the patience message:

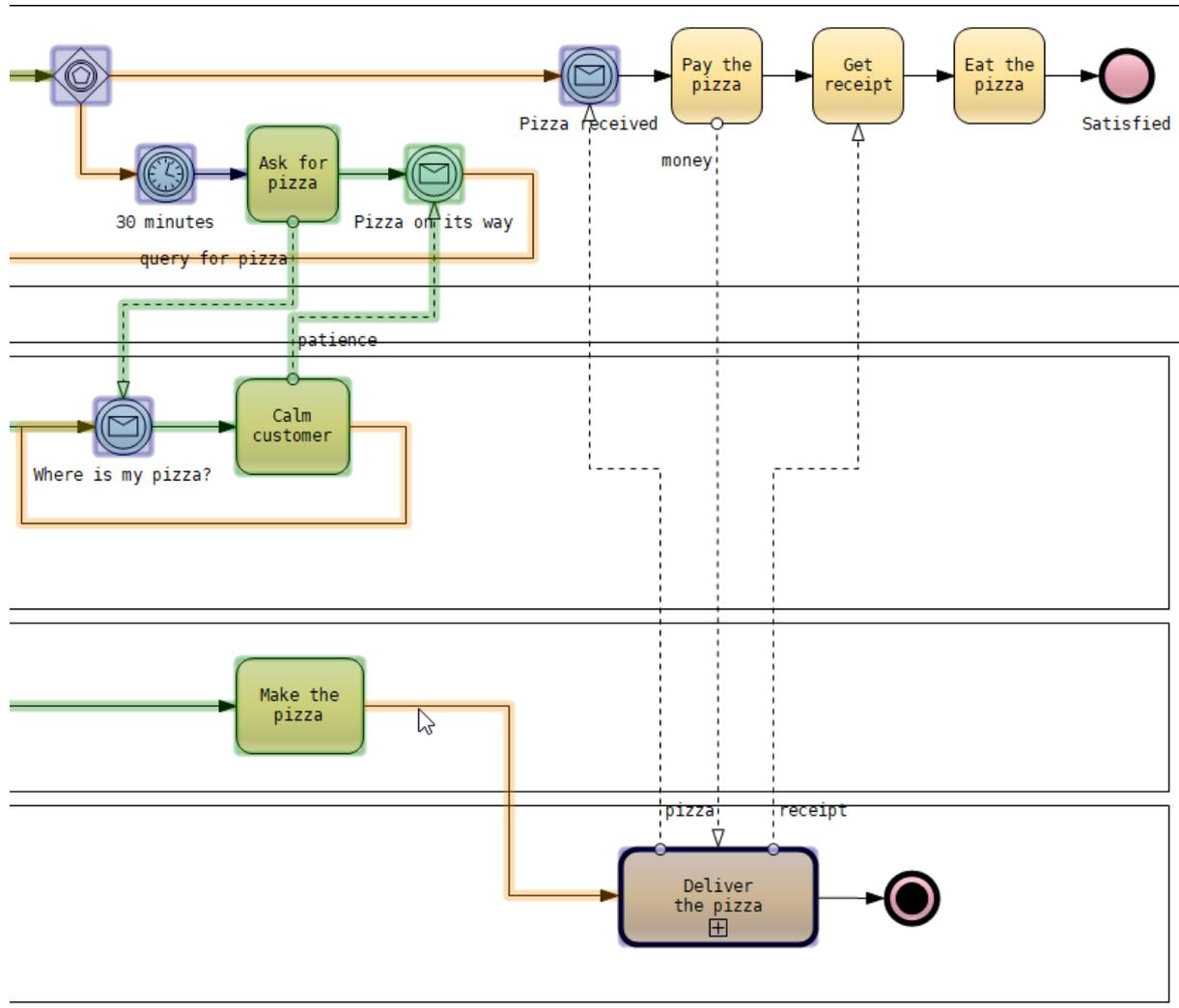


Continue by clicking the looping sequence flow in the Customer process:



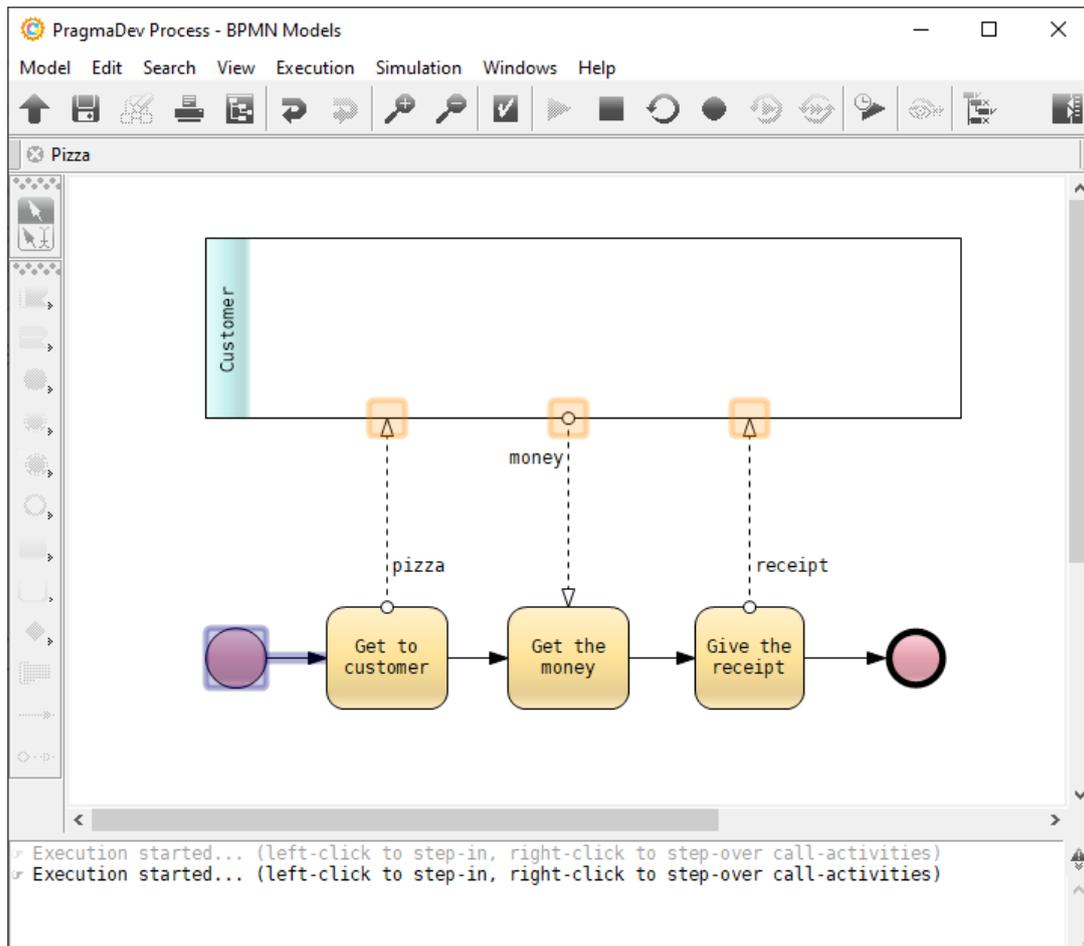
Tutorial

The Customer will get back to waiting for the pizza or for another 30 minutes to pass before querying the Clerk again. We will not let the Customer wait any longer, so let's make sure the pizza is ready by clicking the sequence flow outgoing Make the pizza:

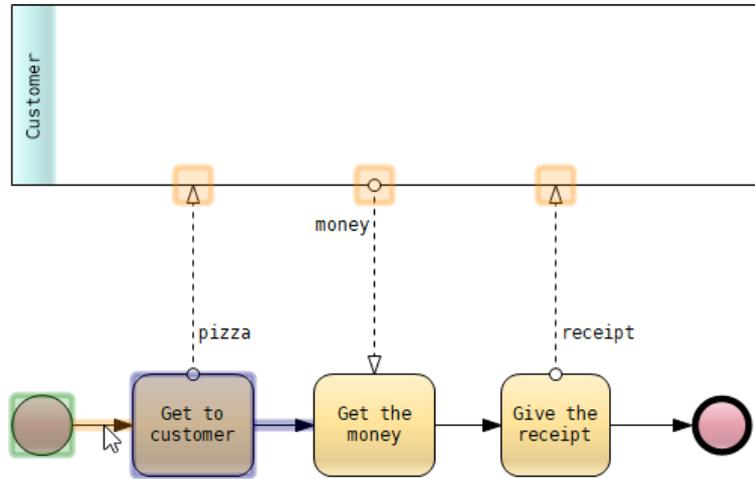


Tutorial

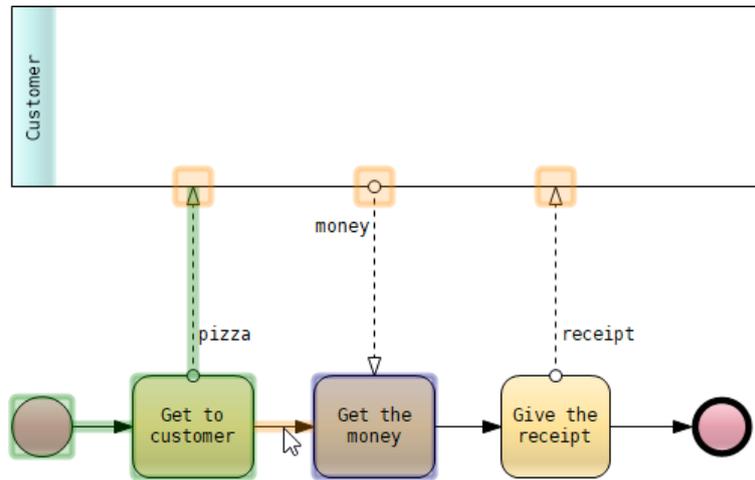
Now it's time to Deliver the pizza. This is a BPMN call-activity which calls the process defined in the delivery diagram. We can either step-over (right-click) or step-in (left-click) the call-activity. Stepping over the call-activity will not execute the called process, but will consider the activity as being a simple BPMN task. In this case the execution will block because the activity will wait for the receipt message before sending the pizza message. Stepping in the call-activity will show the delivery diagram in the editor and start the called process:



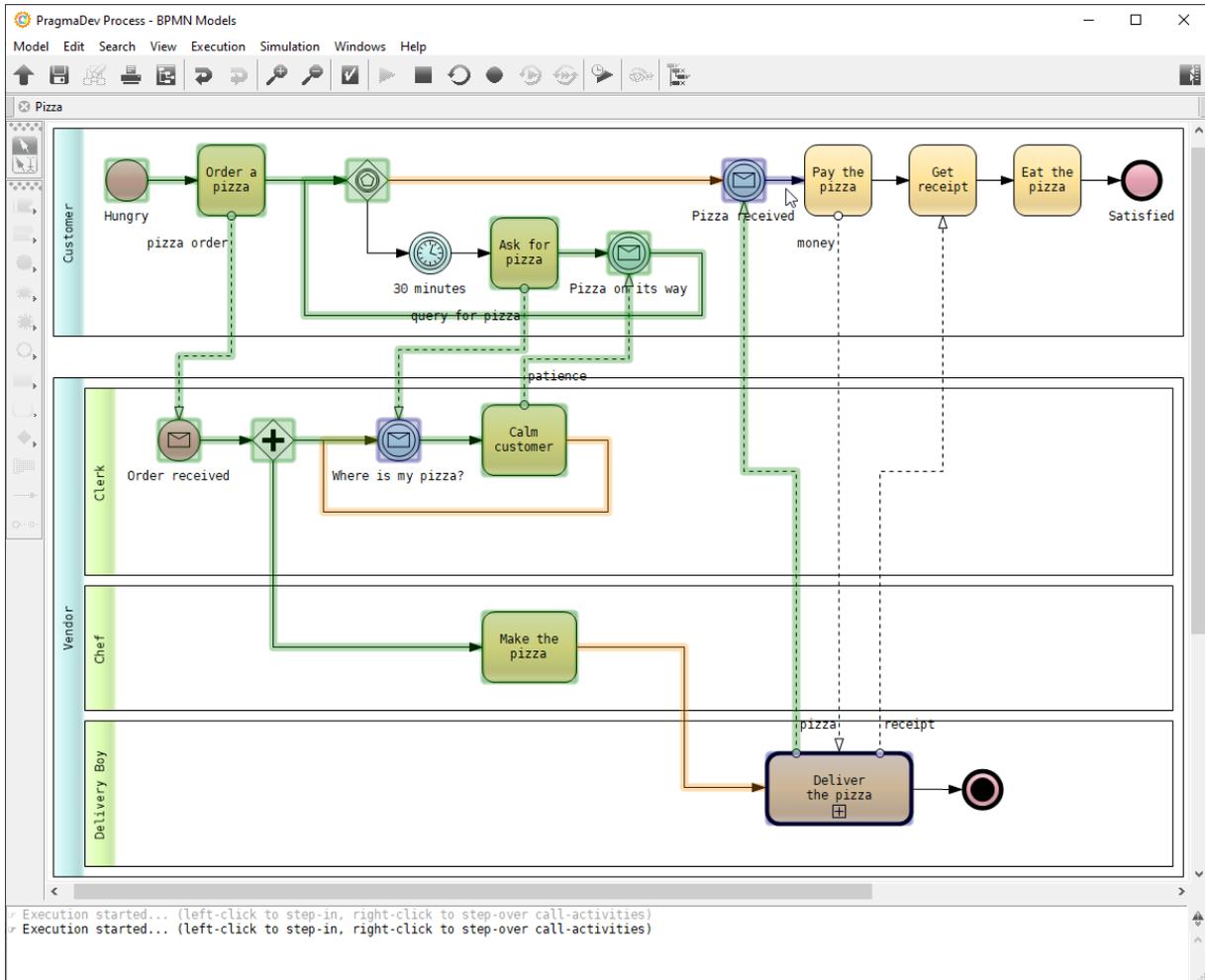
We can Give the pizza to the Customer by clicking the sequence flow:



and then the following sequence flow which will automatically send the pizza message:

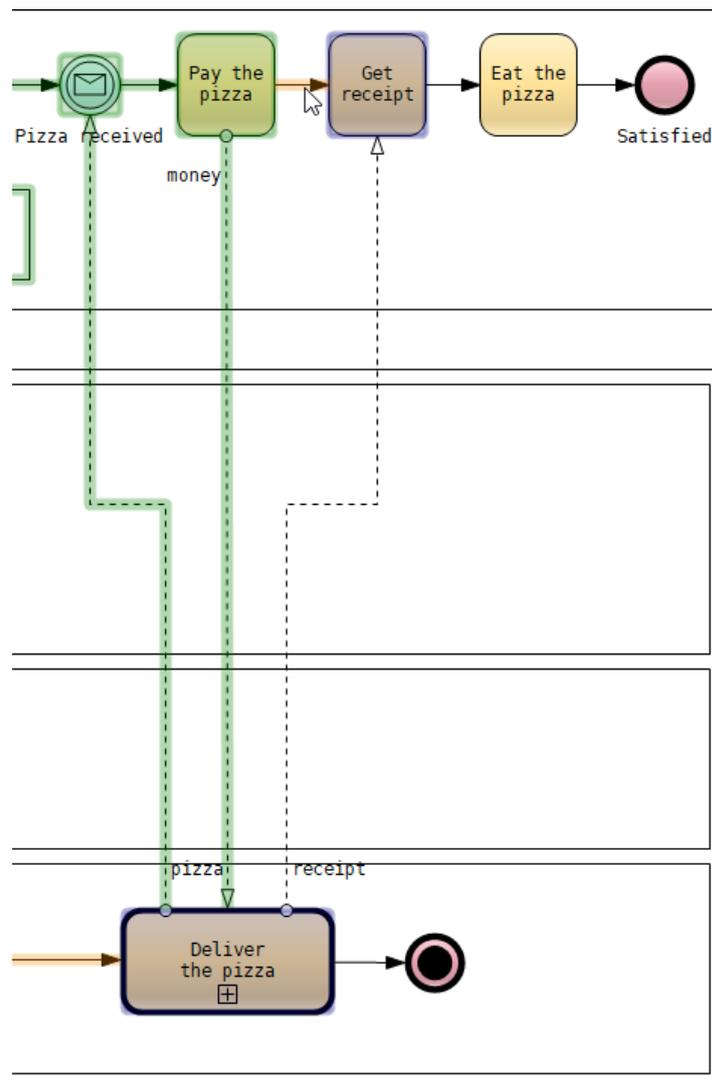


If we switch to the main diagram in the editor we can see that the Customer has indeed received the pizza and can proceed with the payment:

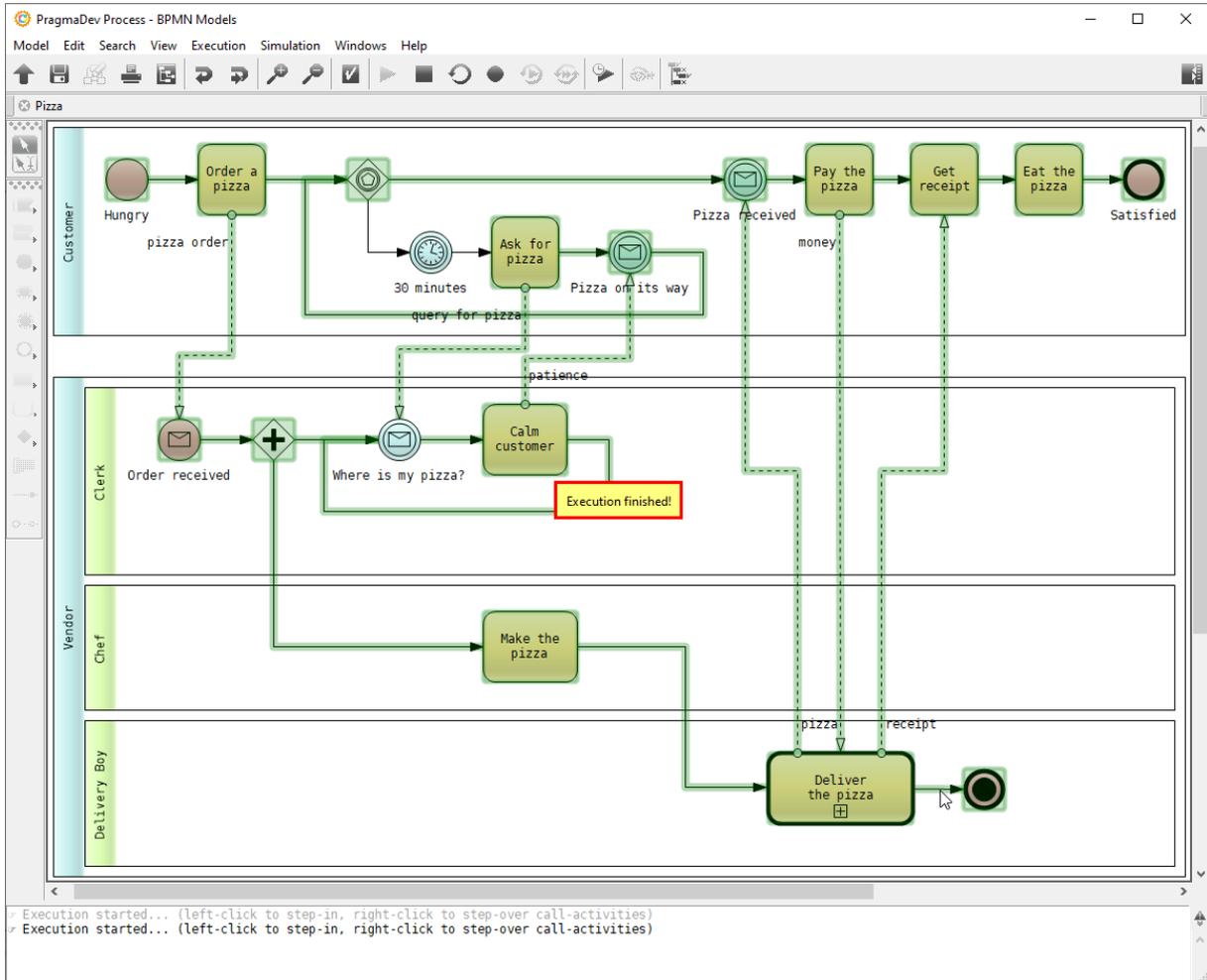


Tutorial

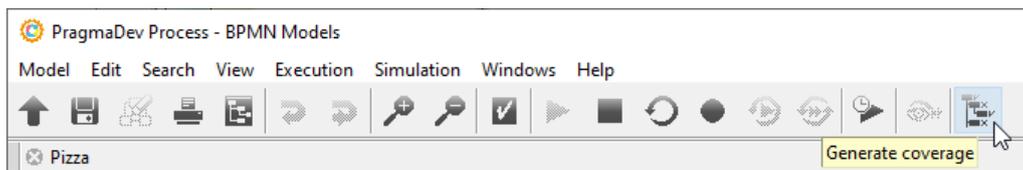
Click the next two sequence flows to give the money to the Delivery Boy:



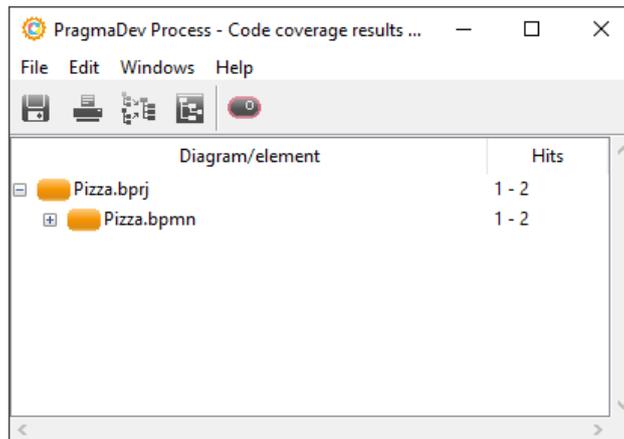
Continue by clicking all possible flows in both diagrams until there is nothing left to do, i.e., execution is finished:



To generate model coverage click the "Generate coverage" button:

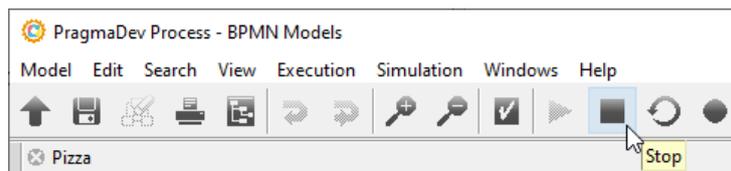


Coverage information will be shown as follows:

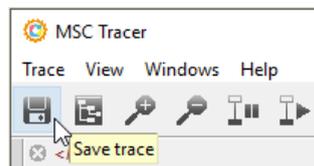


Coverage information helps to identify complementary scenarios in order to verify the process. Please note several coverage information can be merged to make sure a set of scenarios do actually cover all symbols.

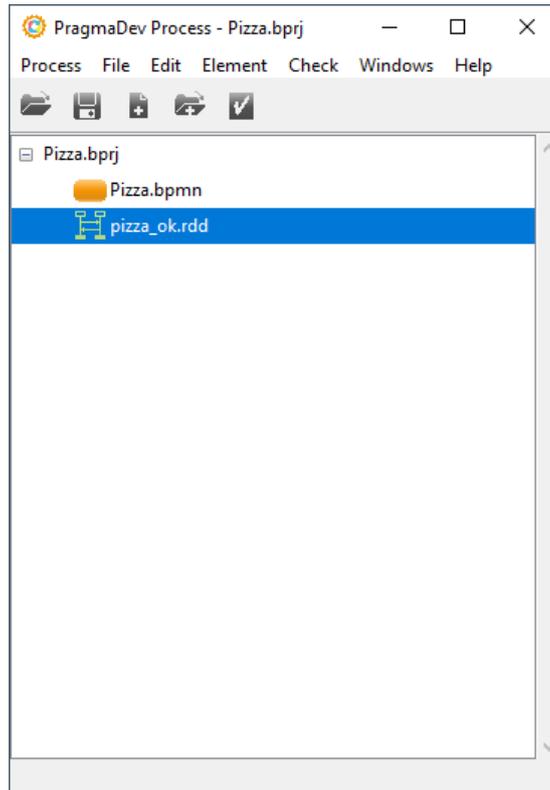
Close the coverage window and stop the execution via the "Stop" button:



Save the recording via the "Save trace" button in the *MSC Tracer*:



Give it a name (e.g., pizza_ok), and it will be added automatically to the project:



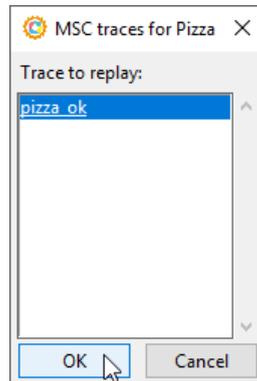
3.3 Automatic execution

3.3.1 Single-trace execution

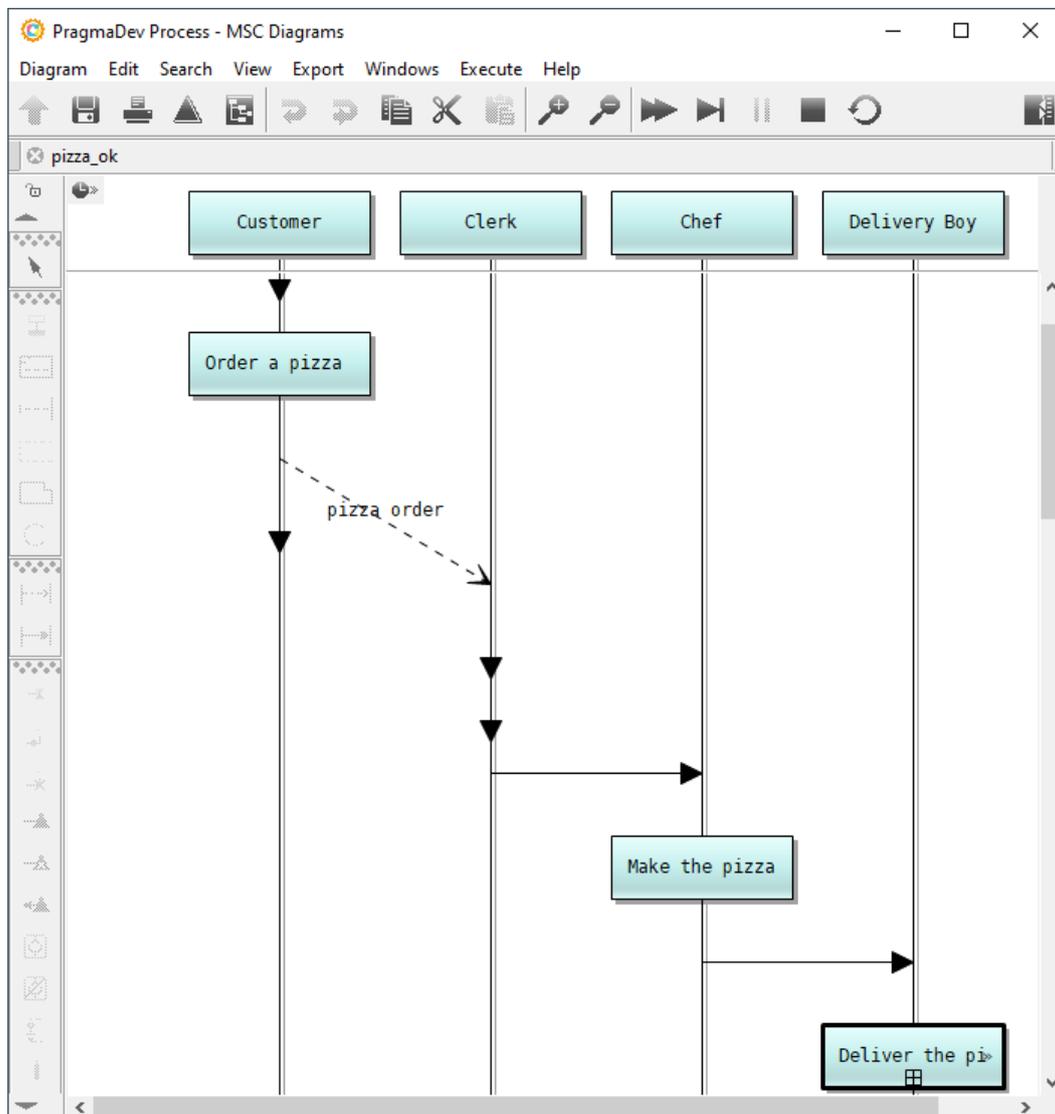
It is possible to replay a scenario. With `Pizza.bpmn` opened in the editor (double-click on it in the project manager), click the "Replay" button:



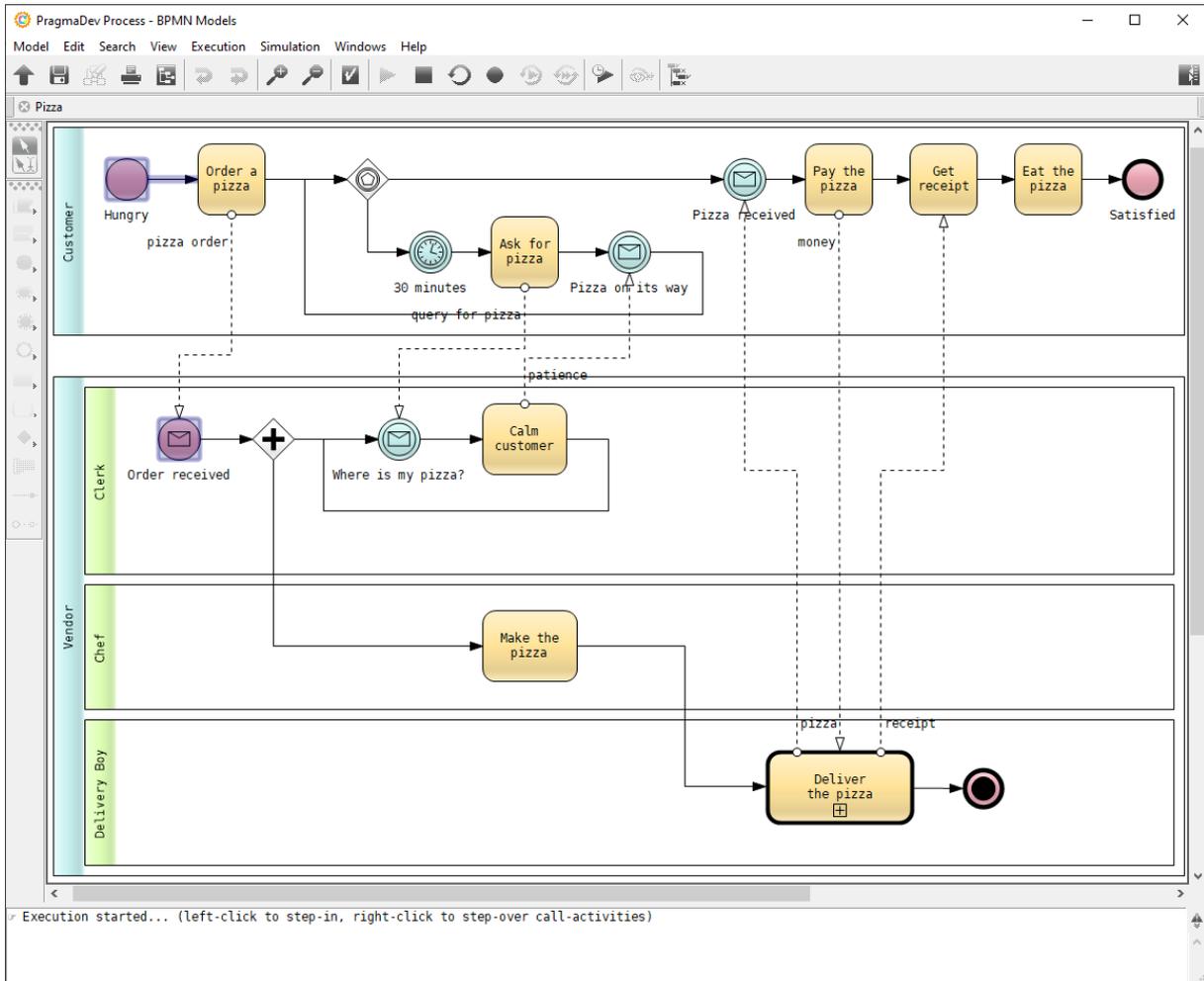
All recordings (MSC traces) found in the project will be listed; select pizza_ok and click the "OK" button:



The pizza_ok will be opened in the MSC editor:



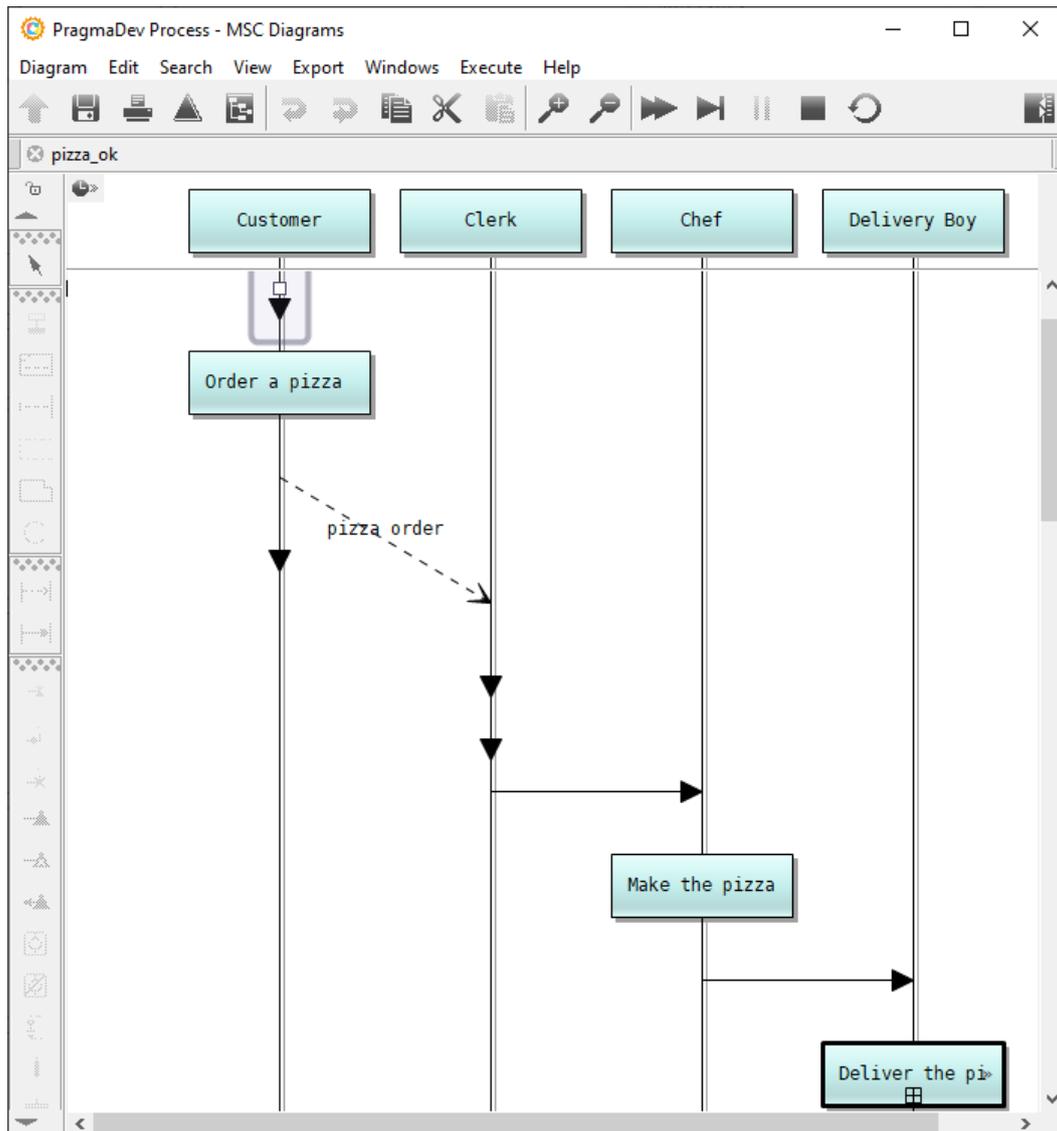
while the execution will start automatically in the BPMN editor:



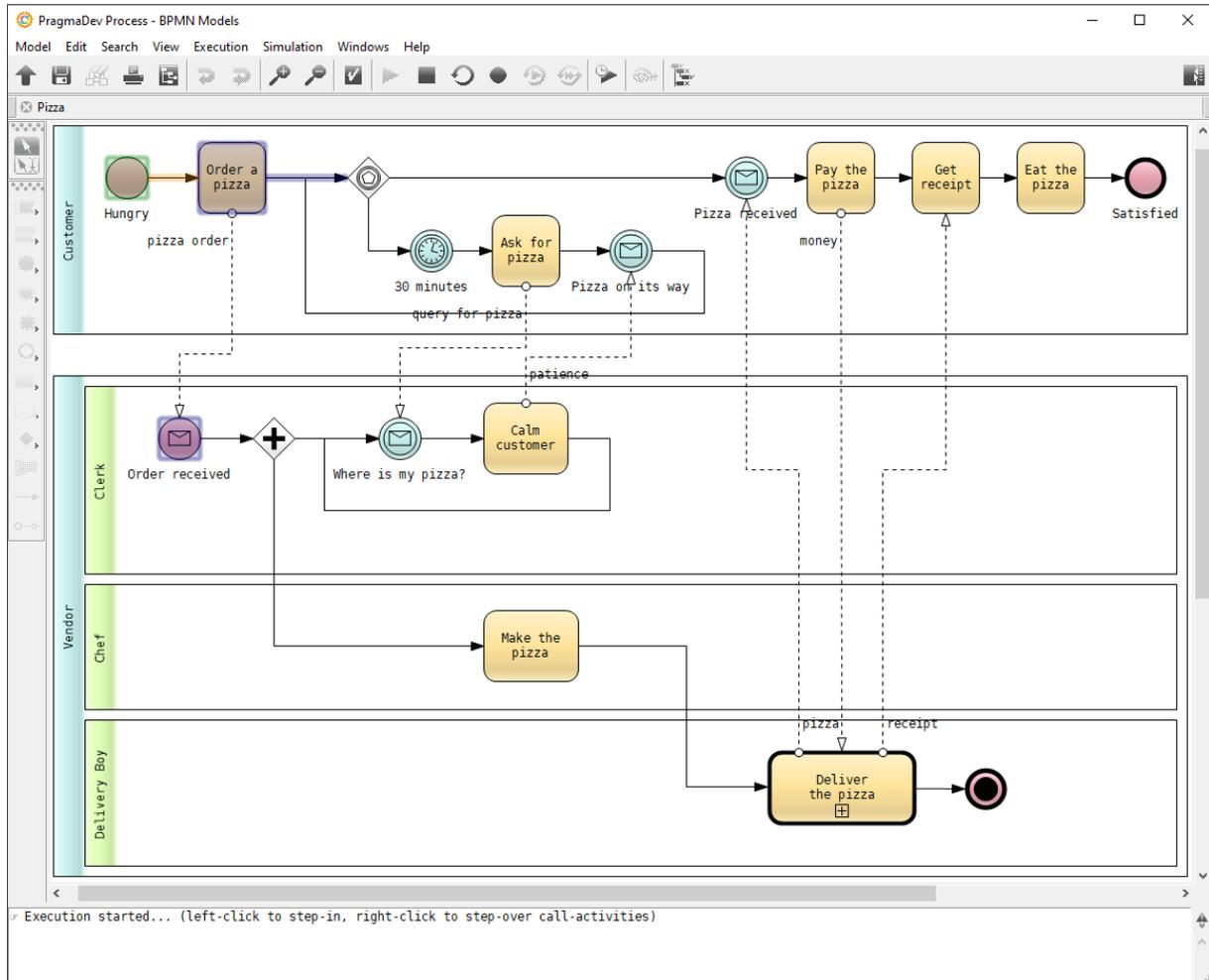
Click the "Step" button in the MSC editor:



The first sequence flow will be selected in the MSC editor:



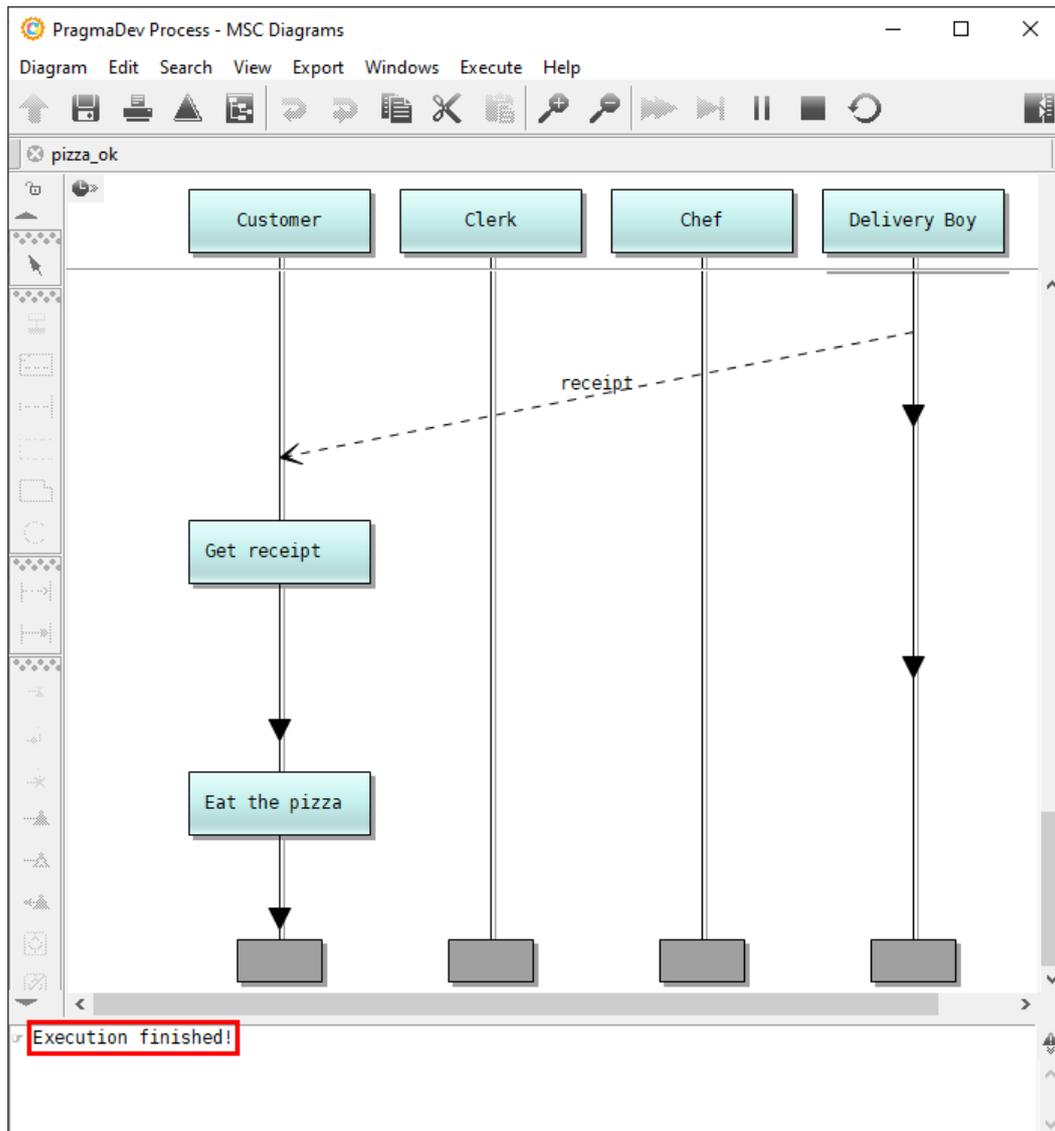
and executed in the BPMN editor:



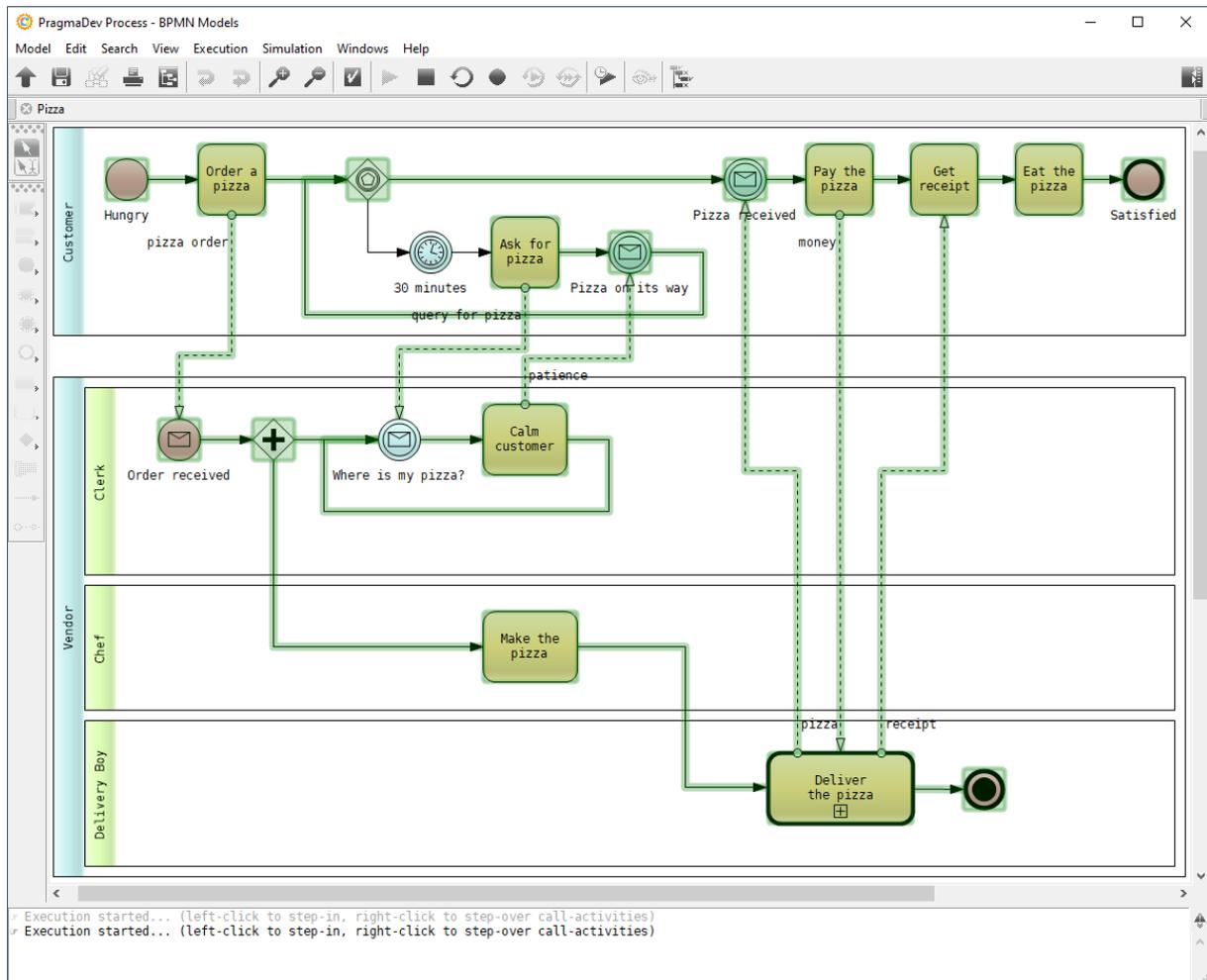
Try the "Step" button a couple of times and observe both (MSC trace and BPMN model) as execution advances in steps. Now click the "Run" button:



Execution will continue until no more steps are left:

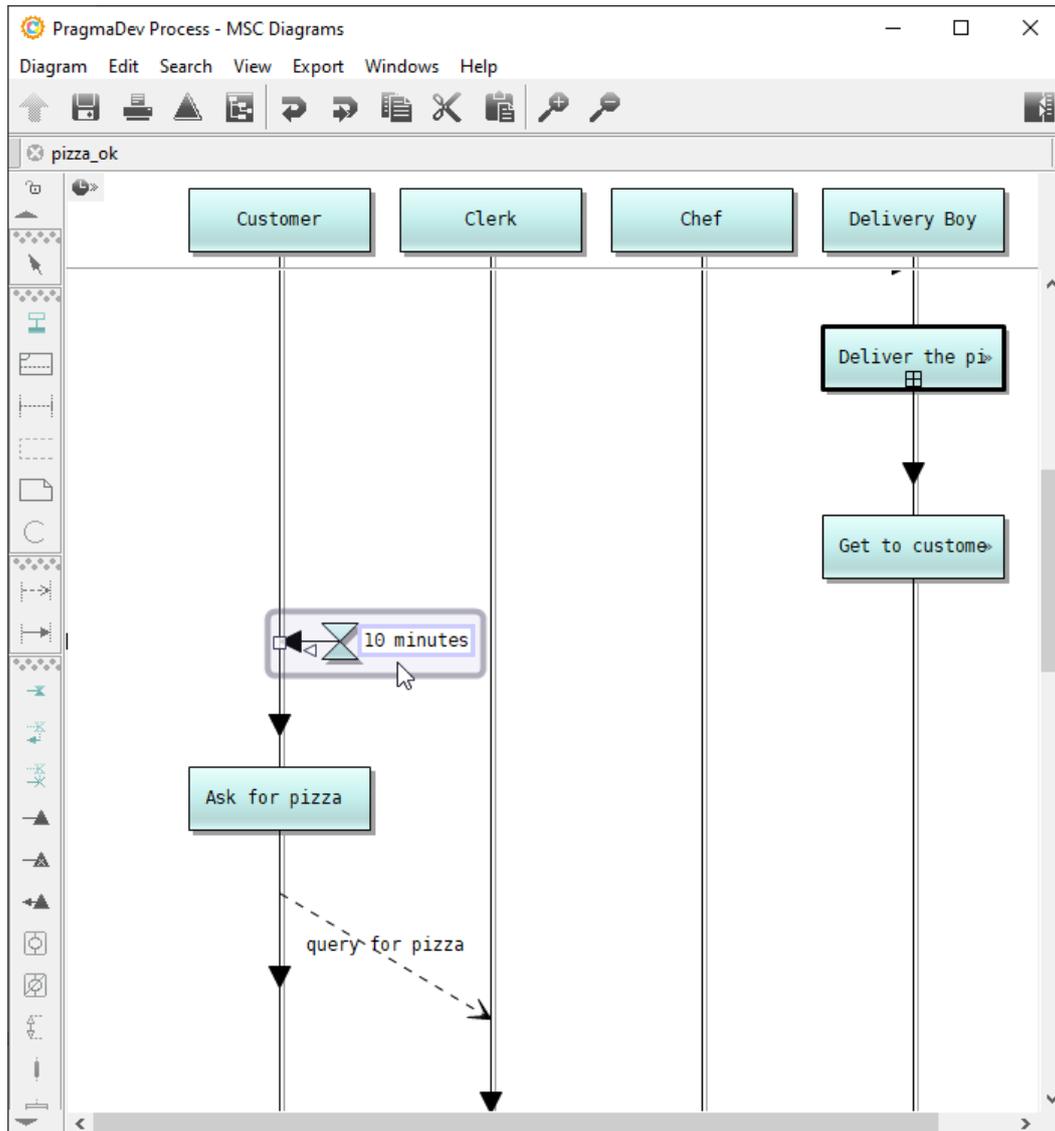


Check also the BPMN editor:

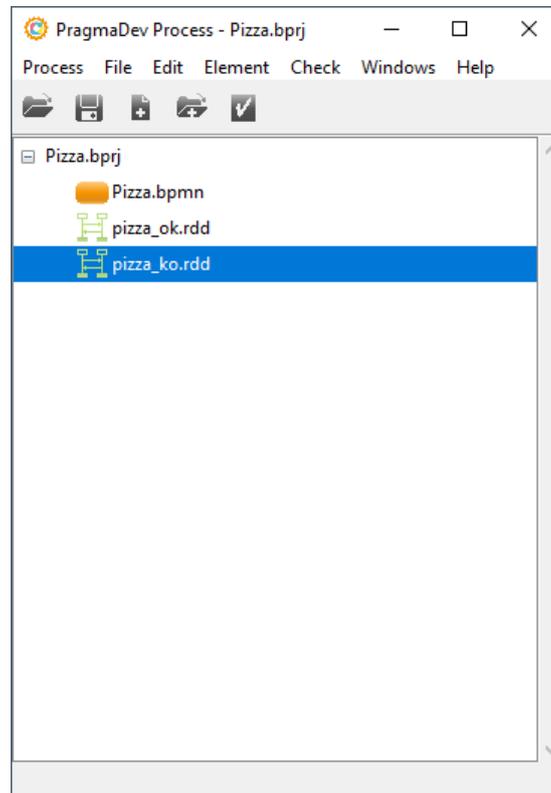


Use the "Stop" button to terminate execution.

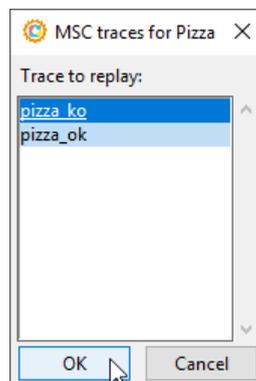
With the pizza_ok opened in the editor, find the 30 minutes timer and change it to 10 minutes:



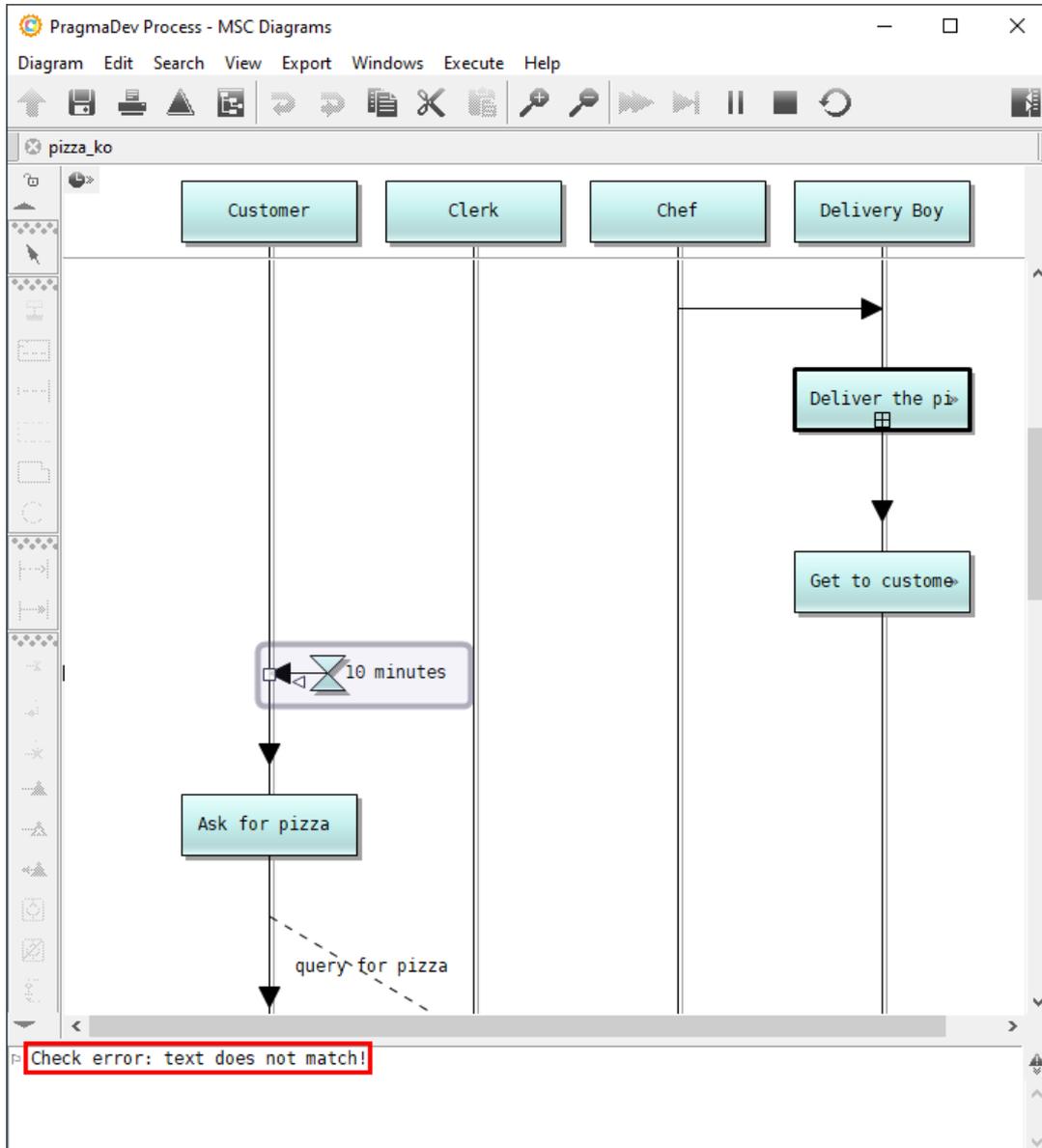
Save the modified MSC trace as pizza_ko via the menu "Diagram / Save as..."; it will be added to the project:



With Pizza.bpmn still opened in the editor, click the "Replay" button, and select pizza_ko for execution:

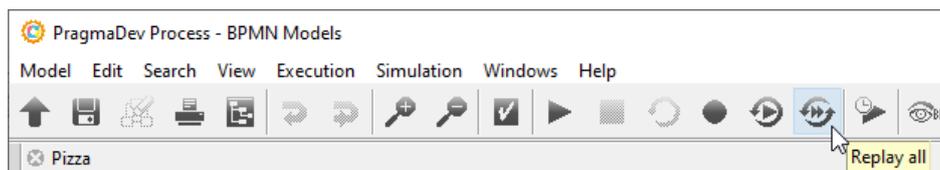


In the MSC editor click the "Run" button. Execution will stop at the timer symbol complaining about text mismatch:



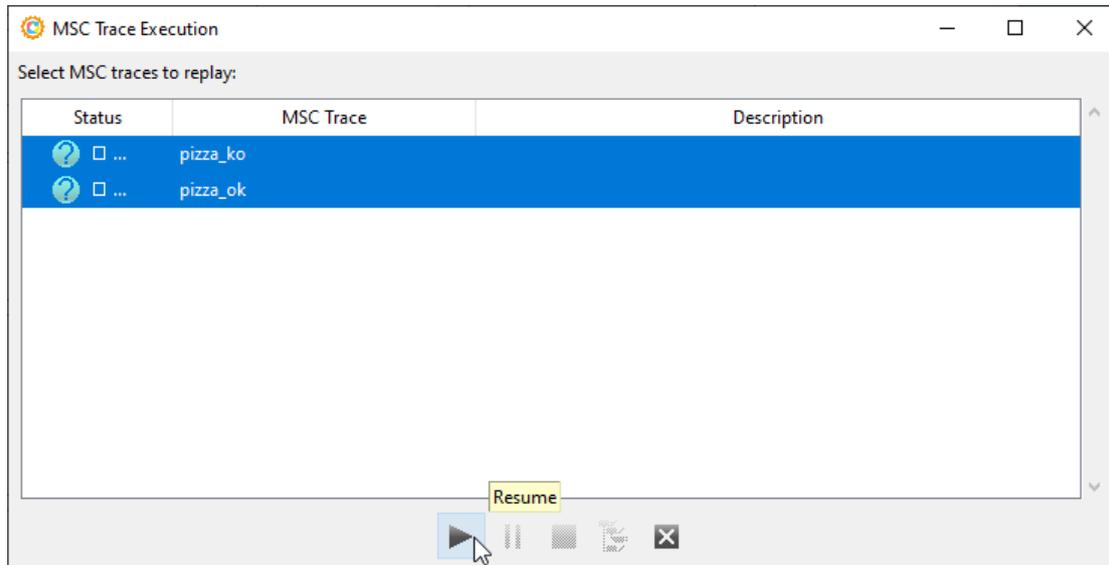
3.3.2 Multi-trace execution

The tool can replay automatically several scenarios in a row to make sure they are still valid. Stop execution (if still running), and with Pizza . bpmn opened in the editor, click the "Replay all" button:

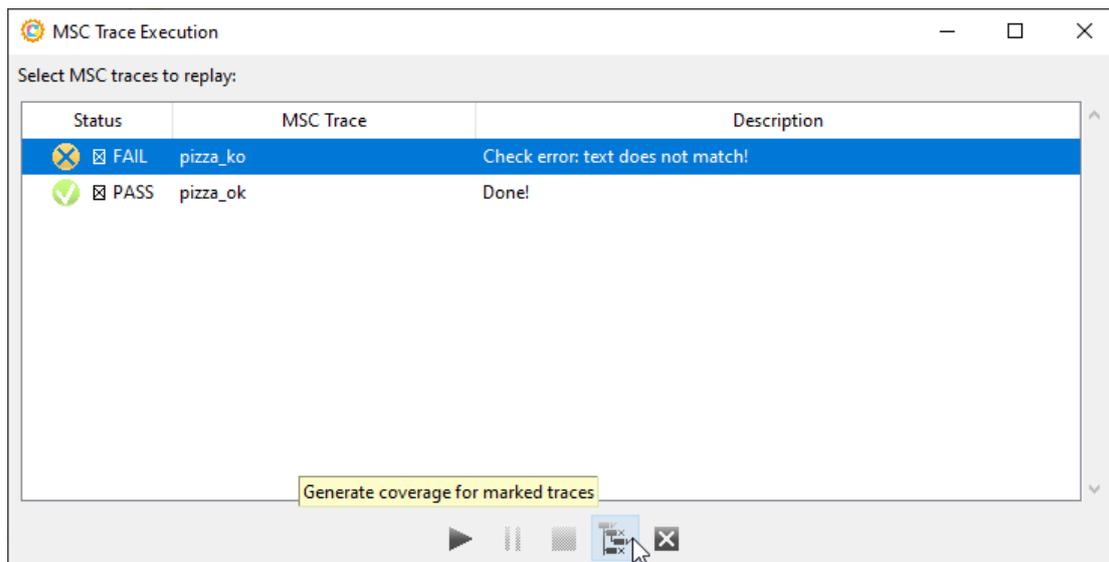


Tutorial

Select `pizza_ok` and `pizza_ko` by clicking on them while holding "Ctrl". With both traces selected click the "Resume" button:



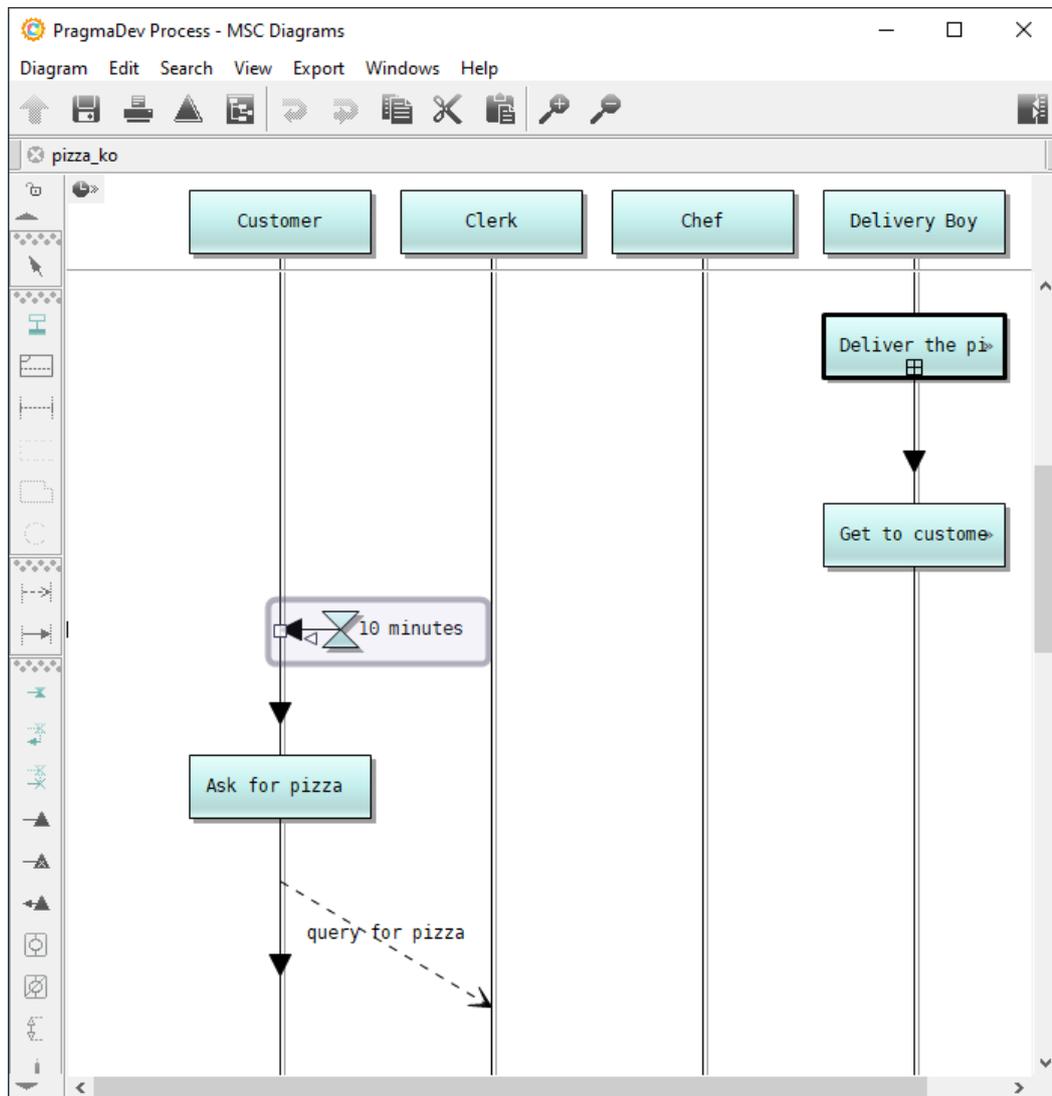
The traces will be executed in the background, and the result of such execution will be shown in the "Status" column:



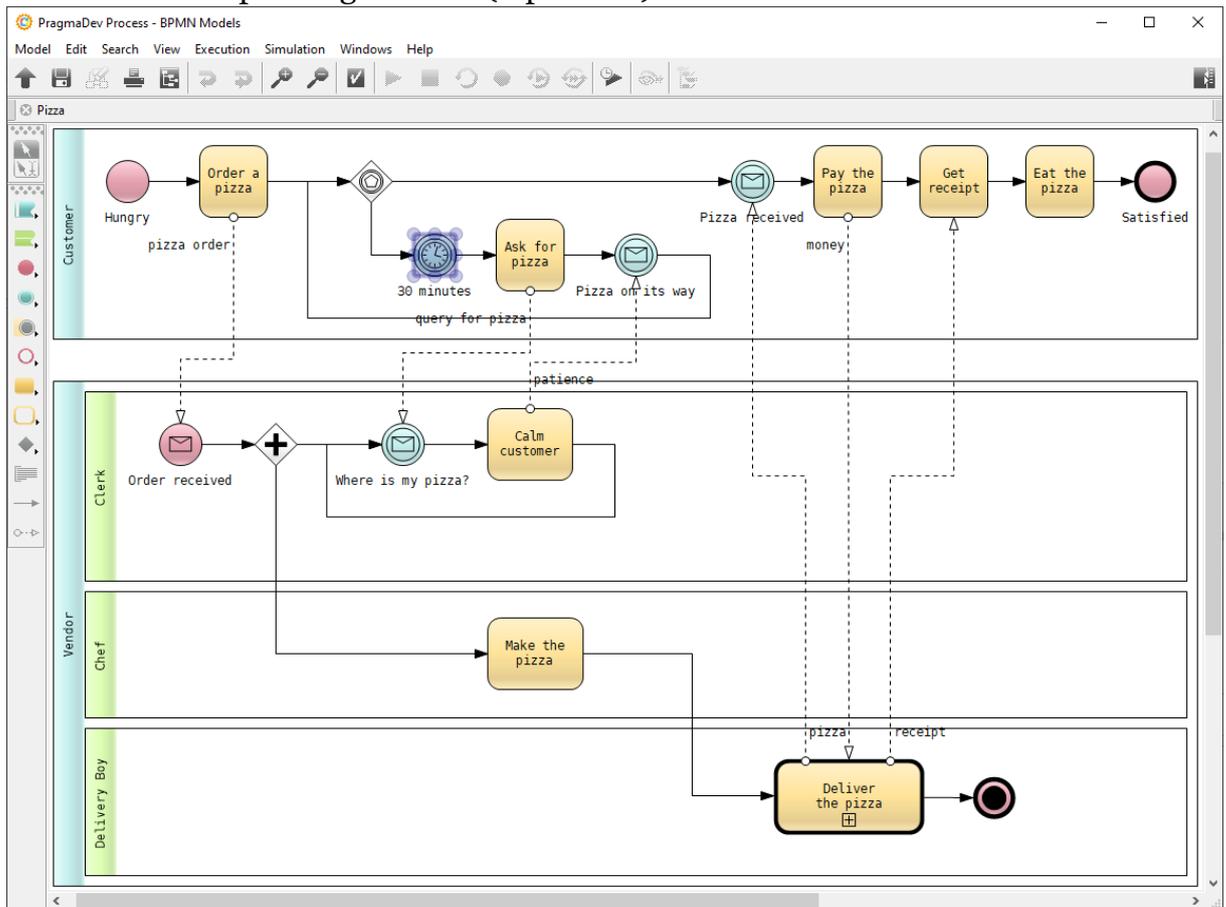
Note that model coverage can be generated via the "Generate coverage for marked traces" button.

Double-clicking a failed trace will:

- Open the trace in the MSC editor and select the concerned element:



- Select the corresponding element (if possible) in the BPMN editor:



4 Exploration

Exploration of BPMN models in PragmaDev Process is done via OBP (see User Manual). PragmaDev Process exploration feature can be used to check:

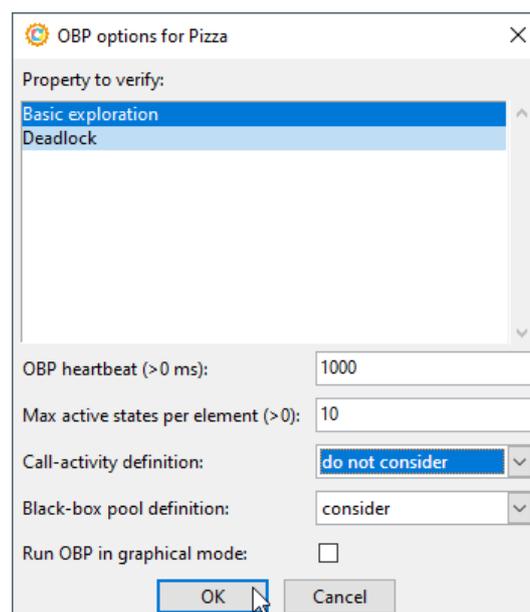
- *Complexity*: through full exploration of the model.
- *Reachability*: identification of unreachable paths.
- *Deadlock*: identification of blocking scenarios.
- *Property*: verification of a property expressed in either PSC (Property Sequence Chart) or GPSL (Generic Property Specification Language).

4.1 Complexity check

The tool can automatically execute any possible combination of flows to evaluate the complexity and the reachability of the model. With `Pizza.bpmn` opened in the editor (double-click on it in the project manager), click the "Explore with OBP" button:

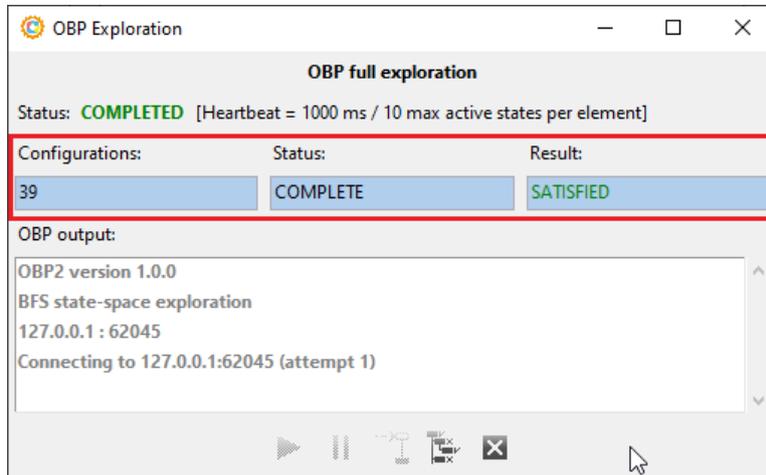


Select "Basic exploration", set "Call-activity definition" to "do not consider", and click the "OK" button:



The "do not consider" option will step-over call-activities during exploration.

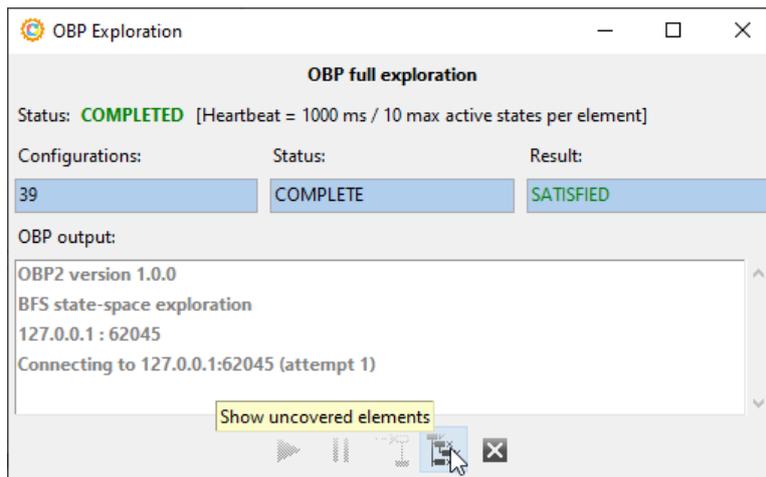
Observe the increasing number of configurations⁴ while waiting for the exploration to complete. The number of configuration can be compared to the model complexity to find out if that result is too high or normal (see User Manual).



⁴The exploration may be interrupted before completion when using the free version of PragmaDev Process.

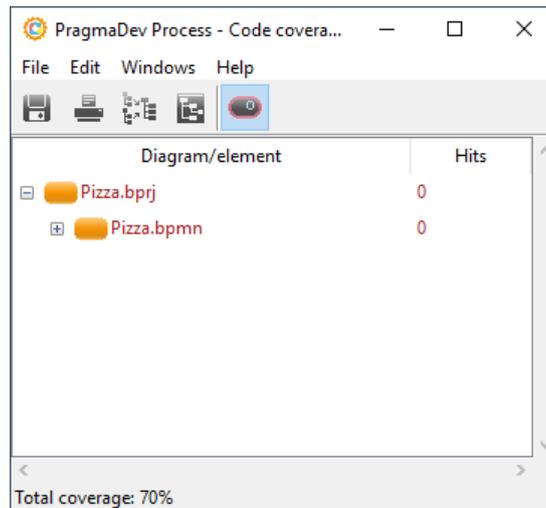
4.2 Reachability

An automatic exploration will find any reachable paths in the process. If some symbols are not reachable there is probably a problem in the model. To identify unreachable symbols, after an exploration is completed, click the "Show uncovered elements" button:

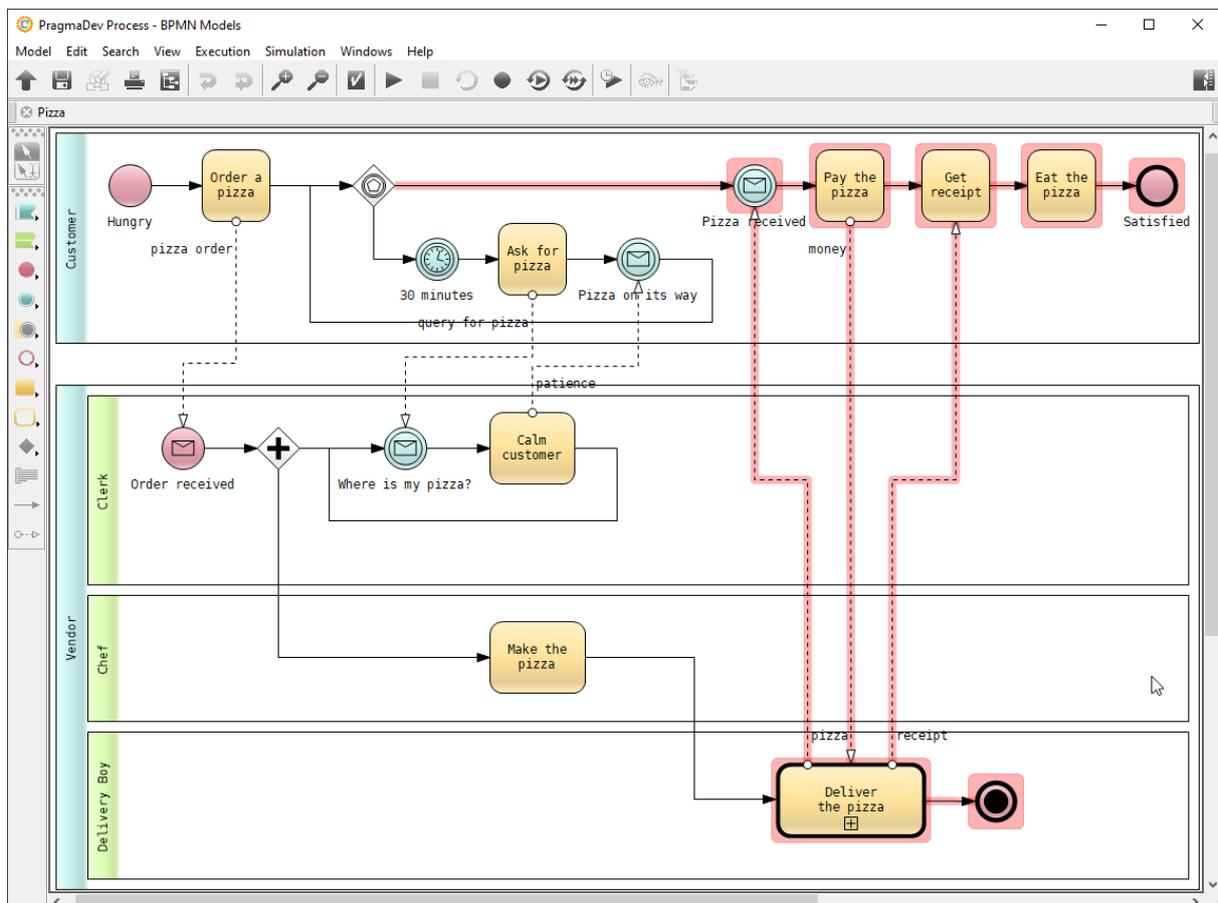


Tutorial

Coverage information will be shown as follows:



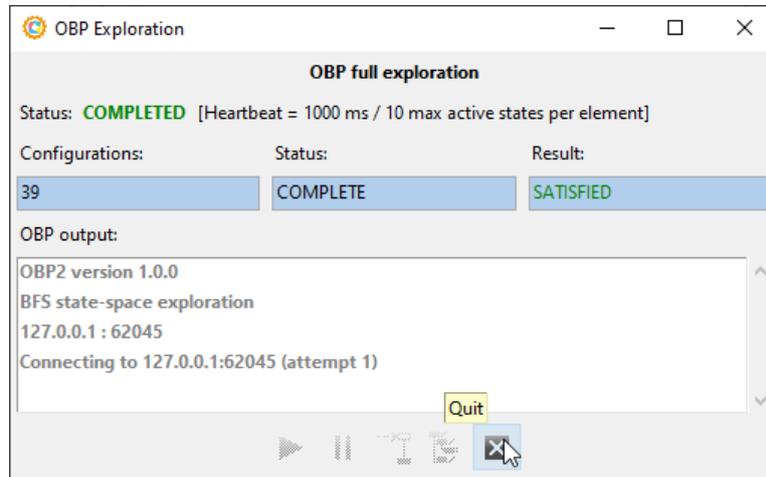
All non covered elements during exploration will be marked in red in the editor:



In our example, stepping over the Deliver the pizza call-activity resulted in being stuck during exploration. This is because the behavior of a stepped over activity is to wait for all incoming message flows before executing all outgoing message flows. Outgoing sequence flows can be executed only when all message flows have been treated.

The Deliver the pizza call-activity cannot send the pizza message before receiving the money message, which cannot happen.

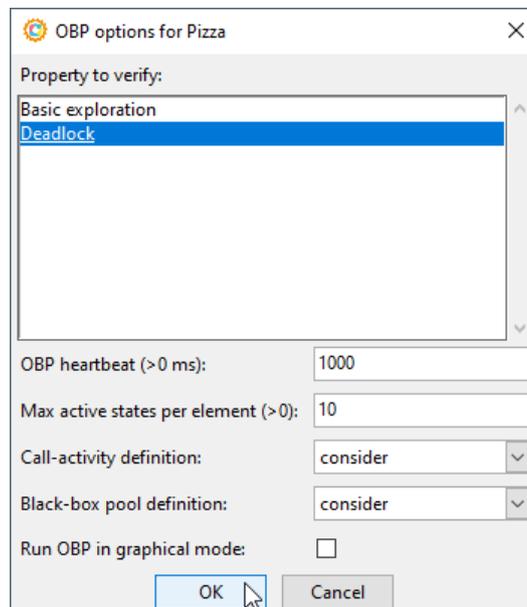
"Quit" OBP.



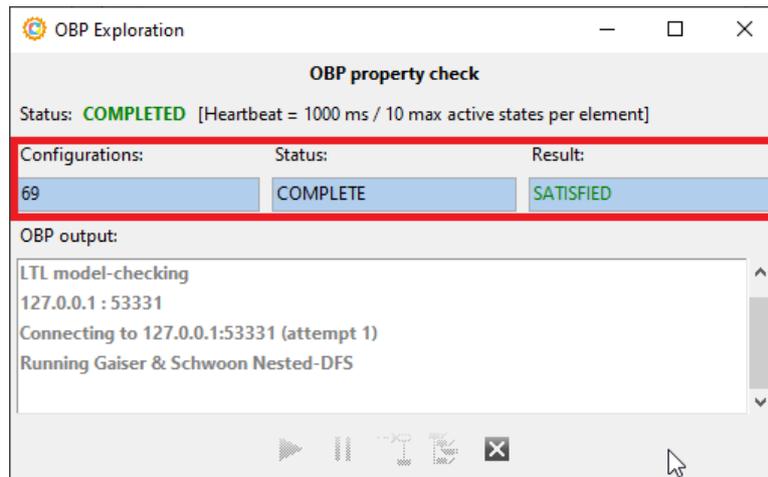
Close also the coverage information window.

4.3 Deadlock check

Now let's check the model for deadlocks. A deadlock is a state where there are no actions to perform but the process is not finished (terminated). Run OBP again with "Deadlock" selected:



Observe the result returned by OBP saying that the property was satisfied:

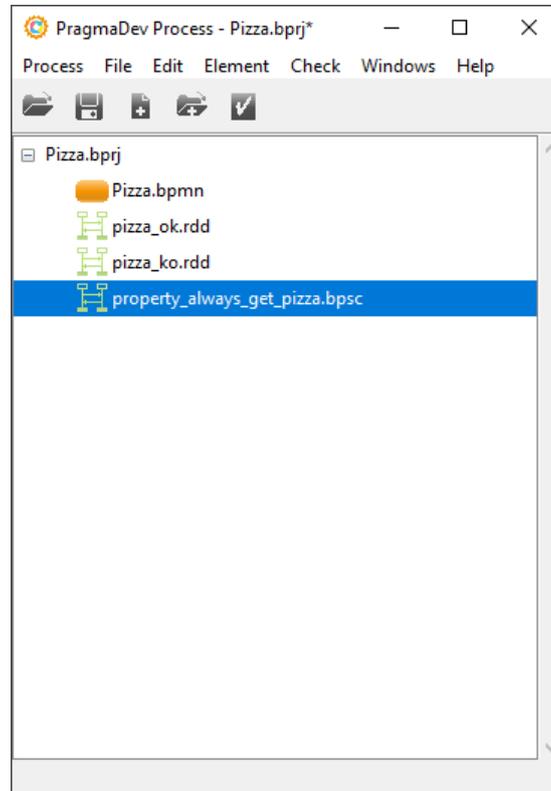


This means that there are no deadlocks in the model.

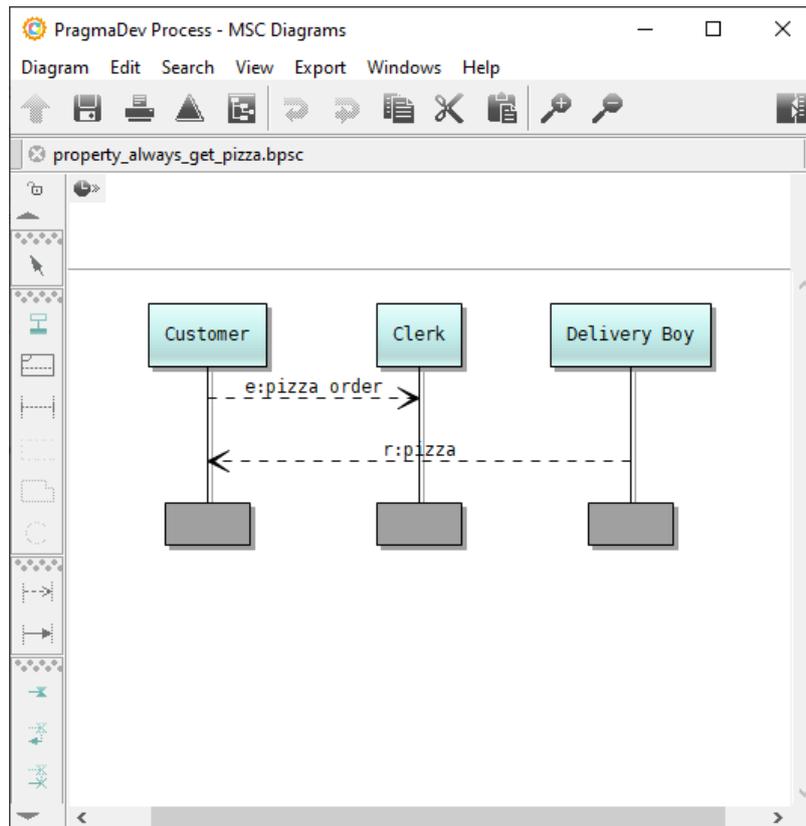
Note that the presence of non covered elements in the model does not mean that there is also a deadlock. An infinite loop is a typical case where the process never terminates, but there is always at least one action to perform. The following section will illustrate this case using a property.

4.4 Property verification

We will first create a property and then verify it on the model. In the Project Manager create and add a new PSC file to the project via the button in the toolbar, and name it `property_always_get_pizza`:



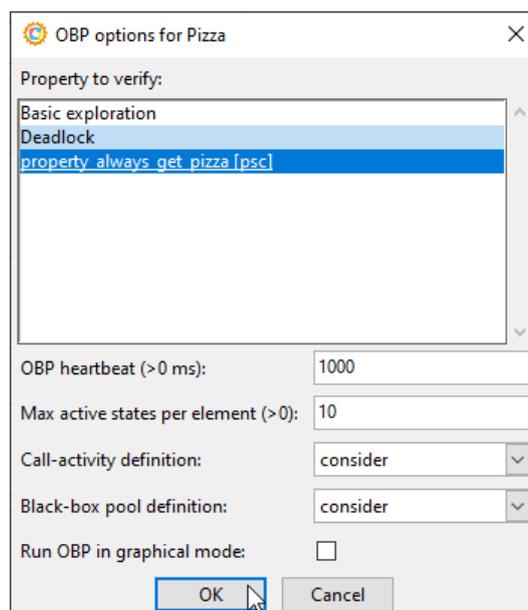
Double click on it to open the MSC/PSC Editor, and draw the following property:



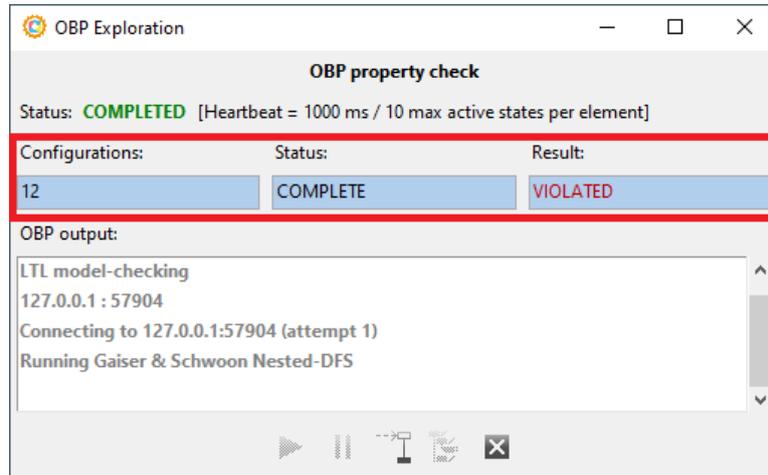
The PSC property says the following:

- If the Customer has sent a pizza_order to the Clerk, then
- the Delivery Boy *must* hand over the pizza to the Customer.

To verify this property, with the Pizza.bpmn opened in the editor, click the "Run OBP" button. Select property_always_get_pizza and click "OK":

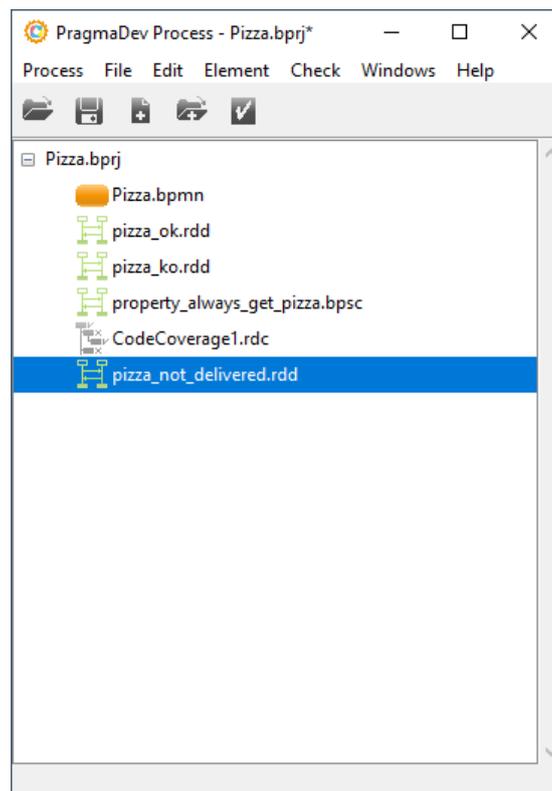


Observe the result returned by OBP saying that the property was violated.^a Property violation will activate the "Display counter example" button, click it:

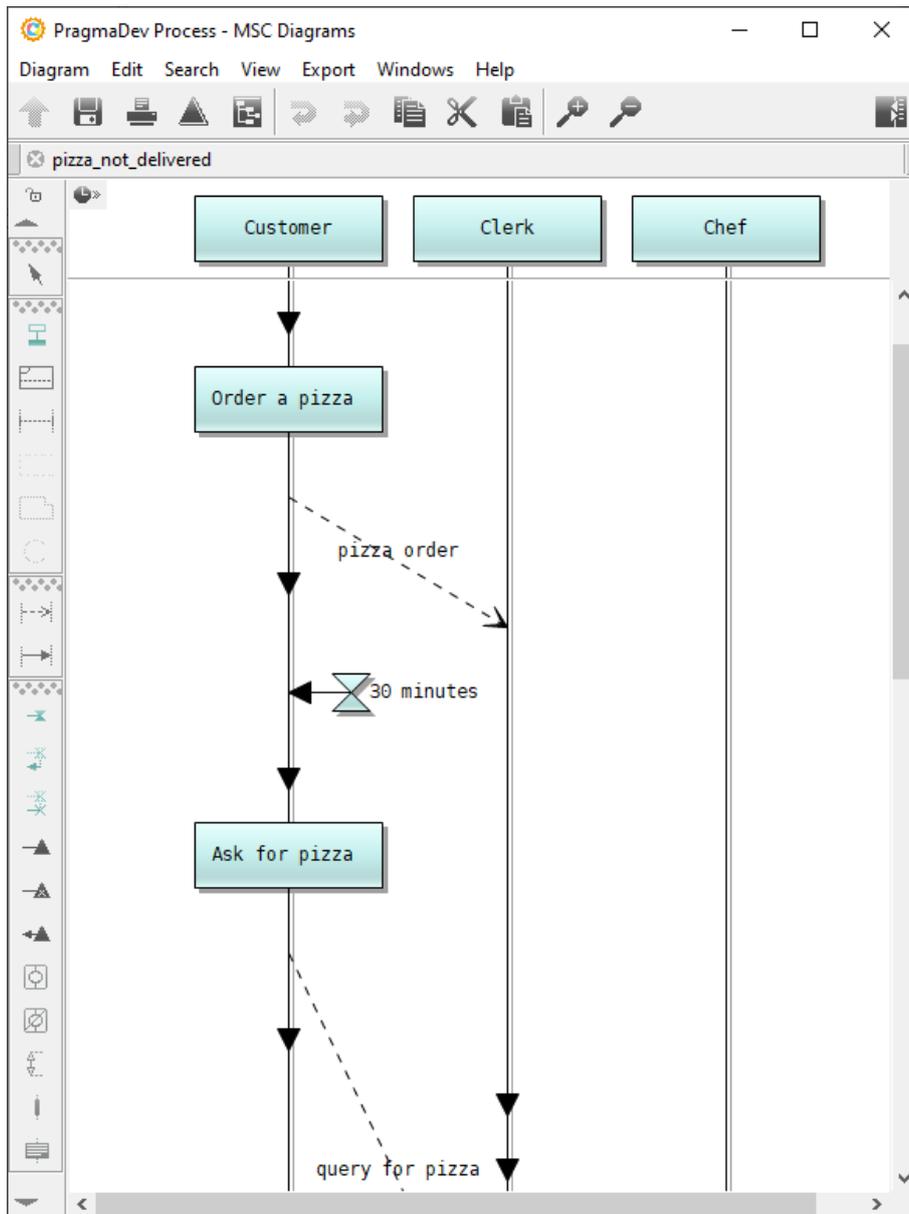


^aThe exploration will be interrupted before completion when using the free version of PragmaDev Process.

When asked to save the MSC, name it `pizza_not_delivered` and save it. The counter example will be added to the project:



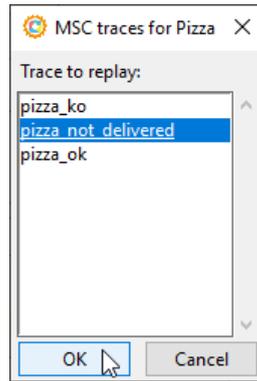
and displayed in the MSC Editor:



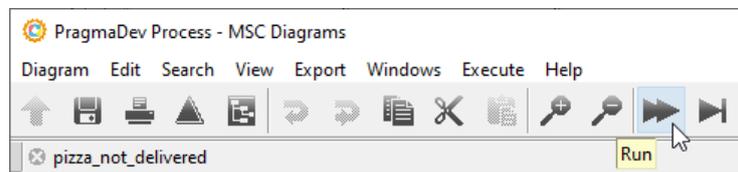
Quit OBP and hit the "Replay" button in the BPMN Editor:



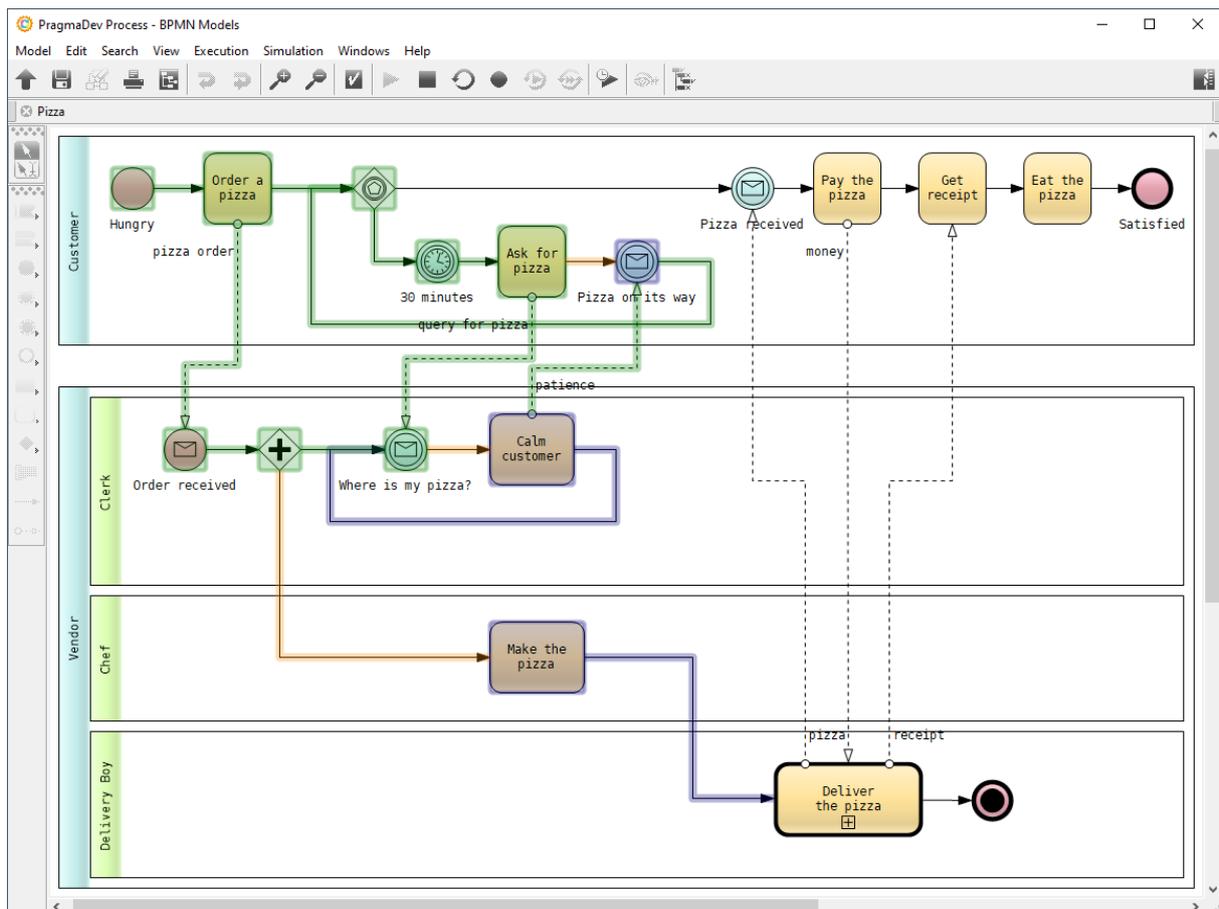
Select pizza_not_delivered and hit "OK":



Hit the "Run" button in the MSC Editor:



Observe the counter example being replayed in the BPMN editor until the end:



The property was violated because there exists a case (as shown above) where the Cus-

Tutorial

tomr is stuck in an infinite loop always asking for his/her pizza, and thus never receiving it.

5 Simulation

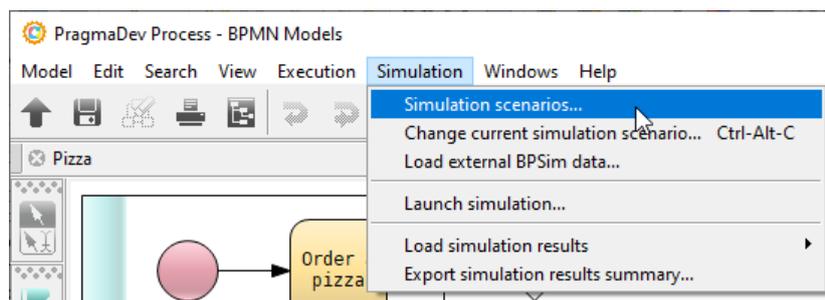
The objective of a simulation is to evaluate the time needed to perform a given process, as well as its cost. As an example, simulation can help in choosing the best method of delivery for the pizza, e.g., bike vs car.

5.1 Simulation parameters

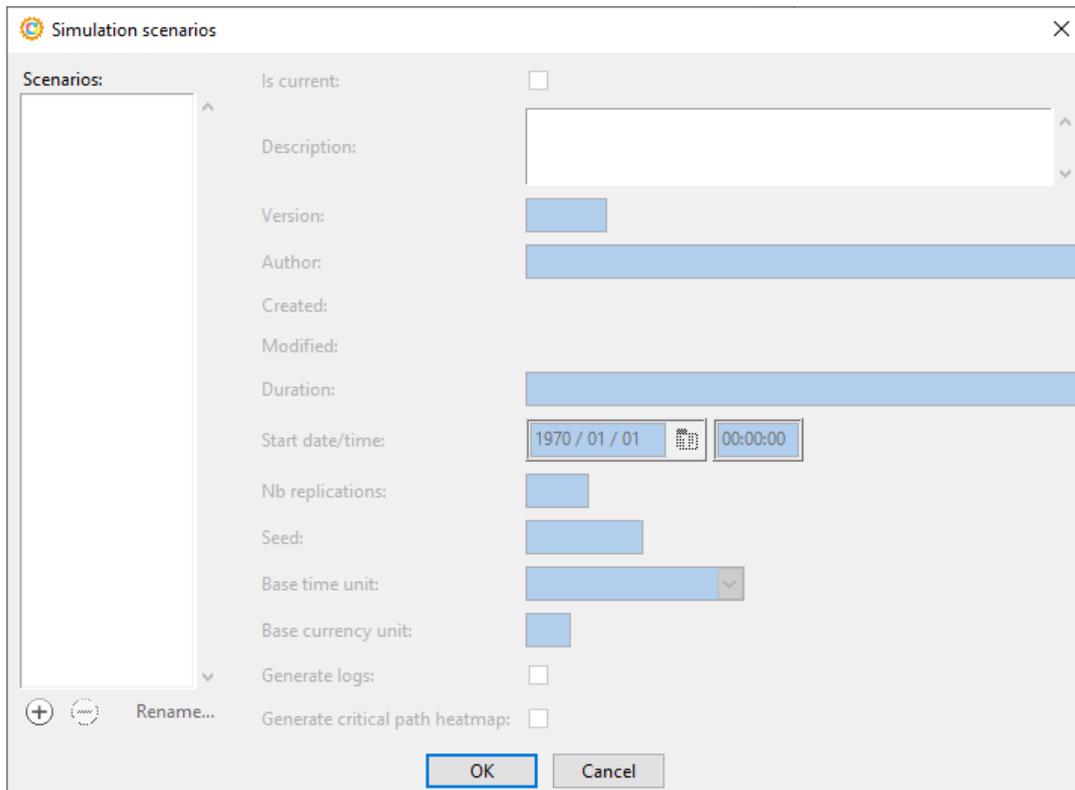
5.1.1 Bike delivery

5.1.1.1 Scenario parameters

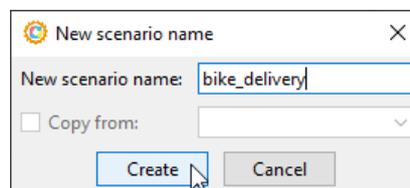
With the Pizza.bpmn opened in the BPMN editor, select "Simulation scenarios..." in the "Simulation" menu:



Add a new simulation scenario via the "New / copy scenario" button:



Name it bike_delivery and hit "Create":



Fill out the scenario attributes as follows and hit "OK":

Simulation scenarios

Scenarios: bike_delivery

Is current:

Description:

Version:

Author:

Created: 2022-08-23T17:00:00

Modified: 2022-08-23T17:00:00

Duration:

Start date/time: 2022 / 08 / 23 17:00:00

Nb replications: 100

Seed: 123456

Base time unit: minutes

Base currency unit: EUR

Generate logs:

Generate critical path heatmap:

+ - Rename... OK Cancel

The number of replications (i.e. runs) is set to 100, the time will be measured in minutes, and cost will be measured in EUR.

Tutorial

5.1.1.2 Element parameters

Time, cost, and control parameters

Simulation properties for every BPMN element in the model can be accessed via the contextual menu by selecting "Simulation properties...":

The screenshot displays the PragmaDev Process - BPMN Models application. The main workspace shows a BPMN diagram for a pizza delivery process, organized into swimlanes for Customer, Clerk, Chef, and Delivery Boy. The process starts with a Customer task 'Order a', followed by a timer event '30 minutes', and then a task 'Ask for pizza'. A message event 'query for pizza' connects to a task 'Calm customer' in the Clerk swimlane. Another message event 'patience' connects to a task 'Make the pizza' in the Chef swimlane. A contextual menu is open over the '30 minutes' timer event, with 'Simulation properties...' selected. The right-hand panel shows the 'Simulation properties' for the selected element, with a red box highlighting the 'Current scenario' field set to 'bike_delivery', and dropdown menus for 'Time parameters: none', 'Cost parameters: none', and 'Control parameters: none'. A 'Parent process params' button is also visible.

Notice that the current scenario is the bike_delivery we created earlier. Start by configuring the parameters of the Hungry start event. Select "Control parameters: trigger" and fill the parameters as follows:

The screenshot shows the PragmaDev Process - BPMN Models interface. The main workspace displays a BPMN diagram for a process named "Pizza". The diagram is organized into swimlanes for Customer, Clerk, Chef, and Delivery Boy. The Customer swimlane starts with a "Hungry" start event (purple circle with dots) leading to an "Order a pizza" task (yellow rounded rectangle). This task outputs a "pizza order" message to a "Clerk" swimlane. The Clerk swimlane has an "Order received" start event (pink circle with envelope) leading to a split gateway (+). The Chef swimlane has a "Make the pizza" task (yellow rounded rectangle) triggered by the split gateway. The Delivery Boy swimlane has a "Where is my pizza?" start event (blue circle with envelope) triggered by the split gateway, leading to a "Calm customer" task (yellow rounded rectangle). The "Calm customer" task outputs a "patience" message back to the Customer swimlane. The Customer swimlane also has a "30 minutes" timer event (clock icon) leading to an "Ask for pizza" task (yellow rounded rectangle), which outputs a "Pizza" message to the Clerk swimlane. The Clerk swimlane also has a "query for pizza" message event (circle with magnifying glass) leading to the "Ask for pizza" task. The "Ask for pizza" task outputs a "Pizza" message to the Clerk swimlane. The right-hand panel shows the configuration for the "Hungry" start event. The "Control parameters: trigger" dropdown is selected and highlighted with a red box. Below it, the "Inter-trigger timer" is set to "Fixed integer value" with a "Value" of 10 and "Results" of "-". The "Trigger count" is also set to "Fixed integer value" with a "Value" of 10 and "Results" of "-".

Tutorial

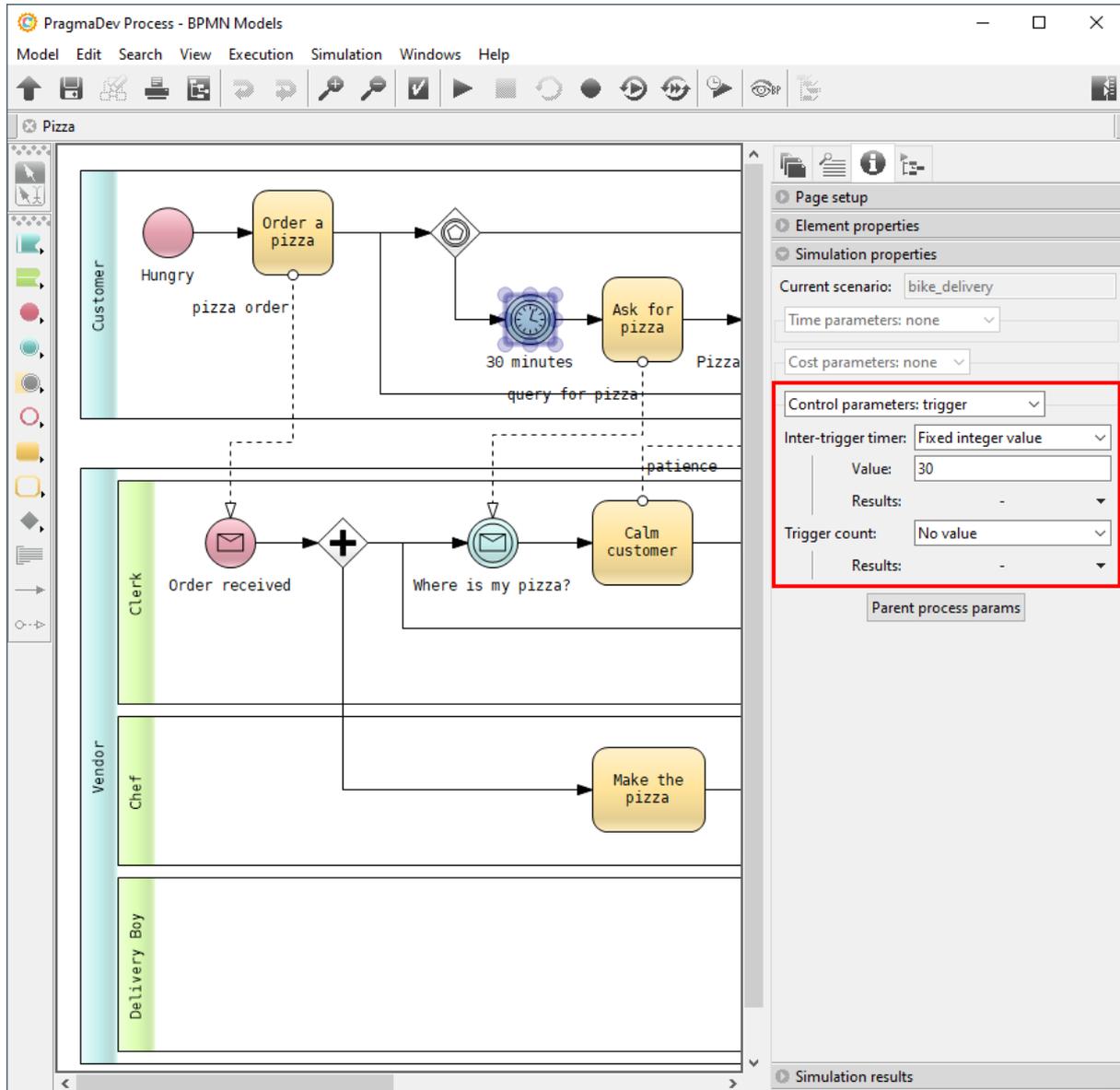
The values mean that every simulation run (i.e. replication) will handle 10 pizza orders with a delay of 10 minutes from one order to the other. Let's continue with the simulation parameters for the task Order a pizza:

The screenshot displays the PragmaDev Process - BPMN Models interface. The main workspace shows a BPMN diagram for a pizza ordering process, organized into swimlanes for Customer, Clerk, Chef, and Delivery Boy. The process starts with a 'Hungry' event leading to the 'Order a pizza' task. This task is followed by a gateway that branches into two paths: one leading to a '30 minutes' timer and another to an 'Ask for pizza' task. The 'Ask for pizza' task leads to a 'Pizza' event, which then triggers a 'query for pizza' event. This event leads to a 'patience' event, which then triggers a 'Calm customer' task. The 'Calm customer' task leads to a 'Where is my pizza?' event, which then triggers a 'Make the pizza' task. The 'Make the pizza' task leads to a 'Delivery Boy' swimlane. The 'Order received' event is triggered by the 'Hungry' event. The 'Order received' event leads to a gateway that branches into two paths: one leading to the '30 minutes' timer and another to the 'Make the pizza' task. The '30 minutes' timer leads to the 'Ask for pizza' task. The 'Where is my pizza?' event leads to the 'Calm customer' task. The 'Calm customer' task leads to the 'Make the pizza' task. The 'Make the pizza' task leads to the 'Delivery Boy' swimlane.

On the right side, the 'Simulation properties' panel is open, showing the following configuration for the 'Order a pizza' task:

- Current scenario: bike_delivery
- Time parameters: basic
- Processing time: Triangular distribution
- Mode: 3.0
- Min: 1.0
- Max: 5.0
- Results: -

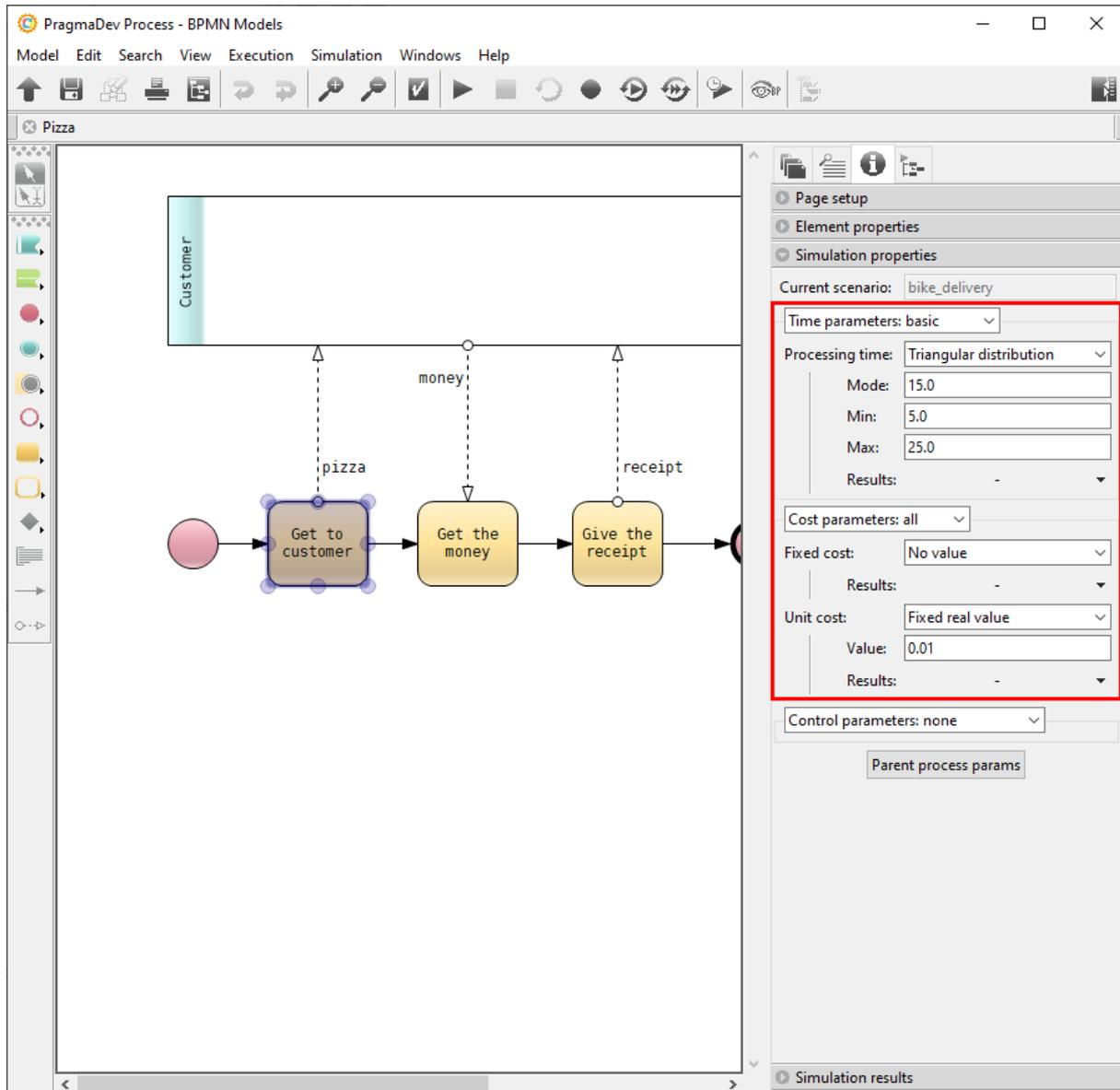
This task is set to take from 1 to 5 minutes with a mean of 3 minutes (following a triangular distribution). Next, set the timer to fire after 30 minutes:



Set the parameters for all the tasks in the main diagram with the following values (using a triangular distribution):

Task	mode	min	max
Ask for pizza	3	2	5
Pay the pizza	1	1	2
Get receipt	1	1	2
Eat the pizza	20	15	30
Calm customer	2	1	5
Make the pizza	10	8	15

Switch to the delivery diagram and set the values of the task Get to customer as follows:



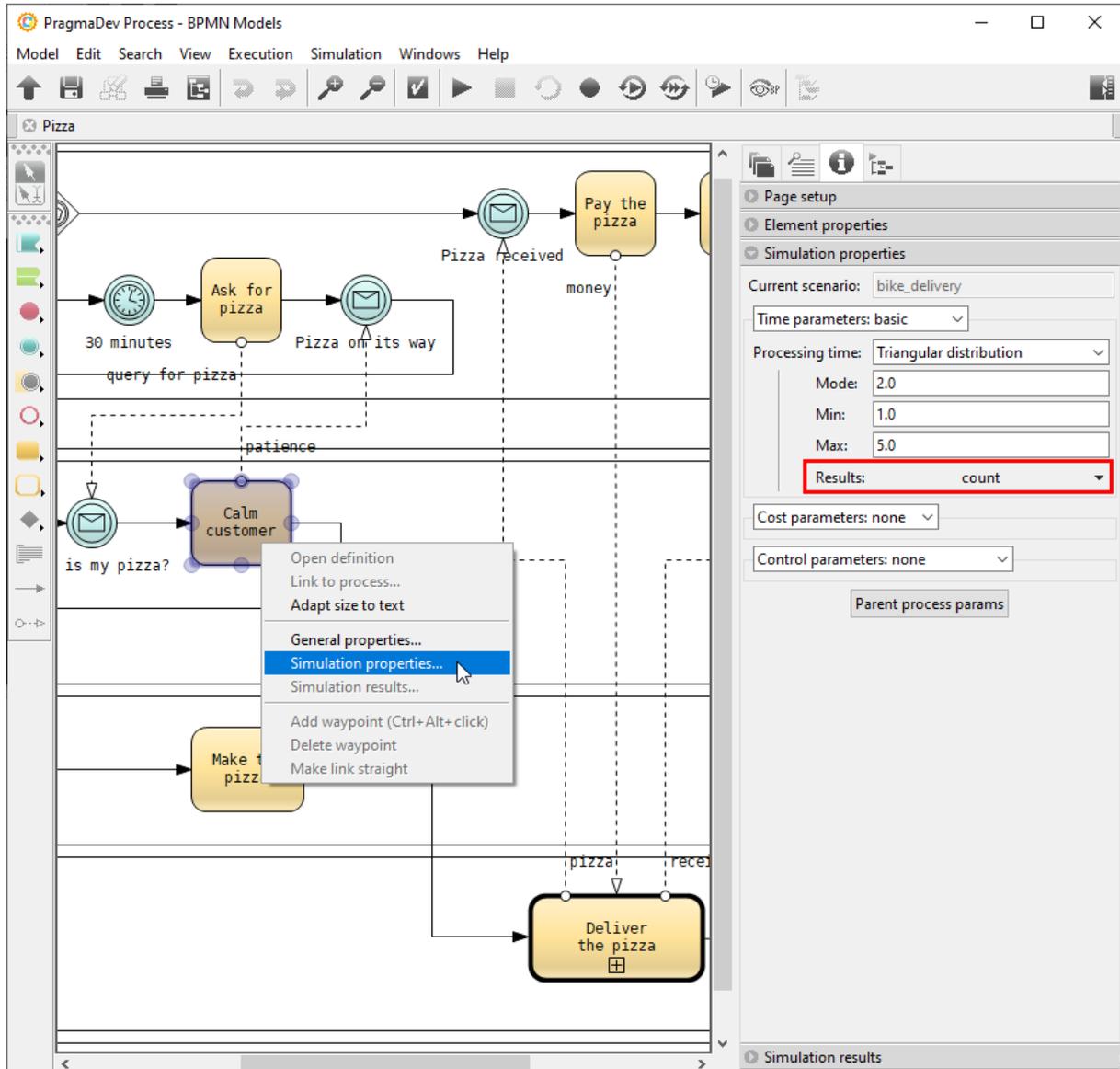
Note that for this task the "Unit cost" is set to 0.01 EUR/minute. This value represents a rough estimation of the cost of using a bike for the delivery. Complete the remaining tasks of the delivery diagram with the following values:

Task	mode	min	max
Get the money	1	1	2
Give the receipt	1	1	2

Tutorial

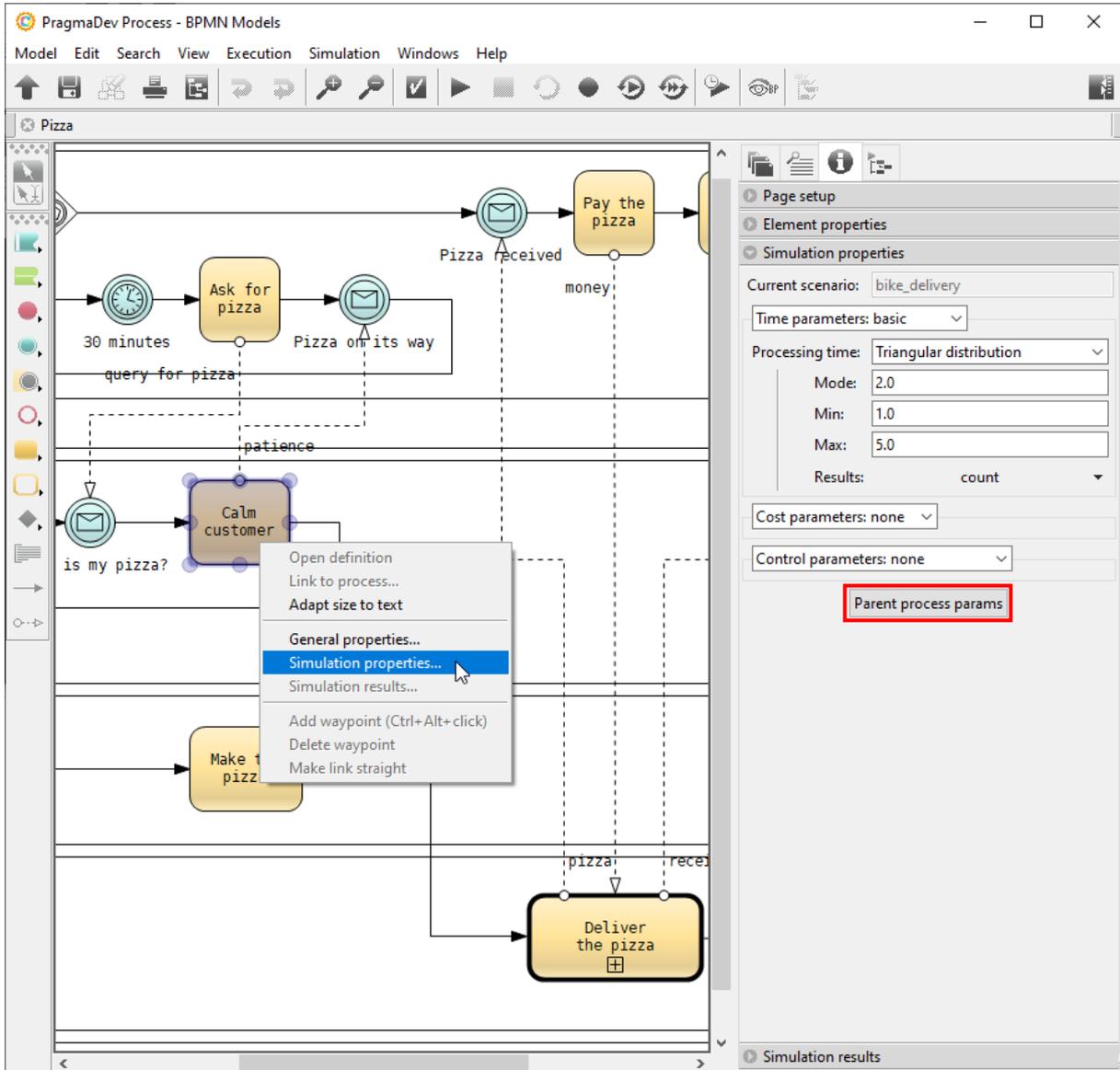
Result requests

In the element parameters, in addition to simulation inputs (e.g., time, cost, control), we can set also the desired outputs (or results) of the simulation. The outputs can be requested on a single BPMN element and/or on a BPMN process. Let's request some results from the simulation. Return to the main diagram and go to the simulation properties of the task **Calm customer**. Select "count" for the "Results" as shown:

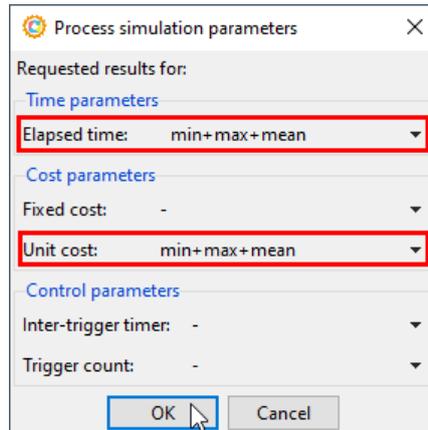


This will request the number of times the Clerk had to deal with complaints from Clients. The value will give us an indicator for the service quality, i.e., less complaints means less unsatisfied clients, which is better for the business.

Still with the properties of Calm customer shown, hit the "Parent process params" button:



Select "min", "max", "mean" for both "Elapsed time" and "Unit cost", and hit "OK":

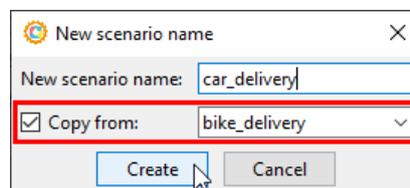


This will request from the possible simulation results the minimum, average, and maximum time and cost needed to perform the Vendor process.

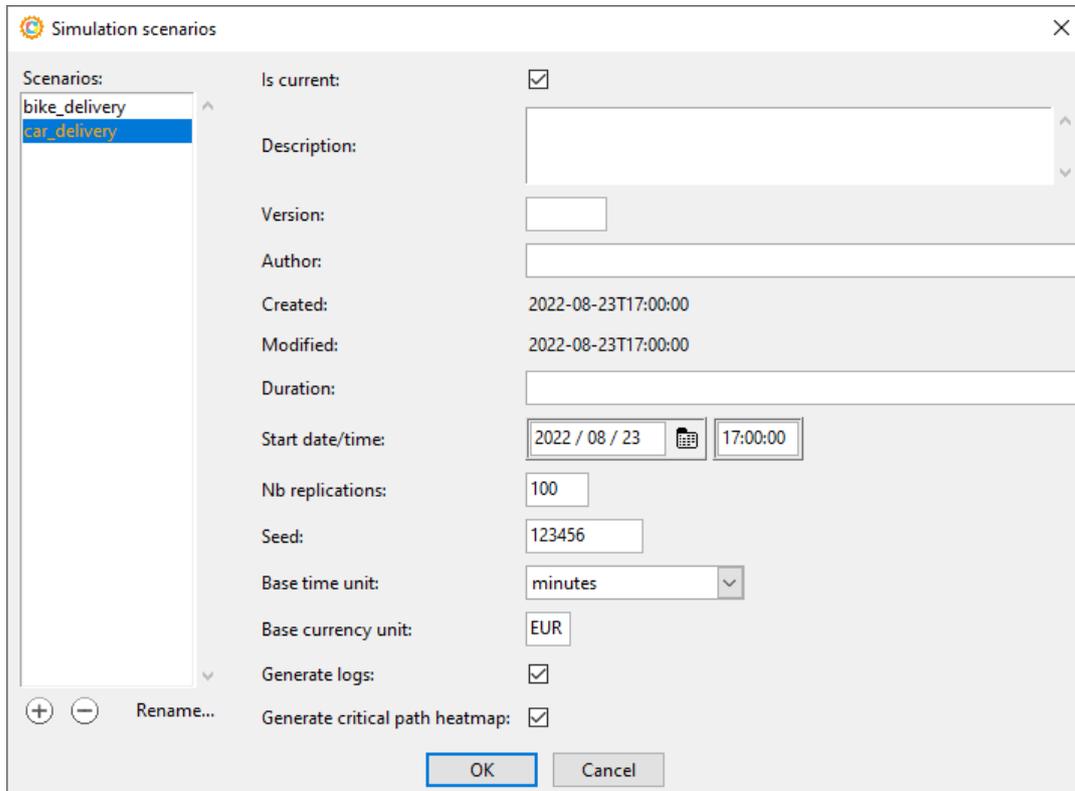
5.1.2 Car delivery

5.1.2.1 Scenario parameters

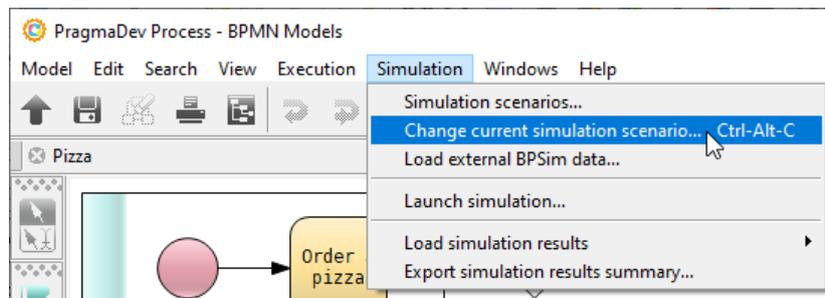
With the `Pizza.bpmn` opened in the BPMN editor, select "Simulation scenarios..." in the "Simulation" menu. Add a new simulation scenario, name it `car_delivery`, and make sure its initial values are copied from the `bike_delivery` scenario:



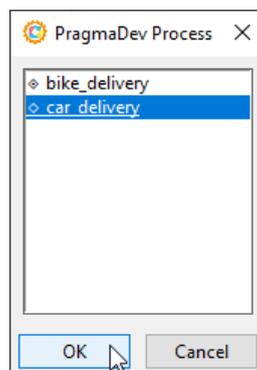
Hit "Create" to add the new scenario, and then "OK" to apply the changes in the scenarios:



Make sure the current simulation scenario is the new one. For this, in the "Simulation" menu, select "Change current simulation scenario...":



Select car_delivery in the list of scenarios and hit "OK":



Tutorial

5.1.2.2 Element parameters

In the delivery diagram, change the simulation properties of the task Get to customer as follows:

The screenshot shows the PragmaDev Process - BPMN Models interface. The main workspace displays a BPMN diagram for a pizza delivery process. The process starts with a start event (pink circle) leading to a task 'Get to customer' (blue rounded rectangle). This task is connected to another task 'Get the money' (yellow rounded rectangle) via an arrow. The 'Get the money' task is connected to a third task 'Give the receipt' (yellow rounded rectangle) via an arrow. A swimlane labeled 'Customer' is shown above the process. Data flows are indicated by dashed lines: 'pizza' flows from the start event to 'Get to customer', 'money' flows from 'Get to customer' to 'Get the money', and 'receipt' flows from 'Give the receipt' to the end event. A context menu is open over the 'Get to customer' task, with 'Simulation properties...' selected. The right-hand side of the interface shows the 'Simulation properties' panel, which is highlighted with a red box. The panel contains the following settings:

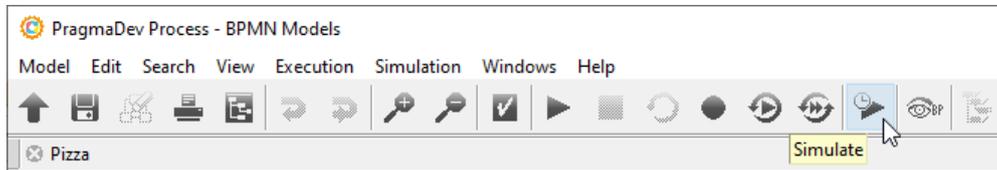
- Current scenario: car_delivery
- Time parameters: basic
- Processing time: Triangular distribution
 - Mode: 10.0
 - Min: 5.0
 - Max: 20.0
 - Results: -
- Cost parameters: all
- Fixed cost: No value
 - Results: -
- Unit cost: Fixed real value
 - Value: 0.1
 - Results: -
- Control parameters: none
- Parent process params

Note that the delivery by car takes less time but is more expensive compared to the delivery by bike.

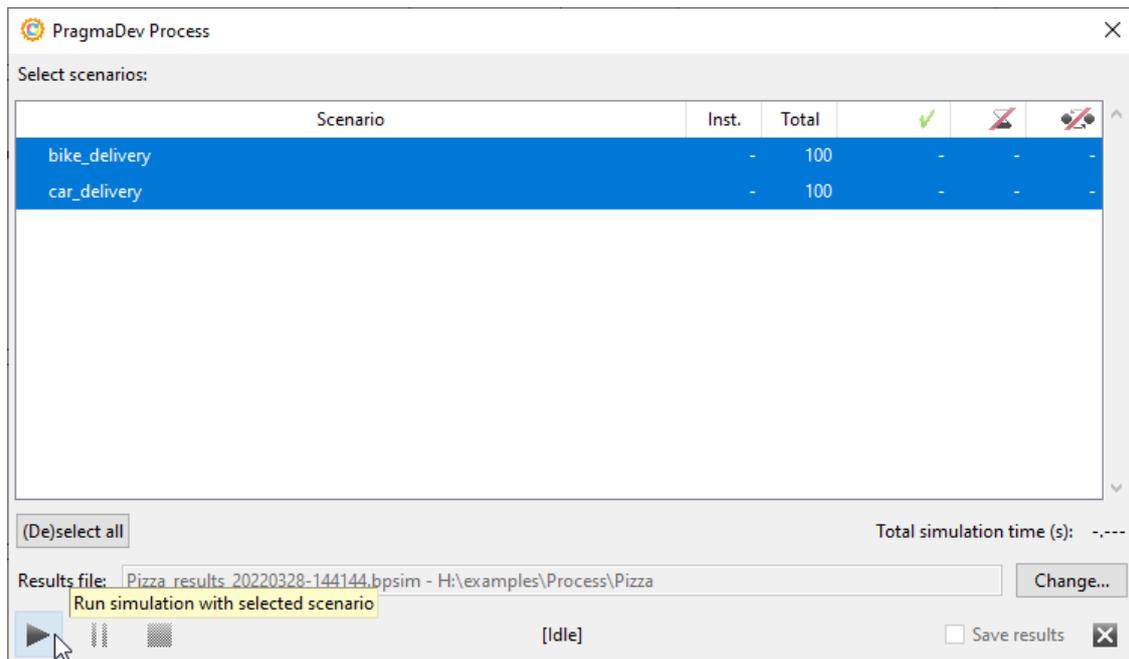
"Save model" to apply all changes.

5.2 Running the simulation

With the Pizza . bpmn opened in the BPMN editor, and the main diagram shown, hit the "Simulate" button:

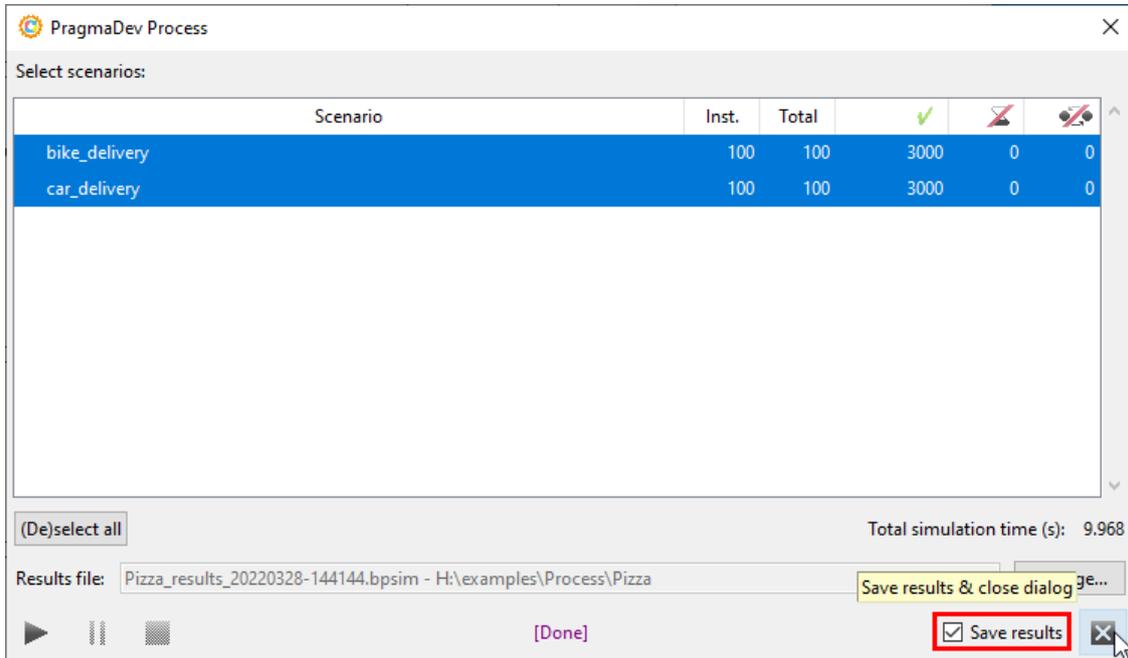


With both scenarios selected hit the "Run simulation with selected scenario" button:

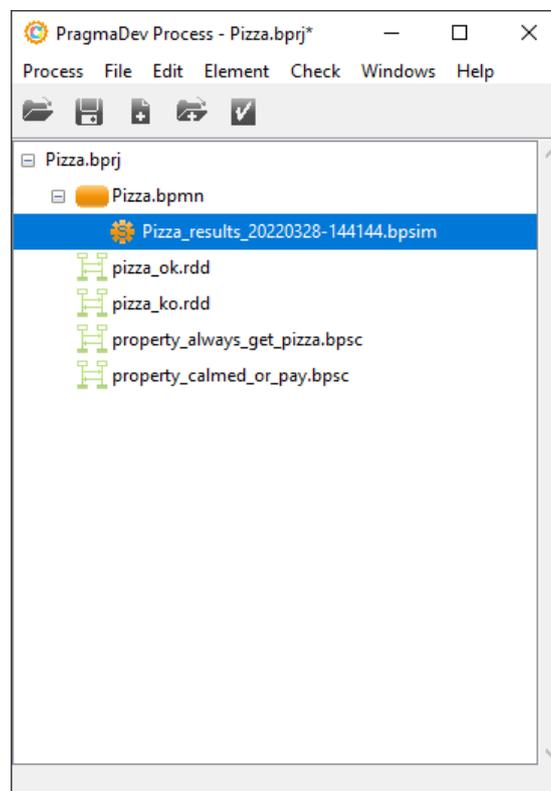


Tutorial

When done make sure the "Save results" is checked and hit the "Save results & close dialog" button:



A new simulation results file (in BPSim format) will be added into the project under the BPMN file:



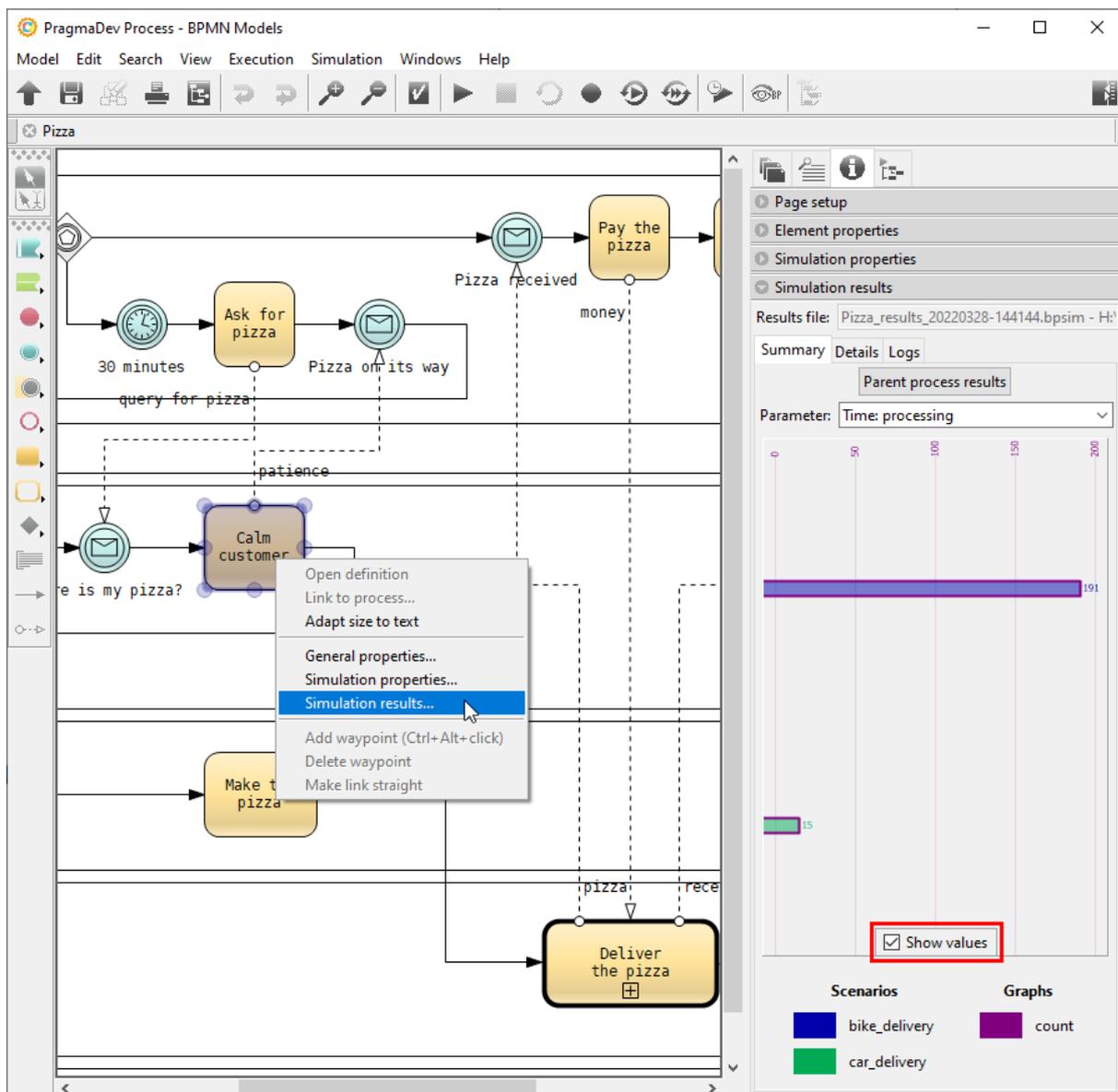
Save the project.

Tutorial

Note that simulation results files are not editable. They are always associated to a BPMN file in the project, and opening a results file will open the corresponding BPMN file in the editor and load the results with it.

5.3 Simulation results

Double-click the simulation results file to load it in the BPMN editor. Right-click the task **CalM customer** and select "Simulation results..." in the contextual menu. Make sure "Show values" is checked to display the exact values^a in the graph:



^aNote that the exact values may differ from the figure.

The bar graph will show the number of times the task has been executed for each scenario. Compared to the delivery by bike, the number of complaints is significantly lower

Tutorial

when a car is used.

Still with the results of the task **Ca'm customer** shown, hit the "Parent process results" button:

The screenshot shows the PragmaDev Process - BPMN Models interface. The main workspace displays a BPMN diagram for a 'Pizza' process. The process flow includes tasks like 'Ask for pizza', 'Make pizza', and 'Deliver the pizza', with various events and data flows. A context menu is open over the 'Ca'm customer' task, with 'Simulation results...' selected. The right-hand panel shows the 'Simulation results' section, with 'Parent process results' highlighted in a red box. Below this, a bar chart displays simulation data for 'Time: processing'.

Scenario	Count
bike_delivery	15
car_delivery	191

Select "Cost: unit" in the "Parameter":

The screenshot displays the PragmaDev Process - BPMN Models interface. The main workspace shows a BPMN diagram for a pizza process. Key elements include:

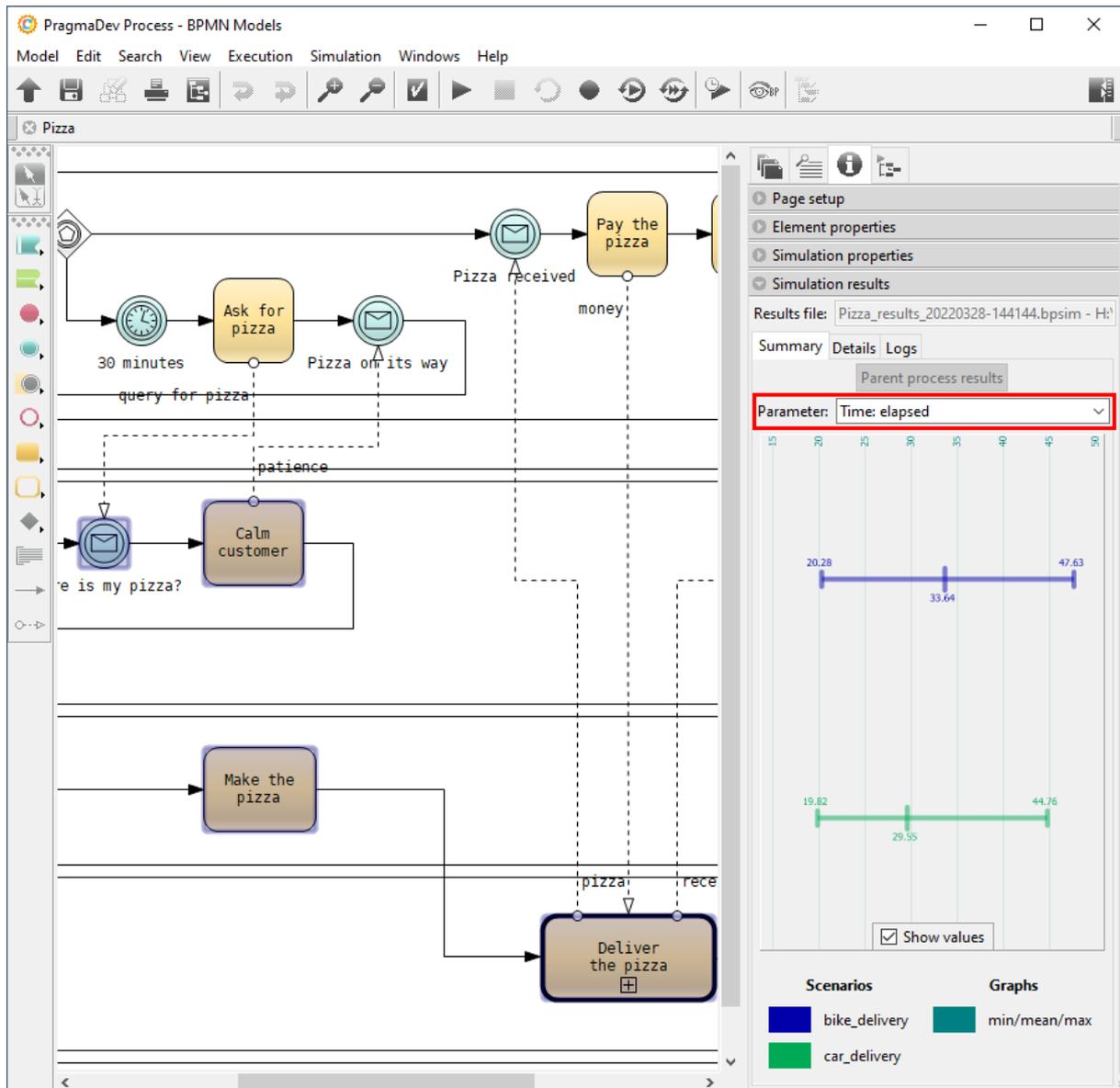
- Start Event:** A start event leading to a timer event labeled "30 minutes".
- Task:** "Ask for pizza" (yellow rounded rectangle).
- Intermediate Event:** "Pizza on its way" (blue circle with envelope).
- Task:** "Calm customer" (blue rounded rectangle).
- Task:** "Make the pizza" (blue rounded rectangle).
- Task:** "Deliver the pizza" (blue rounded rectangle).
- Intermediate Event:** "Pizza received" (blue circle with envelope).
- Task:** "Pay the pizza" (yellow rounded rectangle).
- End Event:** A final end event.

 The simulation results panel on the right is active, showing:

- Page setup**, **Element properties**, **Simulation properties**, and **Simulation results** tabs.
- Results file:** Pizza_results_20220328-144144.bpsim - H'
- Summary** tab selected, showing "Parent process results".
- Parameter:** A dropdown menu is set to "Cost: unit".
- Graphs:** A bar chart compares two scenarios:
 - bike_delivery:** Represented by a blue bar with a range from 0.05 to 0.25.
 - car_delivery:** Represented by a green bar with a range from 0.52 to 1.95.
- Scenarios:** bike_delivery (blue), car_delivery (green).
- Graphs:** min/mean/max (teal).
- Show values:** A checkbox is checked.

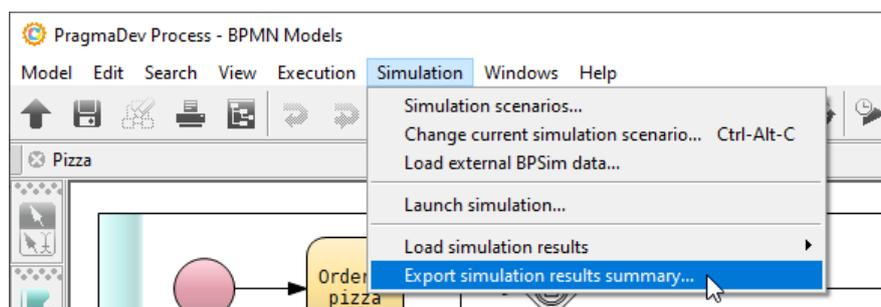
The graph will show the cost for both scenarios, i.e., bike and car delivery. Observe the cost of bike delivery being significantly lower compared to the delivery by car.

Change the selection in the "Parameter" to "Time: elapsed":



The graph will show the times of delivery for both scenarios.

A summary of simulation results can be exported in CSV format. For that, in the "Simulation" menu select "Export simulation results summary...":



Tutorial

The summary is presented as follows:

	A	B	C	D	E	F	G	H	I
1	Scenario id.	Scenario name	Element id.	Param. name	min	max	mean	count	sum
2	SEM_SYMB_74	bike_delivery	SEM_SYMB_40	processing time				191	
3	SEM_SYMB_74	bike_delivery	SEM_SYMB_4_f04a6565a0e766464843044cedf61f06	elapsed time	20.27700504	47.62859523	33.63767197		
4	SEM_SYMB_74	bike_delivery	SEM_SYMB_4_f04a6565a0e766464843044cedf61f06	unit cost	0.053745753	0.245660668	0.149532664		
5	SEM_SYMB_75	car_delivery	SEM_SYMB_40	processing time				15	
6	SEM_SYMB_75	car_delivery	SEM_SYMB_4_f04a6565a0e766464843044cedf61f06	elapsed time	19.81996132	44.76198346	29.55212098		
7	SEM_SYMB_75	car_delivery	SEM_SYMB_4_f04a6565a0e766464843044cedf61f06	unit cost	0.519016866	1.949475961	1.146386		

5.4 Simulation log

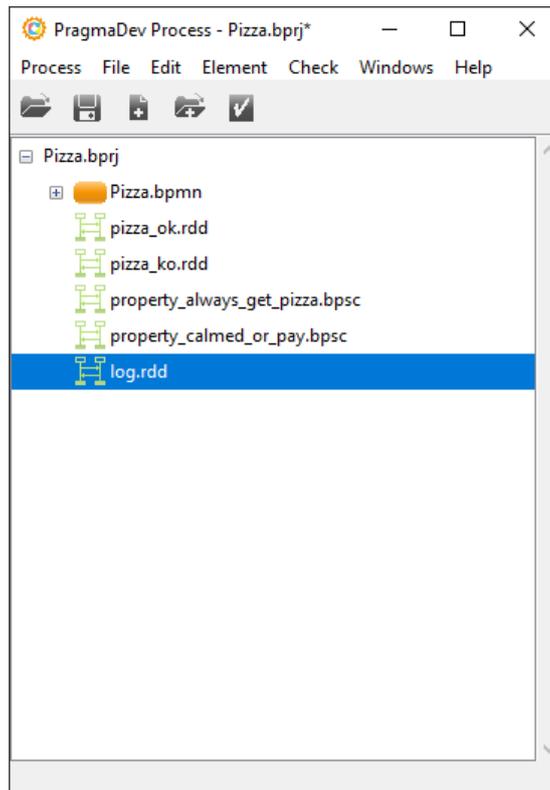
With the simulation results shown, go to the "Log" tab. Select one of the entries and hit the "Save as MSC..." button:

The screenshot shows the PragmaDev Process - BPMN Models application. The main workspace displays a BPMN diagram for a 'Pizza' process. The diagram includes tasks like 'Ask for pizza', 'Make the pizza', 'Deliver the pizza', 'Calm customer', and 'Pay the pizza', along with events and messages. The right-hand panel shows the 'Simulation results' section, with the 'Logs' tab selected. Below the tabs, there is a table of simulation results for two instances of the 'bike_delivery' scenario.

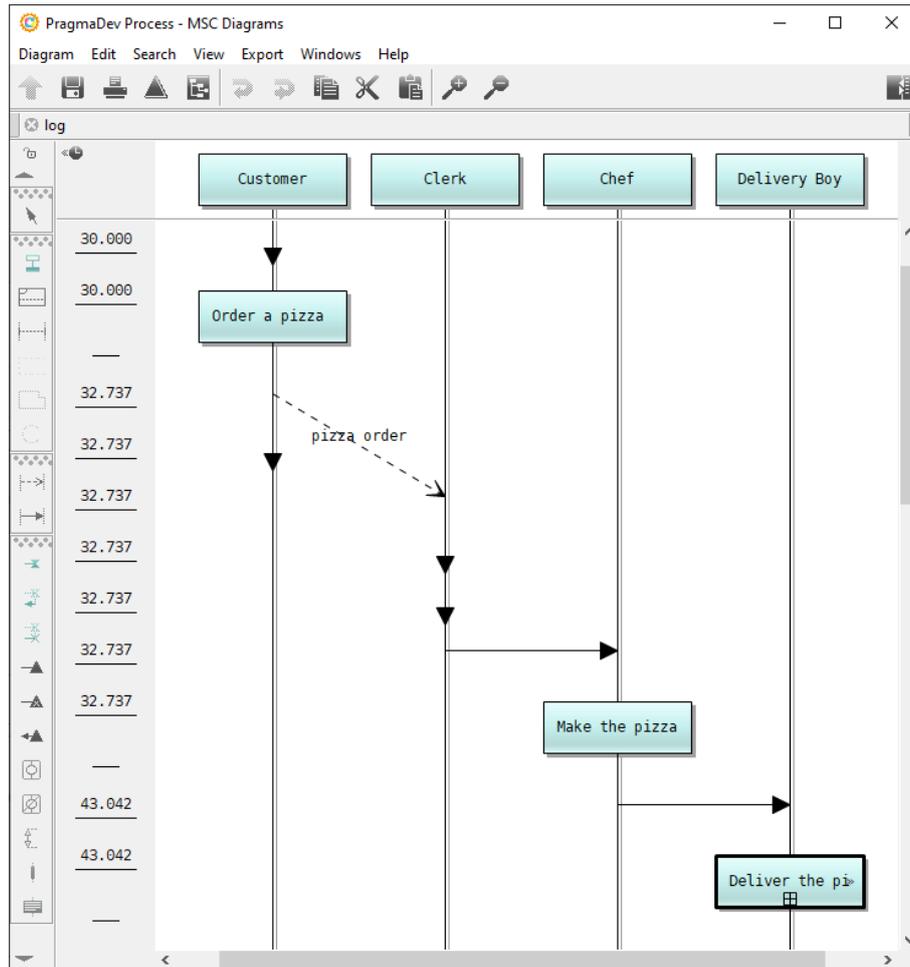
Scenario/instance/run	End	Time	Cost
bike_delivery			
Instance 0			
0	42.67190	0.056678	
1	46.83414	0.089251	
2	61.21891	0.181704	
3	50.94547	0.150391	
4	50.02711	0.092061	
5	48.83371	0.120091	
6	57.26691	0.095361	
7	54.52821	0.098781	
8	50.16271	0.079571	
9	55.57681	0.171181	
Instance 1			
0	54.96221	0.164651	
1	47.45841	0.086321	
2	60.13161	0.142171	
3	53.12601	0.158441	
4	53.38581	0.177191	
5	63.55381	0.175981	
6	59.12071	0.162301	
7	53.00001	0.100001	

At the bottom right of the simulation results panel, there is a button labeled "Save as MSC...".

Name it `log.rdd` and save it. The trace will be added to the project:



and opened in the MSC editor:

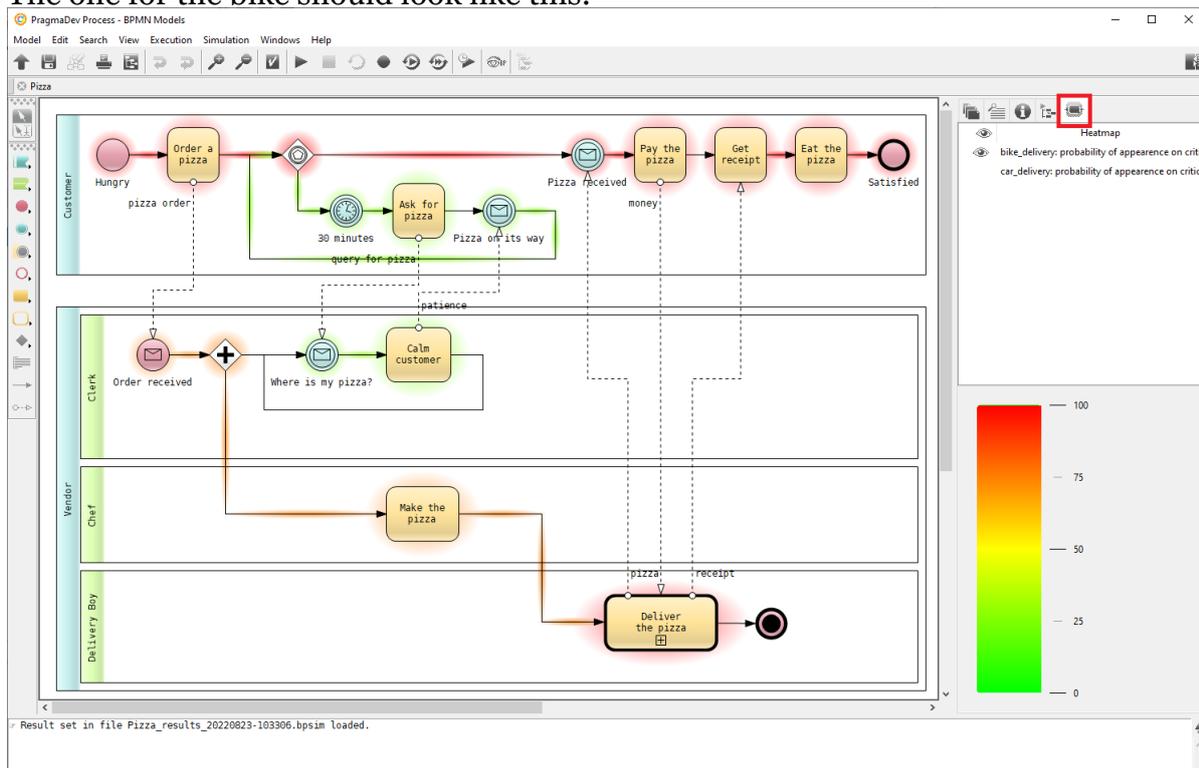


5.5 Critical path

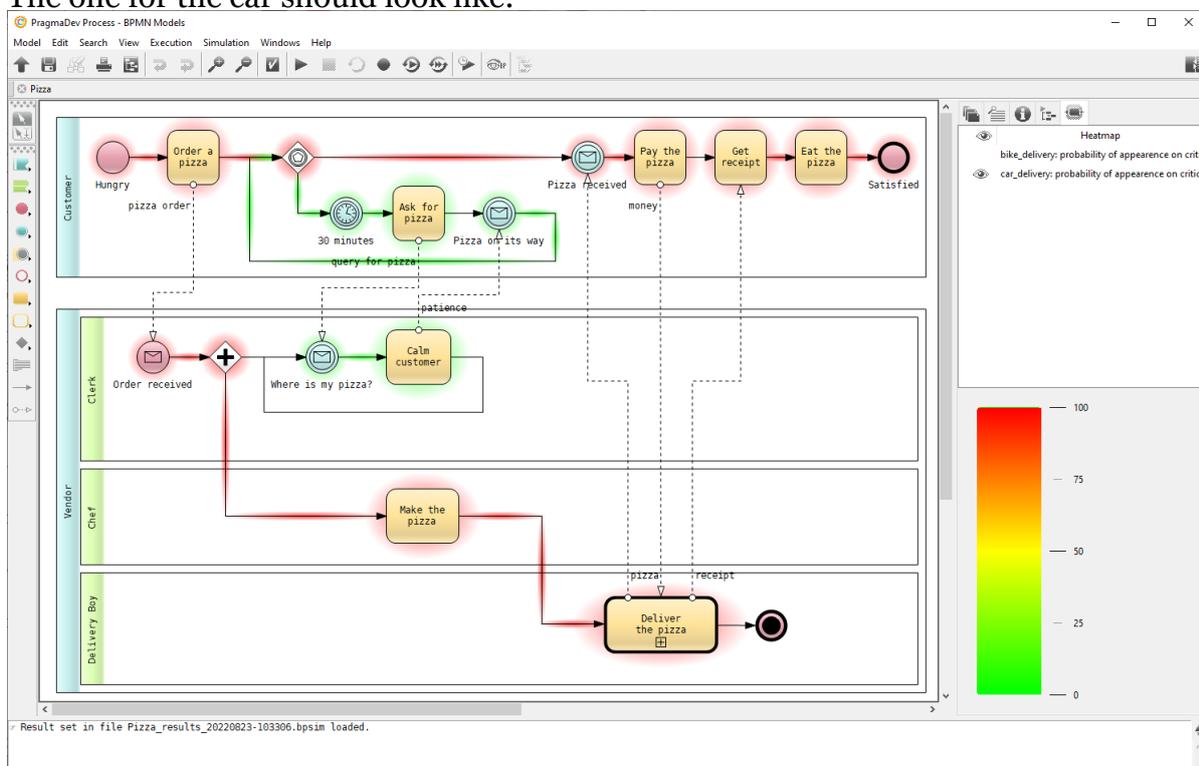
The critical path analysis was checked in the simulation option window. In order to view graphically the critical path, select the Heatmaps tab in the right panel of the editor and one of the scenario.

Tutorial

The one for the bike should look like this:



The one for the car should look like this:



As a first quick analysis, the critical path for the bike scenario is mainly on the delivery part, where the critical path for the car scenario is more balanced between the delivery and the baking.

6 Conclusion

During this tutorial we have been through:

- BPMN,
- Project Manager,
- BPMN Editor,
- BPMN semantic check,
- BPMN Executor,
 - Interactive,
 - Automatic,
- BPMN Explorer,
 - Complexity,
 - Reachability,
 - Deadlock,
 - Property,
- BPMN Simulator,
 - Time & cost,
 - Scenarios,
 - Log,
 - Optimization & trade-off,
 - Critical path.

PragmaDev Process is a powerful tool that allows creating, editing, checking, executing, exploring, simulating, and optimizing BPMN models.