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Knowledge-Based Process Simulation Introduction Slides

First Results from EU Project BIMERR



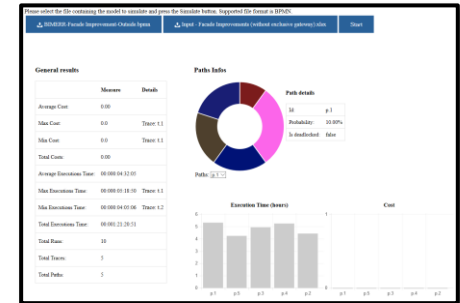
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 820621 Call identifier: LC-EEB-02-2018

Process Simulations and Dashboards



Simulation

- ▶ Start Time – Different Time Slots have different probabilities
- ▶ Deviation of time – Different runs have different times within standard deviation
- ▶ Characteristic – Additional Characteristic can be add „If A then probability is a, If B then probability is b
- ▶ Decision – Probability



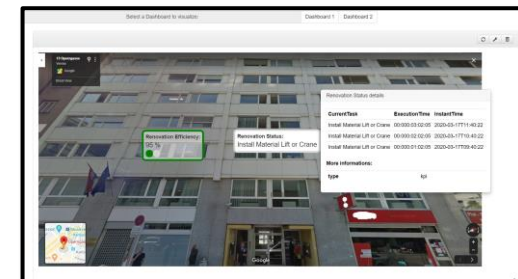
Simulation Input Data

- ▶ How many runs? – the more the better
- ▶ How was the input calculated (from historical data, from expert, calculated,...)
- ▶ Which data (where they come from, how many, how reliable,...)
- ▶ Which Knowledge (which expert, which experience, how many experts, ...)

	Weighted Average	Expert	Formula
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00
Action-1	15.00	15.00	15.00

Dashboard Output Data

- ▶ From Simulation or from assessment data (Process mining)
- ▶ How was the input calculated

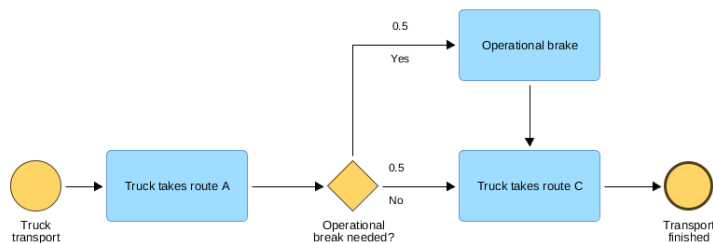
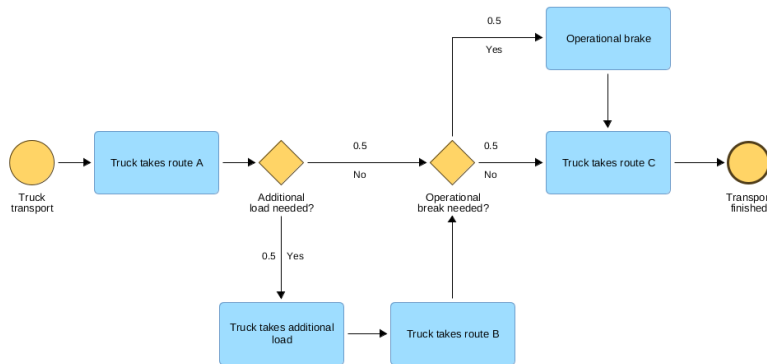




Token Based Discrete Event Simulation


PROCESS SIMULATION

Step 1: Prepare BPMN model(s) for Simulation



- ▶ BPMN models can be easily created to simulate different process variants
- ▶ Following classes are supported
 - ▶ 'C_START_EVENT'
 - 'C_END_EVENT'
 - 'C_TASK'
 - 'C_INTERMEDIATE_EVENT'
 - 'C_SUB_PROCESS'
 - 'C_POOL'
 - 'C_POOL_VERTICAL'
 - 'C_ROLE'
 - 'C_INTERMEDIATE_EVENT_BOUNDARY'
 - 'C_NON_EXCLUSIVE_GATEWAY'
 - 'C_EXCLUSIVE_GATEWAY'

Step 2: Prepare XLS data input



	A	B	C	D	E
12	Truck transport	2019-06-04T17:40:11.950+02:00	Transport 12		
13	Truck transport	2019-06-05T07:20:35.950+02:00	Transport 13		
14	Truck transport	2019-06-05T07:25:35.950+02:00	Transport 14		
15	Truck transport	2019-06-05T08:10:30.230+02:00	Transport 15		
16	Truck transport	2019-06-05T08:20:30.111+02:00	Transport 16		
17	Truck transport	2019-06-05T08:41:35.934+02:00	Transport 17		
18	Truck transport	2019-06-05T08:50:30.943+02:00	Transport 18		
19	Truck transport	2019-06-05T10:10:25.120+02:00	Transport 19		
20	Truck transport	2019-06-05T10:20:33.987+02:00	Transport 20		
21	Truck transport	2019-06-05T10:26:10.350+02:00	Transport 21		
22	Truck transport	2019-06-06T10:31:56.946+02:00	Transport 22		
23	Truck transport	2019-06-06T16:18:35.140+02:00	Transport 23		
24	Truck transport	2019-06-06T16:21:32.130+02:00	Transport 24		
25	Truck transport	2019-06-06T16:45:45.154+02:00	Transport 25		
26	Truck transport	2019-06-06T17:00:00.000+02:00	Transport 26		
27	Truck transport	2019-06-06T17:30:00.000+02:00	Transport 27		
28	Truck transport	2019-06-06T18:00:00.000+02:00	Transport 28		
29	Truck transport	2019-06-07T08:20:50.000+02:00	Transport 29		
30	Truck transport	2019-06-07T08:30:00.000+02:00	Transport 30		
31	Truck transport	2019-06-07T08:40:00.000+02:00	Transport 31		
32	Truck transport	2019-06-07T08:55:00.000+02:00	Transport 32		
33	Truck transport	2019-06-07T09:14:00.510+02:00	Transport 33		
34	Truck transport	2019-06-07T09:26:07.000+02:00	Transport 34		
35	Truck transport	2019-06-07T09:40:00.000+02:00	Transport 35		
36	Truck transport	2019-06-07T09:55:00.000+02:00	Transport 36		
37	Truck transport	2019-06-07T10:41:00.000+02:00	Transport 37		
38	Truck transport	2019-06-07T10:55:00.000+02:00	Transport 38		
39					

C_START_EVENT

C_TASK

C_EXCLUSIVE_GATEWAY

TASK_TIMES_CALCULATION

+

Excel based simulation data input can be used to collect simulation data from different sources (IT systems)

It is possible to track execution of single process instances

Excel supports definition of times for different classes (Start events, Tasks, as well as probabilities for Gateways)

Step 3: Run simulation



Truck transport (with additional loading) (en).bpmn

Path to csv times/costs

Path to output file (without name)

Start

Start the simulation by providing paths to BPMN model and XLS input

General results

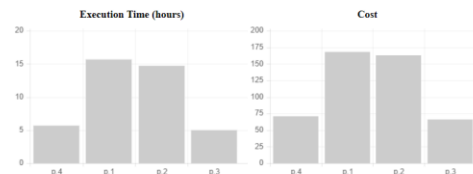
	Measure	Details
Average Cost:	119.16	
Max Cost:	168.0	Trace: t.1
Min Cost:	66.0	Trace: t.3
Total Costs:	4528.00	
Average Executions in 1 day:	1	
Average Executions Time:	00:000:07:27.04	
Max Executions Time:	00:000:15:38.47	Trace: t.1
Min Executions Time:	00:000:03:52.08	Trace: t.1
Total Executions Time:	00:011:19:08.34	
Max Waiting Time:	00:000:00:00.00	Trace: t.1
Max Messages Waiting Time:		Trace:
Min Waiting Time:	00:000:00:00.00	Trace: t.1
Min Messages Waiting Time:		Trace:
Deadlocked Paths:	0	Paths: <input type="text" value="p.4"/>
Total Error Terminated Traces:	38	
Total Deadlocked Traces:	0	

Paths Infos



Path details

Id:	p.4
Probability:	21.05%
Number of different traces:	1
Is deadlocked:	false
Is terminated with exceptions:	true
Min Waiting Time (total):	00:000:00:00.00 SD: 00:000:00:00.00 Trace: t.4
Min Waiting Time (messages):	SD: Trace:



Evaluate results displayed on screen or access details results in XLS format (next slide)

Step 4: Evaluate results



	A	B	C
8	Transport 8	Transport finished	2019-05-05T00:36:29.537
9	Transport 9	Transport finished	2019-05-05T01:08:11.779
10	Transport 10	Transport finished	2019-05-05T01:21:29.537
11	Transport 11	Transport finished	2019-05-05T02:29:15.234
12	Transport 12	Transport finished	2019-05-05T03:38:05.537
13	Transport 13	Transport finished	2019-05-05T02:24:25.244
14	Transport 14	Transport finished	2019-05-05T01:21:49.731
15	Transport 15	Transport finished	2019-05-05T08:50:48.495
16	Transport 16	Transport finished	2019-05-05T09:00:48.376
17	Transport 17	Transport finished	2019-05-05T09:21:54.199
18	Transport 18	Transport finished	2019-05-05T09:30:49.208
19	Transport 19	Transport finished	2019-05-05T04:15:45.414
20	Transport 20	Transport finished	2019-05-05T04:25:54.281
21	Transport 21	Transport finished	2019-05-05T04:31:30.644
22	Transport 22	Transport finished	2019-05-06T09:10:41.135
23	Transport 23	Transport finished	2019-05-07T02:55:44.119
24	Transport 24	Transport finished	2019-05-07T02:58:41.109
25	Transport 25	Transport finished	2019-05-07T03:22:54.133
26	Transport 26	Transport finished	2019-05-06T11:08:08.890
27	Transport 27	Transport finished	2019-05-07T04:07:08.979
28	Transport 28	Transport finished	2019-05-07T05:39:41.51
29	Transport 29	Transport finished	2019-05-07T00:12:58.734
30	Transport 30	Transport finished	2019-05-07T00:22:08.734
31	Transport 31	Transport finished	2019-05-07T00:32:08.734
32	Transport 32	Transport finished	2019-05-07T00:47:08.734
33	Transport 33	Transport finished	2019-05-07T01:06:09.244
34	Transport 34	Transport finished	2019-05-07T01:18:15.734

C_START_EVENT	C_TASK	C_END_EVENT	C_EXCLUSIVE_GATEWAY	RESULTS
---------------	--------	-------------	---------------------	---------

Detailed results are presented for every process instance

Excel results are structured similar to input format and contain times for different classes (e.g. Start events, Tasks, Gateways)

Step 4: Evaluate results



	A	B	C	D	E
		Agreed fix route time	Actual time	Time difference	Deviation and status
			=DATEVALUE(MID((VLOOKUP(RESULTSIA;C_END_EVENTIA:C;3));1;10))+TIMEVALUE(MID((VLOOKUP(RESULTSIA;C_END_EVENTIA:C;3));12;8))-DATEVALUE(MID((VLOOKUP(RESULTSIA;C_START_EVENTIA:C;3));1;10))+TIMEVALUE(MID((VLOOKUP(RESULTSIA;C_START_EVENTIA:C;3));12;8)))	=C-B	=D/B
2					
3	Transport 1	0,5	1,609594907	1,109594907	221,92%
4	Transport 2	0,5	0,60150463	0,10150463	20,30%
5	Transport 3	0,5	0,356805556	-0,143194444	-28,64%
6	Transport 4	0,5	0,570925926	0,070925926	14,19%
7	Transport 5	0,5	0,570925926	0,070925926	14,19%
8	Transport 6	0,5	0,570925926	0,070925926	14,19%
9	Transport 7	0,5	0,570925926	0,070925926	14,19%
10	Transport 8	0,5	0,570925926	0,070925926	14,19%
11	Transport 9	0,5	0,570925926	0,070925926	14,19%
12	Transport 10	0,5	1,609594907	1,109594907	221,92%
13	Transport 11	0,5	1,609594907	1,109594907	221,92%
14	Transport 12	0,5	1,609594907	1,109594907	221,92%
15	Transport 13	0,5	1,609594907	1,109594907	221,92%
16	Transport 14	0,5	1,609594907	1,109594907	221,92%
17	Transport 15	0,5	1,609594907	1,109594907	221,92%
18	Transport 16	0,5	0,723125	0,223125	44,62%
19	Transport 17	0,5	0,752418981	0,252418981	50,48%
20	Transport 18	0,5	0,764803241	0,264803241	52,96%
21	Transport 19	0,5	0,60150463	0,10150463	20,30%
22	Transport 20	0,5	0,615590278	0,115590278	23,12%
23	Transport 21	0,5	0,62337963	0,12337963	24,68%

Excel formulas can be used to build monitoring tools (e.g. cockpits)

Traffic light coding for simple visualisation of critical process delays



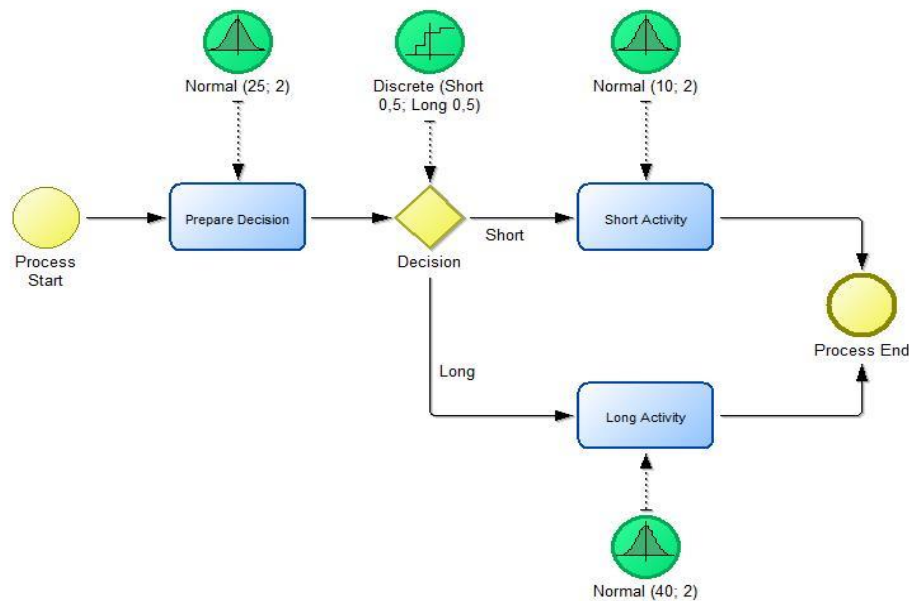
Token based and with individual characteristic Discrete Event Simulation

KNOWLEDGE-BASE PROCESS SIMULATION

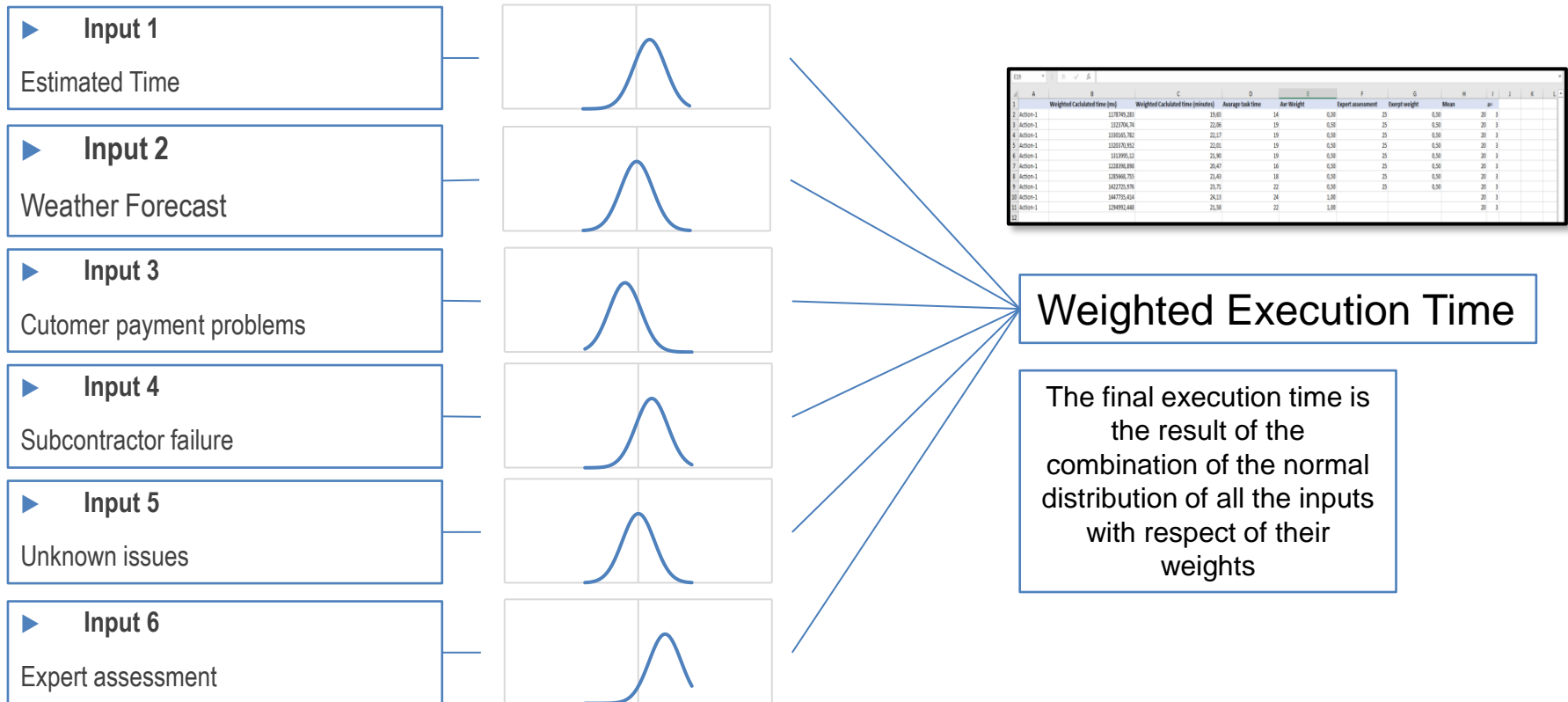
Simulation of Renovation Process - 1



Introduction of how to use extracted knowledge for the simulation of renovation processes.



Simulation of Renovation Process - 2



Knowledge-Based Simulation of Renovation Process – 3



9-Input - Facade Improvements (reorganization).xlsx - Excel

Robert Woitsch

	A	B	C	D	E	F	G	H	I	J
		Weighted Calculated time (ms)	Weighted Calculated time (minutes)	Average task time	Avr Weight	Expert assessment	Expert weight	Mean	a=	
2	1-Install Material Lift	14400000	240,00	211,20	0,00	240	1,00	210	1	
3	1-Install Material Lift	14400000	240,00	208,54	0,00	240	1,00	210	1	
4	1-Install Material Lift	13490118,86	224,84	209,67	0,50	240	0,50	210	1	
5	1-Install Material Lift	13490317,94	224,84	209,68	0,50	240	0,50	210	1	
6	1-Install Material Lift	13507822,76	225,13	210,26	0,50	240	0,50	210	1	
7	1-Install Material Lift	13546113,03	225,77	211,54	0,50	240	0,50	210	1	
8	1-Install Material Lift	13496344,14	224,94	209,88	0,50	240	0,50	210	1	
9	1-Install Material Lift	13485711,33	224,76	209,52	0,50	240	0,50	210	1	
10	1-Install Material Lift	12528361,8	208,81	208,81	1,00			210	1	
11	1-Install Material Lift	12558802,87	209,31	209,31	1,00			210	1	
12										
13				224,84						
14										
15										

Converting
into time
format

Weighted Average
Expert * Expert weight +
Distribution * Distribution weights

Distribution using
NORM.INV(ZUFALLSZAHL();H3;03)

Expert Opinion

Simulation of Renovation Process - Output



Process Modeller Dashboards Simulation Model Wiki xWiki Process Mining

Please select the file containing the model to simulate and press the Simulate button. Supported file format is BPMN.

Facade Improvement Process.bpmn

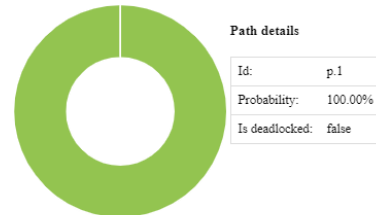
input-moderate-dist1.xlsx

Start

General results

	Measure	Details
Average Cost:	0.00	
Max Cost:	0.0	Trace: t.1
Min Cost:	0.0	Trace: t.1
Total Costs:	0.00	
Average Executions Time:	00:024:20:31:23	
Max Executions Time:	00:036:13:25:59	Trace: t.1
Min Executions Time:	00:033:20:56:20	Trace: t.1
Total Executions Time:	00:138:20:18:29	
Total Runs:	4	
Total Traces:	1	
Total Paths:	1	

Paths Infos



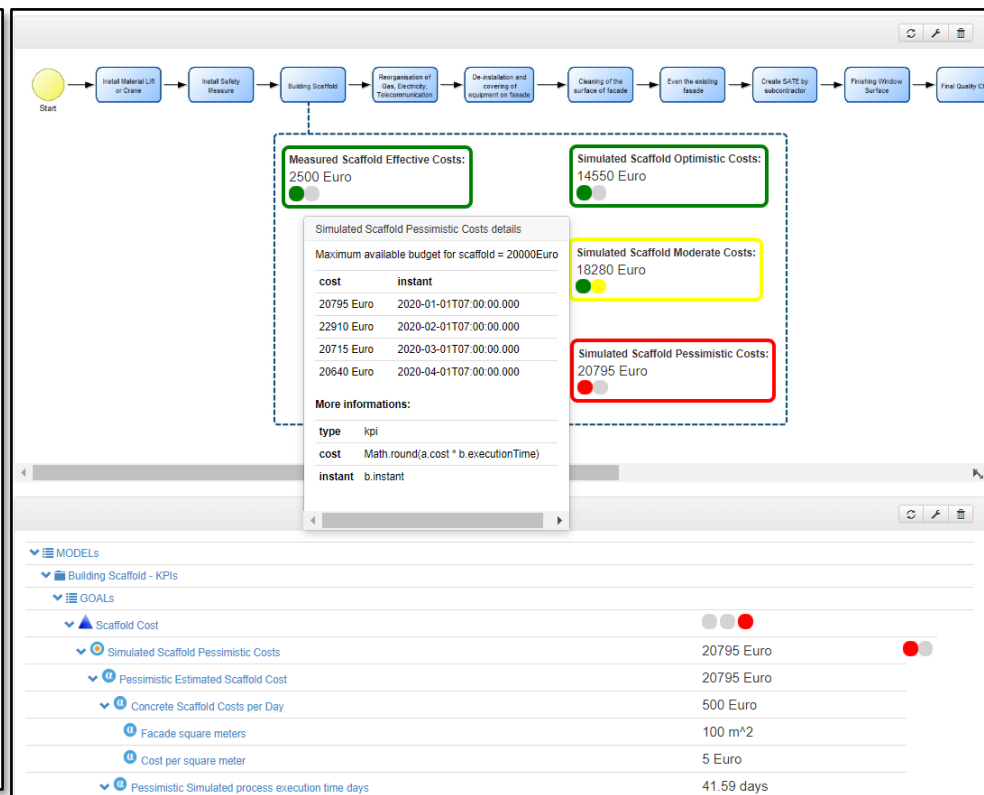
Paths: p.1

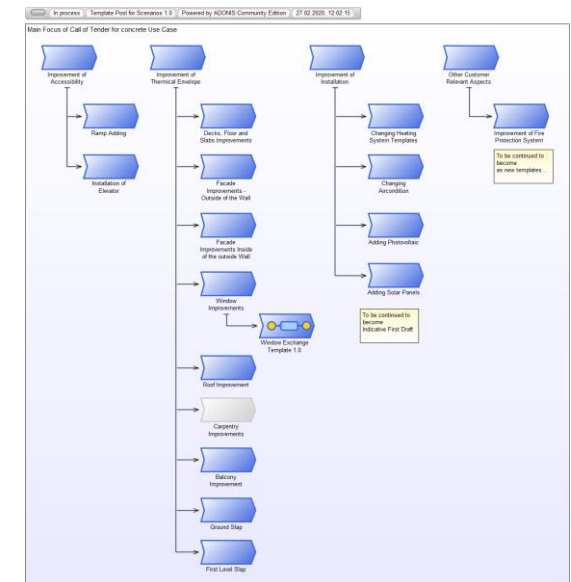


	A	B	C	D
1	Run-1	Install Material Lift or Crane	2019-06-03T07:19:45.130	1185013
2	Run-1	Install Safety Measure	2019-06-03T07:42:02.710	1337697
3	Run-1	Building Scaffold	2019-06-03T08:22:30.171	2427461
4	Run-1	Reorganisation of Gas, Electricity, Telecommunication	2019-06-03T08:43:48.560	1278389
5	Run-1	De-installation and covering of equipment on facade	2019-06-03T09:06:48.813	1380253
6	Run-1	Cleaning of the surface of facade	2019-06-03T09:30:20.251	1411438
7	Run-1	Even the existing facade	2019-06-03T09:54:33.524	1453273
8	Run-1	Create SATE by subcontractor	2019-06-03T10:17:44.185	1390661
9	Run-1	Finishing Window Surface	2019-06-03T10:40:38.600	1374415
10	Run-1	Final Quality Check	2019-06-03T11:02:44.870	1326270
11	Run-1	Install and Uncovering of Equipment on the facade	2019-06-03T11:24:47.257	1322387
12	Run-1	Put Gas, Electricity, Telecommunication back again	2019-06-03T11:49:55.457	1508200
13	Run-1	Dissassemble Scaffolding	2019-06-03T00:11:59.375	1323918
14	Run-1	Cleaning	2019-06-03T00:34:55.511	1376136
15	Run-1	Final Check	2019-06-03T00:57:16.136	1340625
16	Run-2	Install Material Lift or Crane	2019-06-04T07:19:39.540	1179540
17	Run-2	Install Safety Measure	2019-06-04T07:42:21.346	1361806
18	Run-2	Building Scaffold	2019-06-04T08:20:58.770	2317424
19	Run-2	Reorganisation of Gas, Electricity, Telecommunication	2019-06-04T08:43:31.618	1352848
20	Run-2	De-installation and covering of equipment on facade	2019-06-04T09:06:46.347	1394729
21	Run-2	Cleaning of the surface of facade	2019-06-04T09:28:54.801	1328454
22	Run-2	Even the existing facade	2019-06-04T09:50:51.580	1316779
23	Run-2	Create SATE by subcontractor	2019-06-04T10:13:02.241	1330681
24	Run-2	Finishing Window Surface	2019-06-04T10:36:34.801	1412560
25	Run-2	Final Quality Check	2019-06-04T10:57:37.205	1262404
26	Run-2	Install and Uncovering of Equipment on the facade	2019-06-04T11:18:38.772	1261567
27	Run-2	Put Gas, Electricity, Telecommunication back again	2019-06-04T11:39:17.552	1238780
28	Run-2	Dissassemble Scaffolding	2019-06-04T00:02:10.800	1372456



Monitoring and Simulation of Renovation Process





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Design of Renovation Processes

DESCRIPTION OF RENOVATION PROCESS MANAGEMENT



Available Results

BIMERR Development Space at ADOxx.org

- ▶ **Sample Models can be downloaded:**
 - ▶ BPMN images and BPMN format
- ▶ **Sample Tool can be downloaded:**
 - ▶ Download ADOxx 1.5
 - ▶ Download BPMN library
 - ▶ Download Sample Models in ADL format
- ▶ **Documentation is available**
 - ▶ D6.2 Adaptive Renovation Process & Workflow Models 1

Join



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Disclaimer

The results have been developed, improved or adapted during the work in the EU Project BIMERR



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Call identifier: LC-EEB-02-2018