University of Pisa
MSc in Computer Engineering

Process-driven Information Systems

LECTURE 5

http://www.iet.unipi.it/m.cimino/wdis/

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B47) ✓ Scenario #1

- **Process simulation specification (PSS)**:
  - inter arrival time: Fixed to *10 m*
  - # of instances: *10*
- **Resources (RES):**
  - *Claims Handler: 1*
- **Work Schedule (WS):**
  - *Default: Monday – Sunday, 00:00:00 – 23:59:59*
- **Tasks (TSK):**
  - Receive Claim (by Claims handler) 5 m
  - Enter data into the system (by Claims Handler) 5 m
- **Gateways (GTW):**
  - Is policy valid? XOR: NO 100%, YES 0%

B48) ✓ Scenario #1 (short format)

PSS (F, 10m, 10, -, -), RES [(CH, 1, -, De)],
WS [(De: Mon, Sun, 00:00:00, 23:59:59)],
TSK [(RC: CH, -, F, 5m), (EDITS: CH, -, F, 5m)]
GTW [(IPV?: xor, no 100%, yes 0%)]

BIMP Home Simulator Products Help Contact

B49)

Online Simulator

Simulation Results

Back to edit data | Save scenario | Download MXML

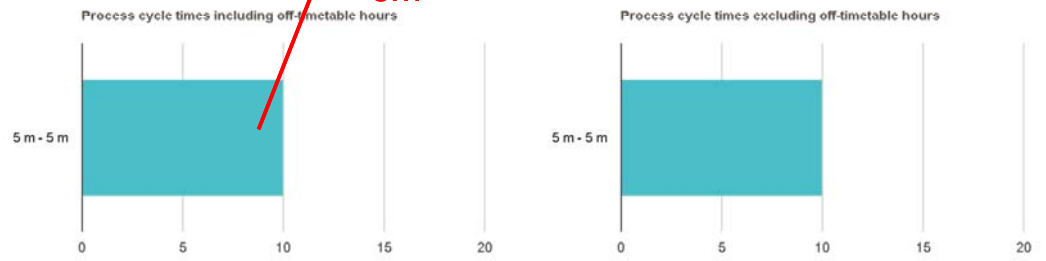
- to inject 10 tokens every 10 m takes 90m
- the last instance takes 5m
- 90m + 5m = 95m = 1.6 h.

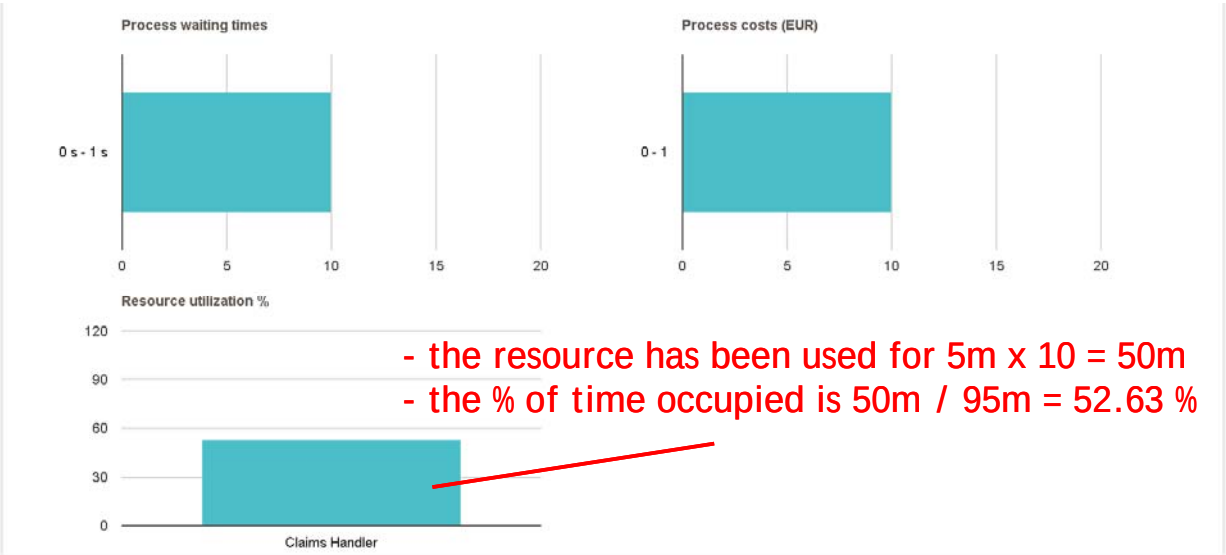
General information

Completed process instances 10
Total cost 0 EUR
Total simulation time 1.6 hours

- Since one resource is sufficient, there is no waiting time, and then every instance takes 5m

Charts





- the resource has been used for 5m x 10 = 50m
- the % of time occupied is 50m / 95m = 52.63 %

Process instance cycle times including off-timetable hours

Minimum cycle time 5 minutes **Maximum cycle time** 5 minutes **Average cycle time** 5 minutes

cycle time = processing time + waiting time

Process instance cycle times excluding off-timetable hours

Minimum cycle time 5 minutes **Maximum cycle time** 5 minutes **Average cycle time** 5 minutes

Process instance costs

Minimum process cost 0 EUR **Maximum process cost** 0 EUR **Average cost** 0 EUR

Task costs and waiting times

Task name	Average cost	Average waiting time
RECEIVE CLAIM	0 EUR	0 seconds

Scenario #2 input

PSS (F, 10m, 10, -, -), RES [(CH, 1, -, De)],
WS [(De: Mon, Sun, 00:00:00, 23:59:59)],
TSK [(RC: CH, -, F, 5m), (EDITS: CH, -, F, 5m)]
GTW [(IPV?: xor, no 0%, yes 100%)]

Scenario #2 output

90m + 10 m = 100m = 1.7 h

- *General Information (GI):*
  - *Completed process instances (CPI): 10*
  - *Total cost (TC): 0€*
  - *Total simulation time (TST): 1.7h*
- *Charts (CH):*
  - *Process cycle times (PCT): 10 x 10m*
  - *Process waiting times (PWT): 10 x [0, 1]s*
  - *Resource utilization (RU) %: Claims Handler 100%*
- *Process Instance cycle times (PICT): 10,10,10*
- *Process instance costs (PIC): 0, 0, 0*
- *Task cost and waiting times (TCWT): 0€, 0s*

Scenario #3 input

PSS (F, 10m, 10, -, -), RES [(CH, 1, -, De)],
WS [(De: Mon, Sun, 00:00:00, 23:59:59)],
TSK [(RC: CH, -, F, 5m), (EDITS: CH, -, F, 5m)]
GTW [(IPV?: xor, no 50%, yes 50%)]

Scenario #3 output

90m + 5m = 95m = 1.6h

GI (CPI 10, TC 0€, TST 1.6h)
CH [PCT (5 x [5.0,5.5]m, 5 x [9.5,10.0]m),
PWT (10 x [0,1]s),
RU: Claims Handler 78.95%

unused resource time:
4 x 5m = 20m
(95m - 20m) / 95m = 78.95%

PICT (5, 10, 7.5)m
PIC (0, 0, 0)€
TCWT (0€, 0s)

5 x 5m, 5 x 10m

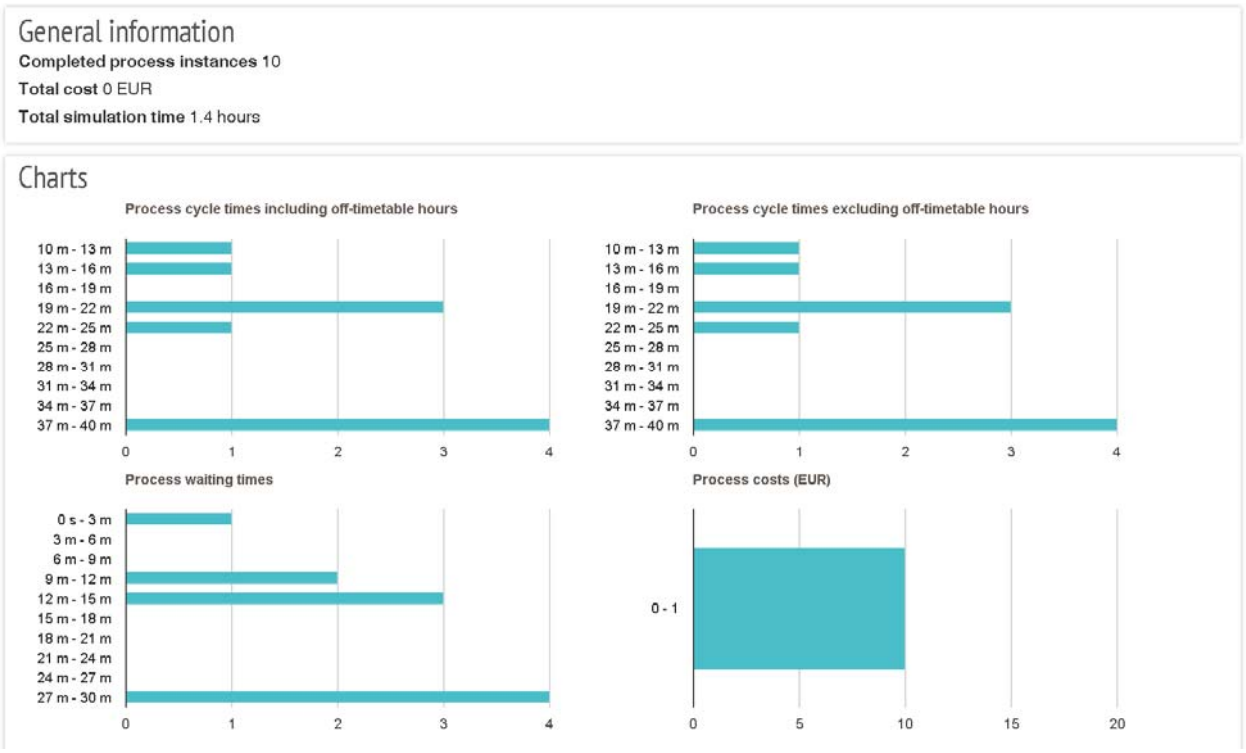
the last instance is immediately followed by the process end, and not by an unused resource time

Scenario #4 input

PSS (F, 5m, 10, -, -), RES [(CH, 1, -, De)],
WS [(De: Mon, Sun, 00:00:00, 23:59:59)],
TSK [(RC: CH, -, F, 5m), (EDITS: CH, -, F, 5m)]
GTW [(IPV?: xor, no 50%, yes 50%)]

Scenario #4 output

GI (CPI 10, TC 0€, TST 1.4h)
CH [PCT (1 x [10,13]m, 1 x [13,16]m, 3 x [19,22]m,
1 x [22,25]m, 4 x [37,40]m)]
PWT (1 x [0,3]m, 2 x [9,12]m, 3 x [12,15]m, 4 x [27,30]m),
RU: Claims Handler 100%
PICT (10, 40, 27)m
PIC (0, 0, 0)€
TCWT [EDIS (0€, 10.7m), RC (0€, 11m)]



Since the order of the 10 answers of the exclusive gateway is not fixed, results may change at every simulation.

Process instance cycle times including off-timetable hours

Minimum cycle time 10 minutes **Maximum cycle time** 40 minutes **Average cycle time** 27 minutes

Process instance cycle times excluding off-timetable hours

Minimum cycle time 10 minutes **Maximum cycle time** 40 minutes **Average cycle time** 27 minutes

Process instance costs

Minimum process cost 0 EUR **Maximum process cost** 0 EUR **Average cost** 0 EUR

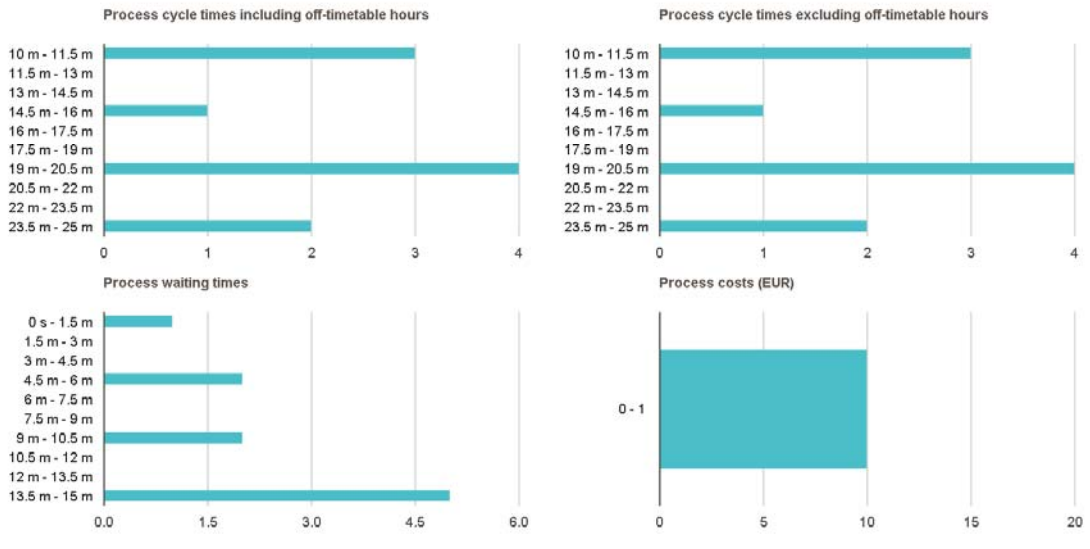
Task costs and waiting times

Task name	Average cost	Average waiting time
ENTER DATA INTO THE SYSTEM	0 EUR	10.7 minutes
RECEIVE CLAIM	0 EUR	11 minutes

General information

Completed process instances 10
Total cost 0 EUR
Total simulation time 1.2 hours

Charts



Process instance cycle times including off-timetable hours

Minimum cycle time 10 minutes **Maximum cycle time** 25 minutes **Average cycle time** 17.5 minutes

Process instance cycle times excluding off-timetable hours

Minimum cycle time 10 minutes **Maximum cycle time** 25 minutes **Average cycle time** 17.5 minutes

Process instance costs

Minimum process cost 0 EUR **Maximum process cost** 0 EUR **Average cost** 0 EUR

Task costs and waiting times

Task name	Average cost	Average waiting time
ENTER DATA INTO THE SYSTEM	0 EUR	3.8 minutes
RECEIVE CLAIM	0 EUR	9 minutes

For increasing number of instances, results become stable.

Scenario #5 input

PSS (F, 5m, 1000, -, -), RES [(CH, 1, -, De)],
WS [(De: Mon, Sun, 00:00:00, 23:59:59)],
TSK [(RC: CH, -, F, 5m), (EDITS: CH, -, F, 5m)]
GTW [(IPV?: xor, no 50%, yes 50%)]

Scenario #5 outputs

GI (CPI 1000, TC 0€, TST 5.2d) PICT (5m, 2.2d, 24h)
TCWT [EDIS (0€, 16.9h), RC (0€, 15.3h)]

GI (CPI 1000, TC 0€, TST 5.3d) PICT (10m, 2.3d, 24h)
TCWT [EDIS (0€, 17.1h), RC (0€, 16.0h)]

GI (CPI 1000, TC 0€, TST 5.2d) PICT (10m, 2.2d, 23.8h)
TCWT [EDIS (0€, 16.6h), RC (0€, 15.4h)]

GI (CPI 1000, TC 0€, TST 5.2d) PICT (5m, 2.2d, 24h)
TCWT [EDIS (0€, 16.9h), RC (0€, 15.4h)]

GI (CPI 1000, TC 0€, TST 5.1d) PICT (10m, 2.1d, 21.6h)
TCWT [EDIS (0€, 15.9h), RC (0€, 14.1h)]

B50) Since the output of the simulator can have a stochastic behavior (e.g. due to the uncertainty in the arrival and the routing of jobs) we repeated 5 times the experiment: it provided stable simulation time values within [5.1,5.3]

B51) In general, the problem is to estimate the output mean of an experiment producing very different output samples at each execution. The **exact output mean** in theory can be calculated by repeating an infinite number of experiments.

B52) A solution is to calculate a **confidence interval** in place of a single value, i.e., an interval with a good chance (confidence) of including the exact output mean.

B53) Let us assume a normal distribution of samples[1] . Let us set alpha to 0.10, **0.05** or 0.01 (confidence level 90%, **95%** or 99%, respectively).

B54) The confidence interval [AVG-CONF, AVG+CONF] has the chance 1-alpha % of including the exact output mean. Use the spreadsheet *confidence_interval.xslx* to calculate confidence interval.

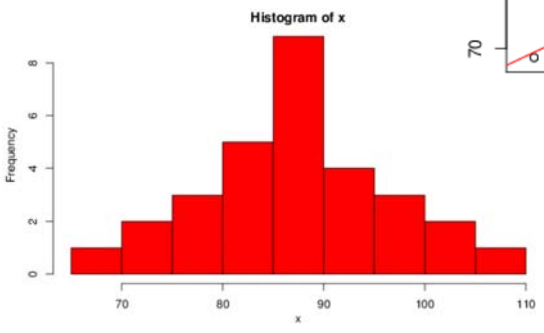
(1) Normal distribution can be verified using Q-Q Plot.
http://www.wessa.net/rwasp_varia1.wasp

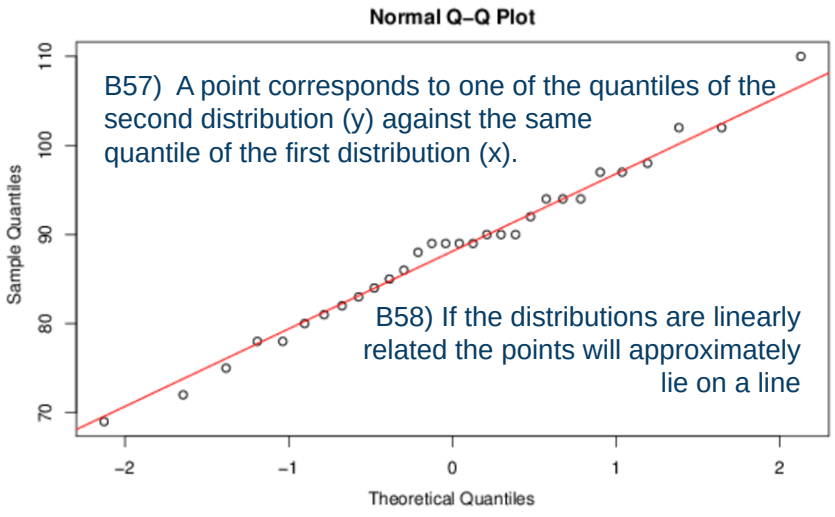
B55) Example of 30 stochastic simulation time values: 85 75 89 97 98 94 83 69 89 94 90 78 88 102 82 110 90 90 80 97 89 94 81 78 102 86 84 89 92 72

B56) Spreadsheet results

- Plots provided by www.wessa.net/rwasp_varia1.wasp

A	B	C
85	COUNT	30
75	**AVG**	**88,23**
89	DEVSTD	9,22
97	**CONFIDENCE**	**3,30**
98	alpha	0,05
94	**AVG-CONFIDENCE**	**84,93**
83	**AVG+CONFIDENCE**	**91,53**
69		
89		





B57) A point corresponds to one of the quantiles of the second distribution (y) against the same quantile of the first distribution (x).

B58) If the distributions are linearly related the points will approximately lie on a line

- roughly speaking, a *p*-quantile is a cutpoint of the set of ranked numbers, below which a certain proportion *p* of that set lie. It divides the range of a probability distribution into contiguous intervals with equal probabilities.

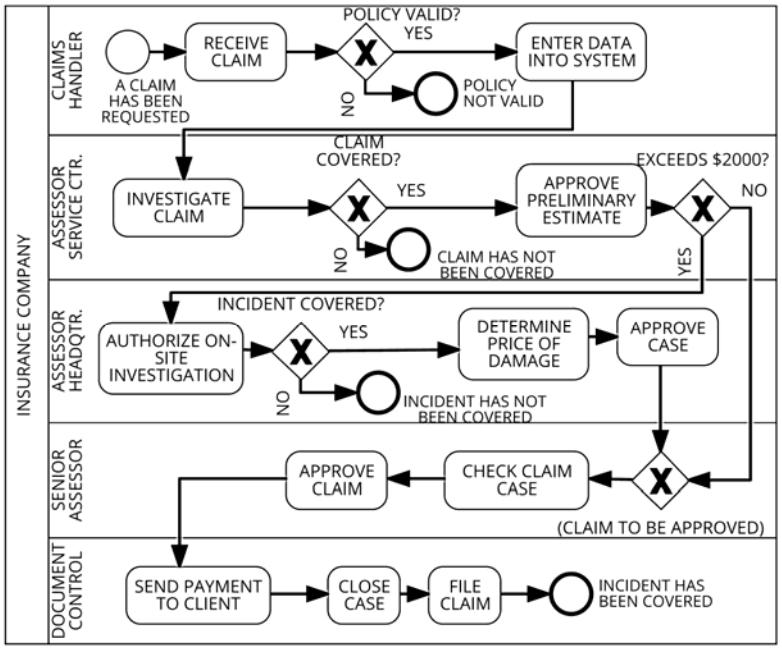
Insurance company: selecting the best staffing level for a claims process

B59) The problem is to find the most efficient staffing levels for each of the five resource types. Each resource type has a maximum limit of **20** people, and the overall headcount in the process cannot exceed **75**. For 1000 claims in a peak scenario, the total duration should be lower than **1 day**.

B60) Perform a what-if analysis of possible solutions to this problem.

B61) To decide which configuration best aligns with service levels and process goals, analyze the trade-offs between headcount and total duration.

B62) Finally, consider also **sensitivity**: which type of resource produces a lower difference in total duration when further reduced by 1.



B63) Problem: minimize the headcount, i.e., the total number of lane instances, under the following constraints: (i) each lane type has a maximum limit of **20**; (ii) total number of lane instances in the process cannot exceed **75**; (iii) total duration should be lower or equal than **1 day**.

B64) A 1st experiment with 20 instances available for all lanes (20, 20, 20, 20, 20) produces a total duration of **1.1d.** Since the output of the simulator can have a stochastic behavior (e.g. due to the uncertainty in the arrival and the routing of jobs) we repeated 5 times the experiment, and it provided the same output.

- Branching proportion

XOR-GATEWAY	AVG. YES
POLICY NOT VALID	5%
CLAIM NOT COVERED	5%
DAMAGE EXCEEDS $2,000	35%
INCIDENT NOT COVERED	2%

- Tasks duration

ACTIVITY>	AVG. DURATION
RECEIVE CLAIM	2.2m
ENTER DATA INTO SYSTEM	10.5m
INVESTIGATE CLAIM	19.4m
APPROVE PRELIMINARY ESTIMATE	3.9m
AUTHORIZE ON-SITE INVESTIGATION	2.8m
DETERMINE PRICE OF DAMAGE	37.3m
APPROVE CASE	2.2m
CHECK CLAIMS CASE	3.6m
APPROVE CLAIM	1.3m
SEND PAYMENT TO CLIENT	7.2m
CLOSE CASE	1.8m
FILE CLAIM	3.4m