



Management of Data Science and Business Workflows
H420

Assignment – 2

Date – 5th November, 2023

Submitted By

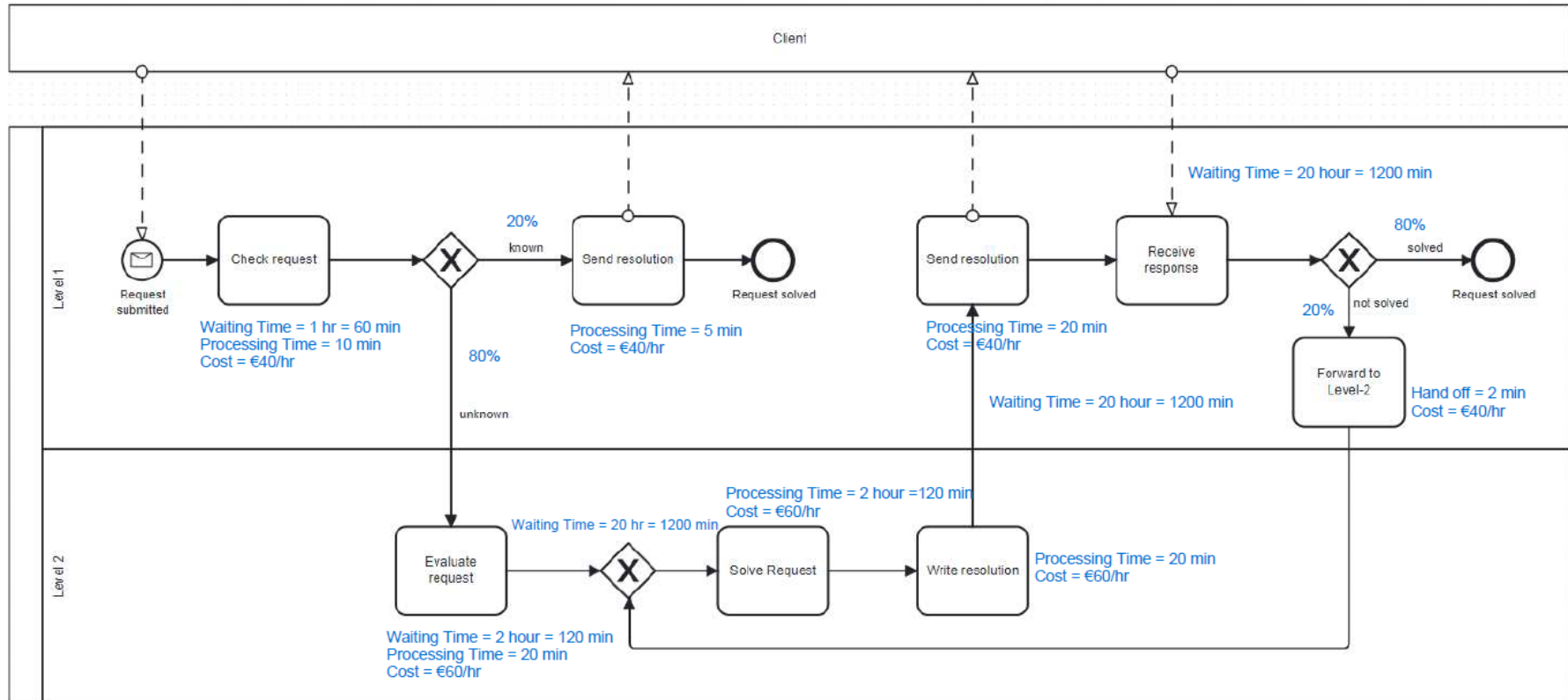
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Question 1

The processing time, waiting time and cost for performing each task has been represented in the BPMN Diagram as shown below. Based on the cost and time allocation, Processing Time, Cycle Time, Cycle Time Efficiency and Cost are calculated.

1: Considering “Forward to Level-2” Step as handoff and not including it while calculating Processing Time and Cost per Execution:



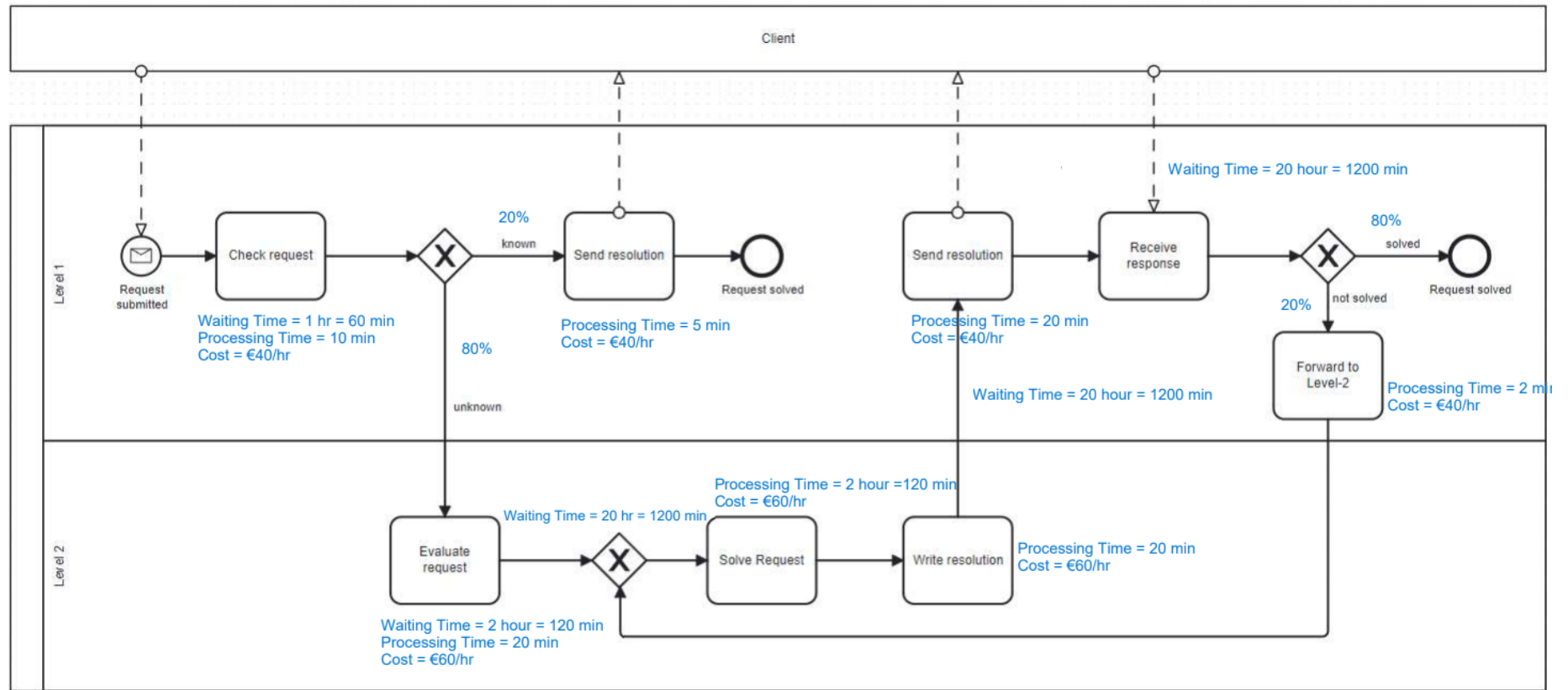
$$\text{Processing Time} = 10 + 0.2 * 5 + 0.8(20 + (160 + \frac{0.2 * (160)}{0.8})) = 187 \text{ mins}$$

$$\text{Cycle Time} = 70 + 0.2 * 5 + 0.8(1340 + (2560 + \frac{0.2 * (2560 + 2)}{0.8})) = 3703.4 \text{ mins}$$

$$\text{Cycle Time Efficiency} = \frac{187 \text{ mins}}{3703.4 \text{ mins}} = 5.06\%$$

$$\text{Cost} = 10 * \frac{2}{3} + 0.2 * 5 * \frac{2}{3} + 0.8(20 * 1 + ((120 * 1 + 20 * 1 + 20 * \frac{2}{3}) + \frac{0.2 * ((120 * 1 + 20 * 1 + 20 * \frac{2}{3}))}{0.8})) = \text{Euro } 176.66$$

2: If we take into consideration “Forward to Level-2” Step and ignore all remaining waiting times:



$$\text{Processing Time} = 10 + 0.2 * 5 + 0.8(20 + (160 + \frac{0.2 * (160 + 2)}{0.8})) = 187.4 \text{ mins}$$

$$\text{Cycle Time} = 70 + 0.2 * 5 + 0.8(1340 + (2560 + \frac{0.2 * (2560 + 2)}{0.8})) = 3703.4 \text{ mins}$$

$$\text{Cycle Time Efficiency} = \frac{187.4 \text{ mins}}{3703.4 \text{ mins}} = 5.06\%$$

$$\text{Cost} = 10 * \frac{2}{3} + 0.2 * 5 * \frac{2}{3} + 0.8(20 * 1 + ((120 * 1 + 20 * 1 + 20 * \frac{2}{3}) + \frac{0.2 * ((120 * 1 + 20 * 1 + 20 * \frac{2}{3}) + 2 * \frac{2}{3})}{0.8})) = \text{Euro } 177.26$$

Question 2

Arrival Rate (λ) = 1 per hour

Processing Time for Level 2 Staff = 3.25 hour

$$\frac{20}{60} + \frac{2 + \frac{20}{60}}{0.8}$$

Mean Service Rate per server (μ) = $1/3.25 = 0.3077$

This is the problem associated with M/M/c queue. Since, calculation related to such problem is complex, <https://qsa.inf.unideb.hu/prod/frontend/schemes/0> provides an interface using which such calculation can be performed easily.

Waiting Time (W) (in hour)			
	c = 4	c = 5	c = 6
$\lambda = 1$ $\mu = 0.3077$	2.68 hour	0.562 hour	0.159 hour

From above chart, we can see that average waiting time is less than 2 when $c \geq 5$.

So, Minimum of 5 Level 2 Staffs are required to ensure that the mean waiting time of a request is less than two working hours.

Screenshots of calculations performed from above site are provided below.

Systems

☐ M | M | c | c

☒ M | M | c

☐ M | M | c | K

☐ M | M | c | K Balking

M | M | c

Required parameters

λ

1

μ

0.3077

c

5

Performance measure	Value	Description
ρ	3.25	Traffic intensity, unit of measure is the erlang
P_0	0.035	Probability that there are no customers in the system
U_s	0.965	System utilization
a	0.65	Server utilization
P_n	0.035	Probability that there are n customers in the system
$P[N \geq c]$	0.303	Probability that all c servers are busy, Erlang's C formula
$P[N \geq n]$	1	Probability that there are at least n customers in the system
\bar{N}	3.81	Average number of customers in the system
$\text{var}(N)$	6.57	Variance of number of customers in the system
\bar{Q}	0.562	Average number of customers in the queue
$\text{var}(Q)$	2.33	Variance of the queue length
\bar{W}	0.562	Average waiting time

Question 3

During Simulation, for each task provided in BPMN diagram, necessary parameters were set based on whether the task is of type fixed, exponential or normal.

In case of fixed task like “Forward to Level 2 Staff”, exact time required to perform this task is provided as parameter.

In case of exponential tasks like “Check Request”, “Evaluate Request”, “Solve Request”, “Write Resolution”, average time taken for completion of corresponding task is provided as input parameter.

In case of normally distributed task like “Send Resolution”, average time taken for its completion along with its standard deviation is provided as input parameter.

We have taken into consideration waiting time for receiving the response from the client while all internal waiting times have been ignored.

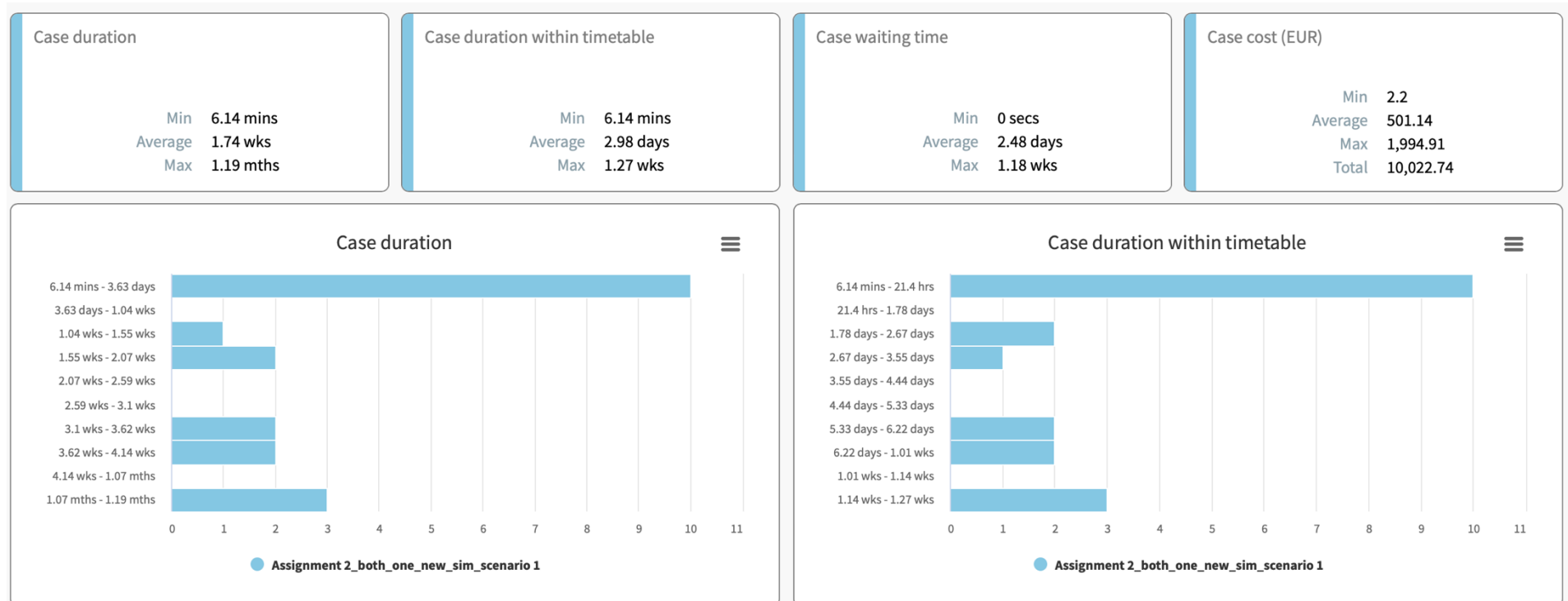


Fig1: Scenario 1 when we have 1 resource for each level

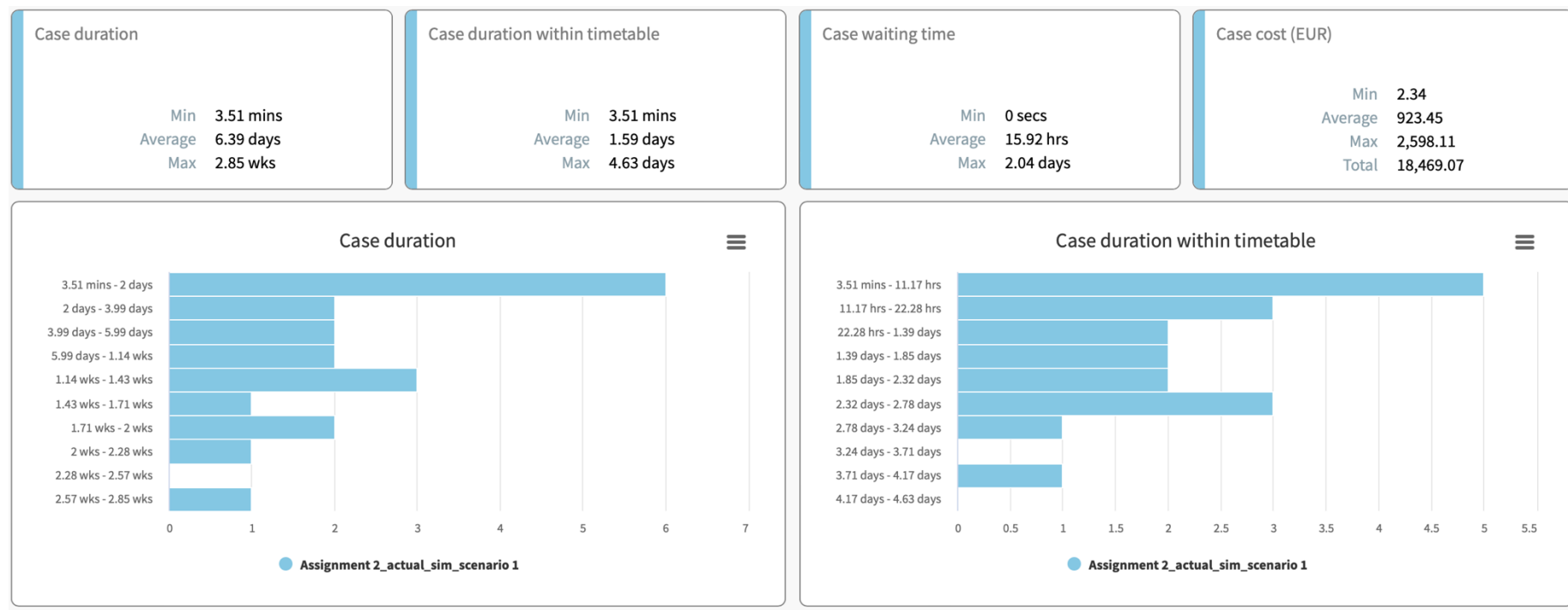


Fig2: Scenario 2 when we have 5 resources for level 1 and 3 resources for level 2

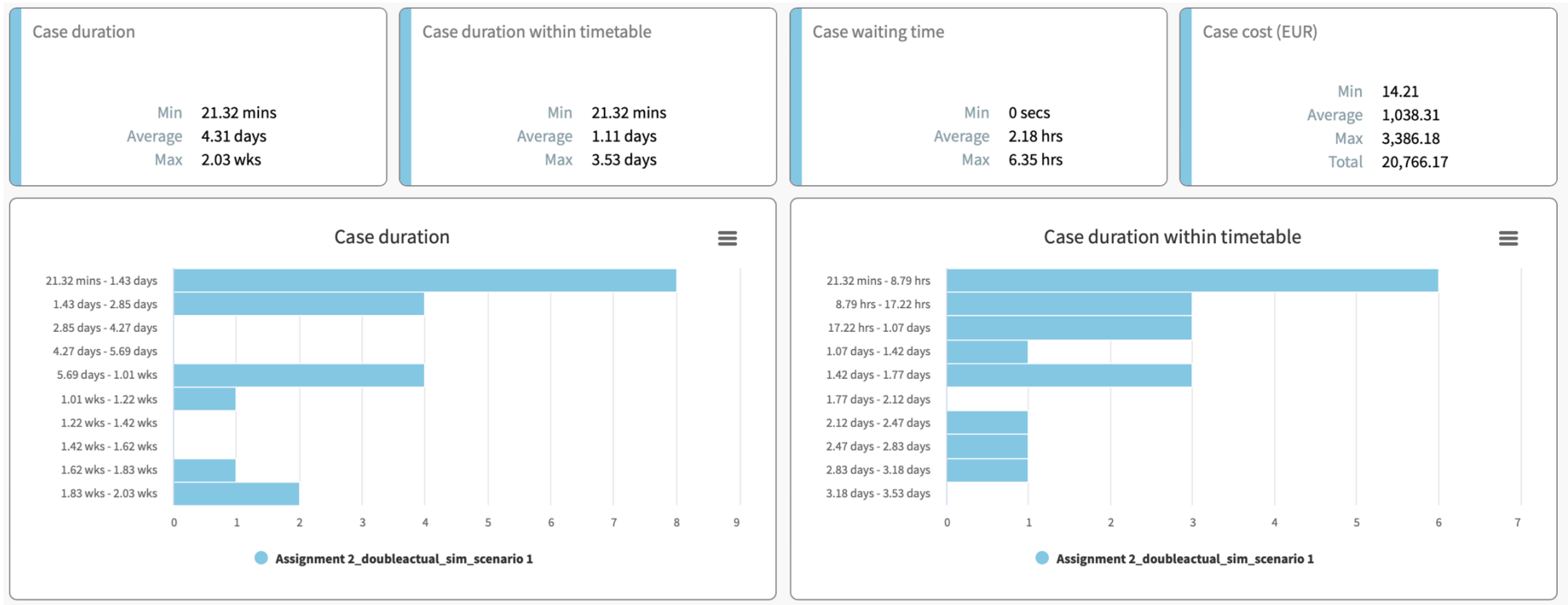


Fig3: Scenario 3 when we have 10 resources for level 1 and 6 resources for level 2

Scenario	Number of Resources	Average case duration	Average case waiting time	Average Case Cost (Euro)	Case Duration Within Timetable
1	L1=1, L2=1	1.74 weeks	2.48 days	501.14	2.98 days
2	L1=5, L2 =3	6.39 days	15.92 hours	923.45	1.59 days
3	L1=10, L2=6	4.31 days	2.18 hours	1038.31	1.11 days

We have considered 3 scenarios by varying the number of resources for level-1 and level-2 staff and have compared the statistics along time and cost dimension.

For Scenario 1, we have taken the least number of resources, i.e., 1 for level-1(L1) and 1 for level-2(L2). For Scenario 2, we have 5 level-1 and 3 level-2 resources. Similarly, for Scenario 3, we have increased this number by 2 times considering 10 resources for level-1 and 6 for level-2. In scenario 1, it takes longest time for the process to complete in average compared to when we have higher number of resources as in scenario 2 and 3. In average, it takes 1.74 weeks for the first scenario while this number decreases to 6.39 days for scenario 2 and to 4.31 days for scenario 3. Similar is the case for average waiting time, where it is 2.48 days for scenario 1 while the time decreases to 15.92 hours for scenario 2 and to 2.18 hours for scenario 3.

However, if we look into the average cost associated with each scenario, the cost is highest when we increase the number of recourses. This is illustrated by the figure in the table above. It costs 1038.31 euro for scenario 3 where we have highest number of recourses. But, when the number of recourses is dropped as in scenario 2, it cost 923.45 euro. This cost drops to 501.14 euro when the resources are even limited as in scenario 1.

In conclusion, parameters associated with cost and time is directly associated to number of resources being assigned in the process.

Question 4

Issues Identified in the process

1. The resolution identified by Level 2 Staff cannot be directly sent to the Client. Instead, it should first be passed to Level 1 staff, who will then send the resolution to the Client.
2. Once the client sends status of resolution i.e., whether it is solved or not, it is being forwarded to Level 2 Staff through Level 1 Staff. Handover process is seen in this case.

Issue Register

Name	Explanation	Data/Hypothesis	Qualitative Impact	Quantitative Impact
Resolution proposed by Level 2 staff taking long time to reach to the Client	The resolution identified by Level 2 Staff cannot be directly sent to the Client. Level2 Staff should first forward resolution to Level 1 Staff, who will then forward resolution to the Client.	Once the resolution is identified by Level 2 Staff, it should wait for an average of 20 hour and 20 minutes before resolution is forwarded by Level 1 Staff to the Client.	Client unsatisfied because of the time-consuming process to get resolution. Lots of time is spent by Level 1 Staff on handover process.	For 80% of cases, 20 hours (1200 mins) is wasted in this process for Level 1 Staff to pick resolution from Level 2 Staff.
Response from the client signifying status of Resolution provided by Level 2 Staff takes long time to reach to Level 2 Staff	Once resolution identified by Level 2 Staff reaches to client, client responds back with its status. Since this status is not directly sent to Level2 Staff, it takes long time for Level 2 Staff to know if the issue was resolved and rework on it if it is unresolved.	Once client responds back with the status of resolution, it takes 2 minutes for Level 1 Staff to forward this status to Level 2 Staff.	Lots of time is spent by Level 1 Staff on handover process.	2 min time is wasted in this process for Level 1 Staff to forward status of resolution to Level 2 Staff.

Proposed Changes and Redesign Heuristic

1. Resolution identified by Level 2 Staff can be directly sent to the client instead of sending it through Level 1 Staff. **Here, Task Composition Redesign Heuristic is used.** By doing this, we will be able to eliminate unnecessary transportation and reduce “context switches”
2. Client can directly send status of resolution to Level 2 Staff instead of forwarding it through Level 1 Staff. **Here, Task Elimination Redesign Heuristic is used.** By doing this, we will be able to eliminate unnecessary task i.e., Forward Response to Level 2 Staff, which as a result will eliminate unnecessary transportation and reduce “context switches”

Question 5

The proposed “To-be” Model is as follows:

