Business Process Management

Lecture 7
Quantitative Process Analysis

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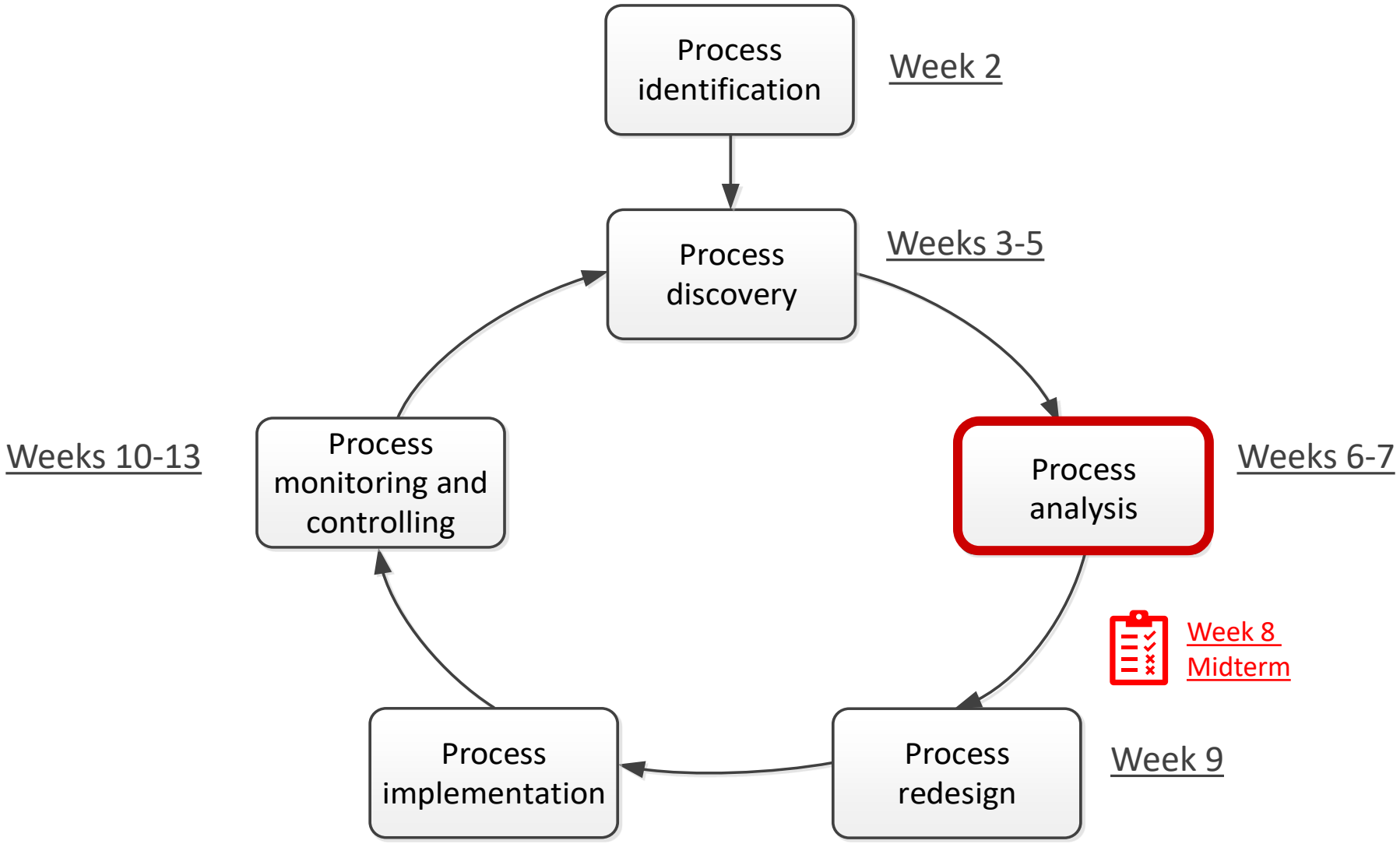
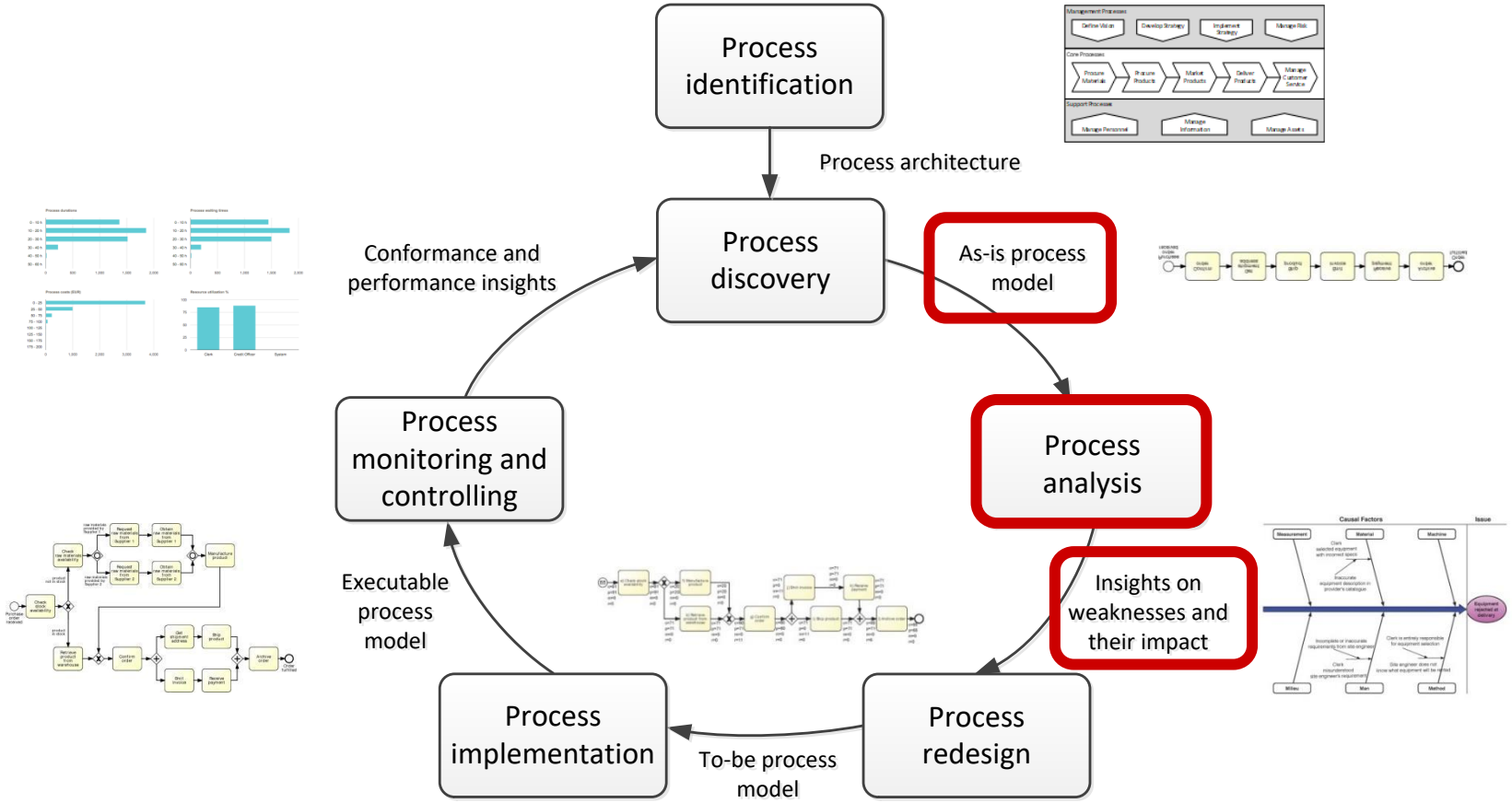
Course structure



Process Analysis in the BPM Lifecycle



Process Analysis Techniques

Qualitative analysis

- Value-Added & Waste Analysis
- Issue Register
- Pareto Analysis
- Root-Cause Analysis

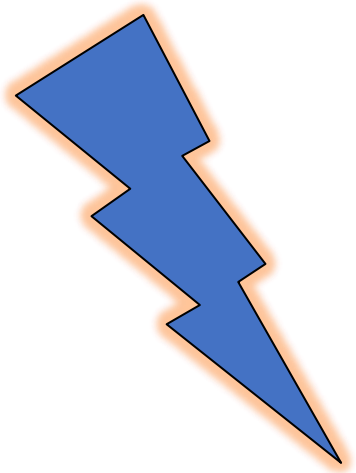
Quantitative Analysis

- Flow analysis
- Queuing analysis
- Simulation

Process performance

If you had to choose between two services, you would typically choose the one that is:

- F…
- C…
- B…

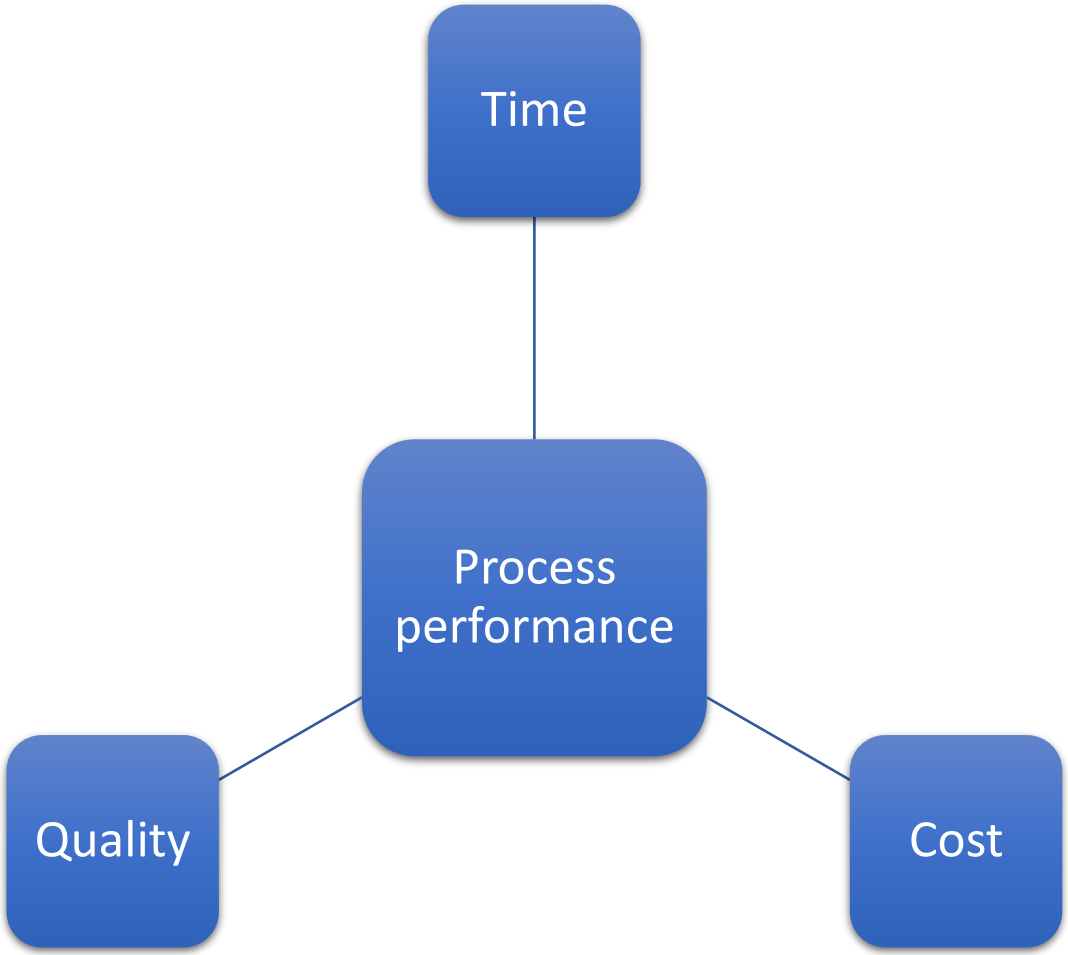


Process performance

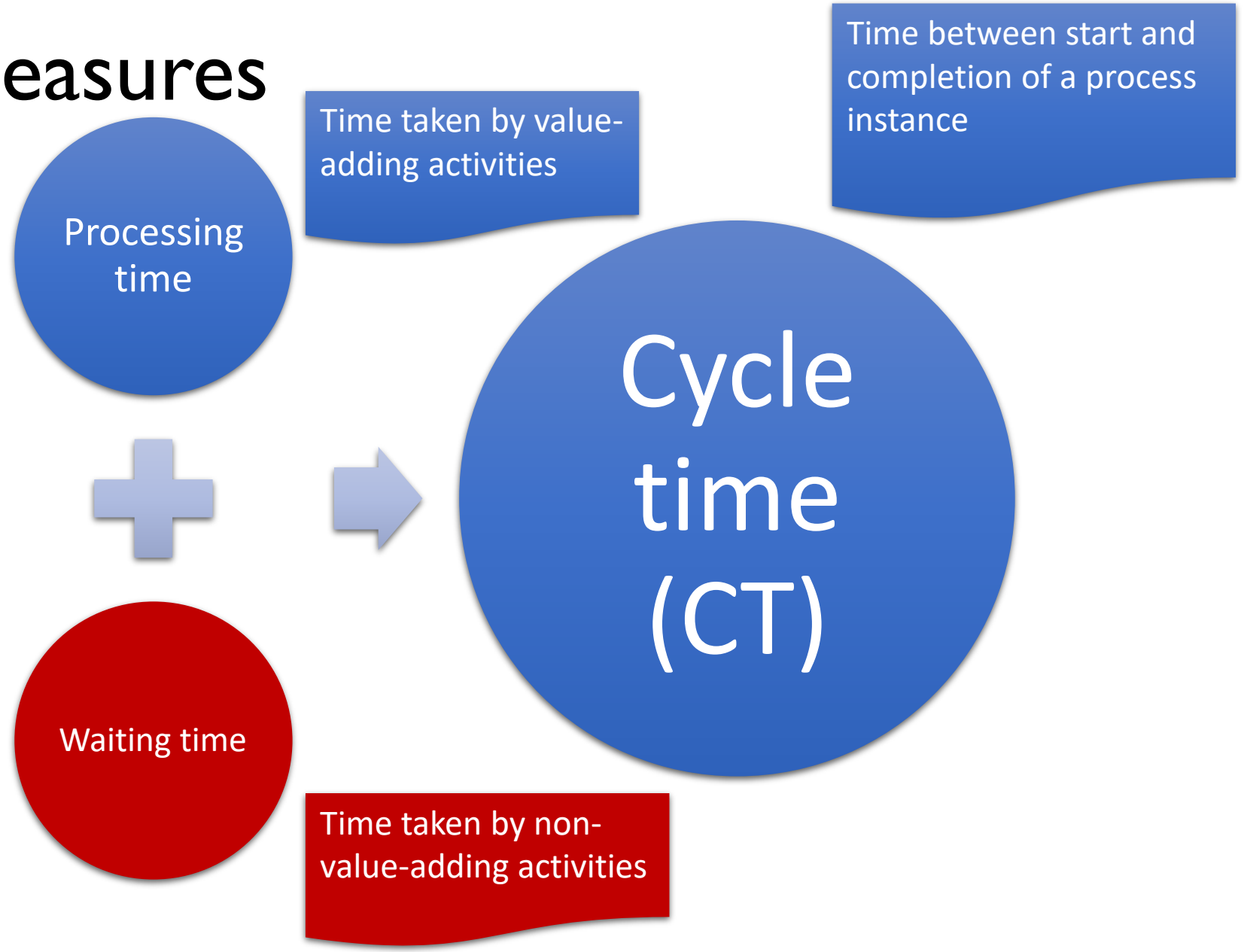
If you had to choose between two services, you would typically choose the one that is:

- Faster
- Cheaper
- Better

Process performance



Time measures



Cycle time efficiency

CT but instead of using the cycle time of each task, we must use instead the **processing time** of each task

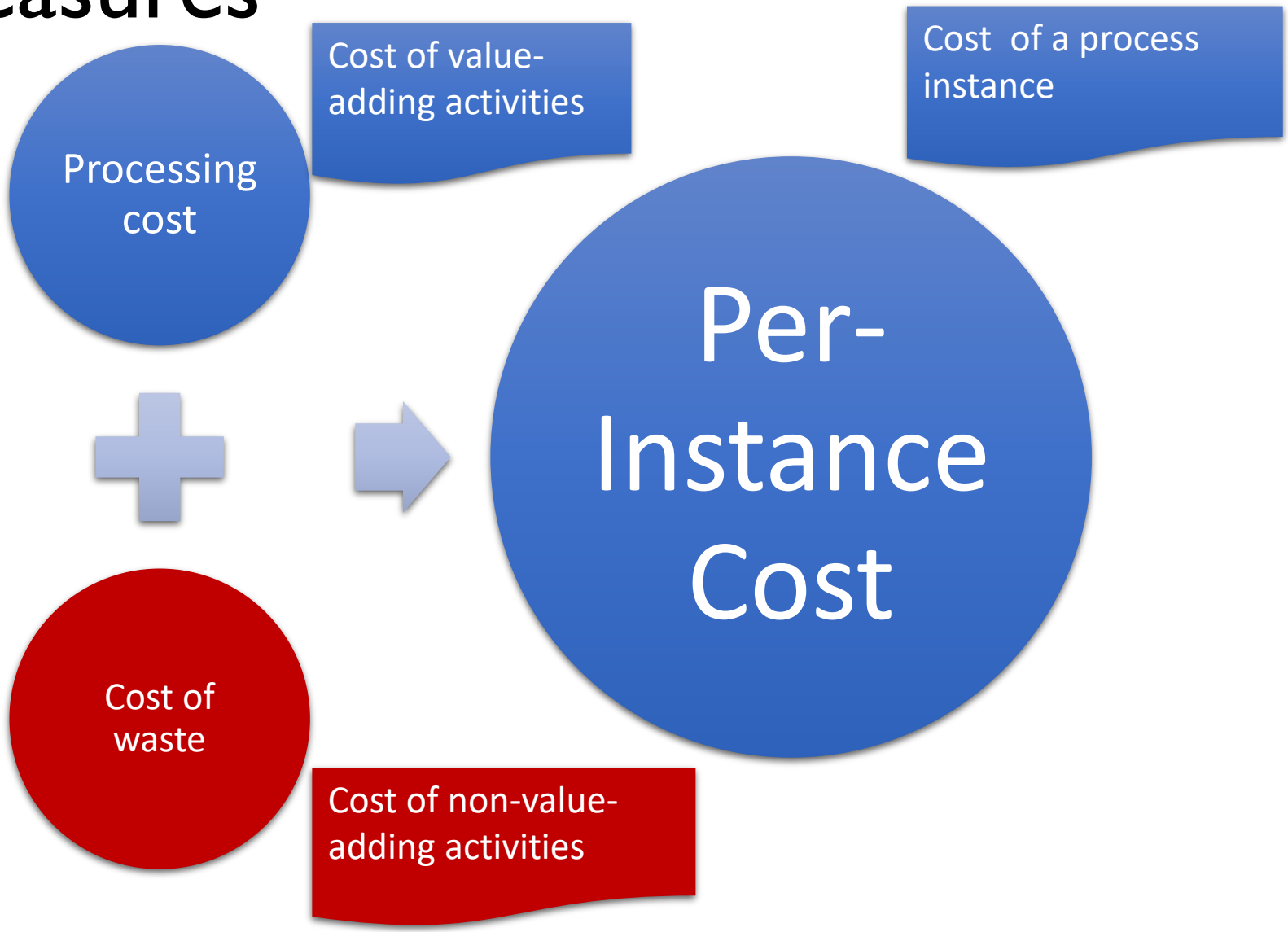
Table 7.4 Analysis of cycle times in white-collar processes [21]

Industry	Process	CT	TCT	CTE
Life Insurance	New policy application	72 h	7 min	0.16%
Consumer Packaging	New graphic design	18 days	2 h	0.14%
Commercial Bank	Consumer Loan	24 h	34 min	2.36%
Hospital	Patient Billing	10 days	3 h	3.75%
Automobile Manufacture	Financial Closing	11 days	5 h	5.60%

https://api.socrative.com/rc/DeimT8

[21] J.D. Blackburn, *Time-based competition: White-collar activities*. Bus. Horiz. **35**(4), 96–101 (1992)

Cost measures



Typical components of cost

Material cost

- Cost of tangible or intangible resources used per process instance

Resource cost

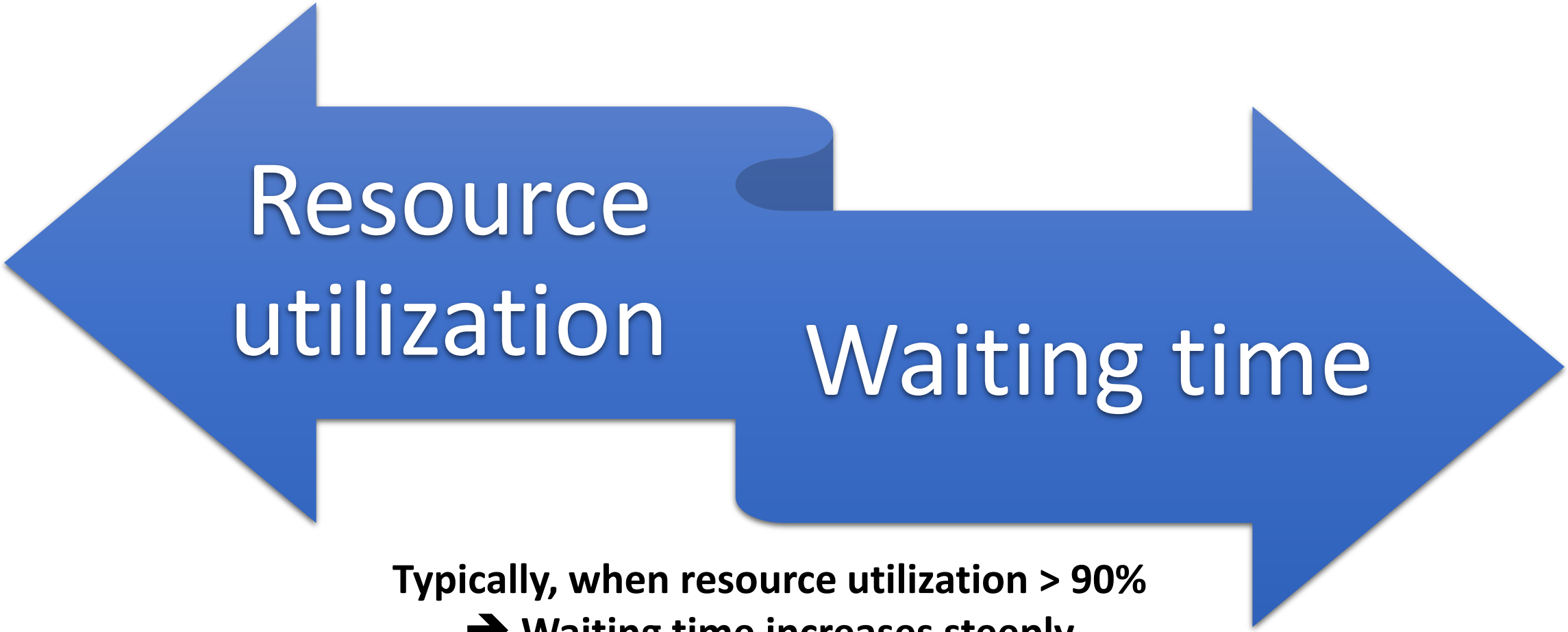
- Cost of person-hours employed per process instance

Resource utilization

Resource utilization = 60%

➔ on average resources are idle 40% of their allocated time

Resource utilization vs. waiting time



Typically, when resource utilization > 90%
➔ Waiting time increases steeply

Quality

Product quality

- Defect rate

Delivery quality

- On-time delivery rate
- Cycle time variance

Customer satisfaction

- Customer feedback score

Identifying performance measures

For each process, formulate process performance objectives

Customer should be served always in a timely manner

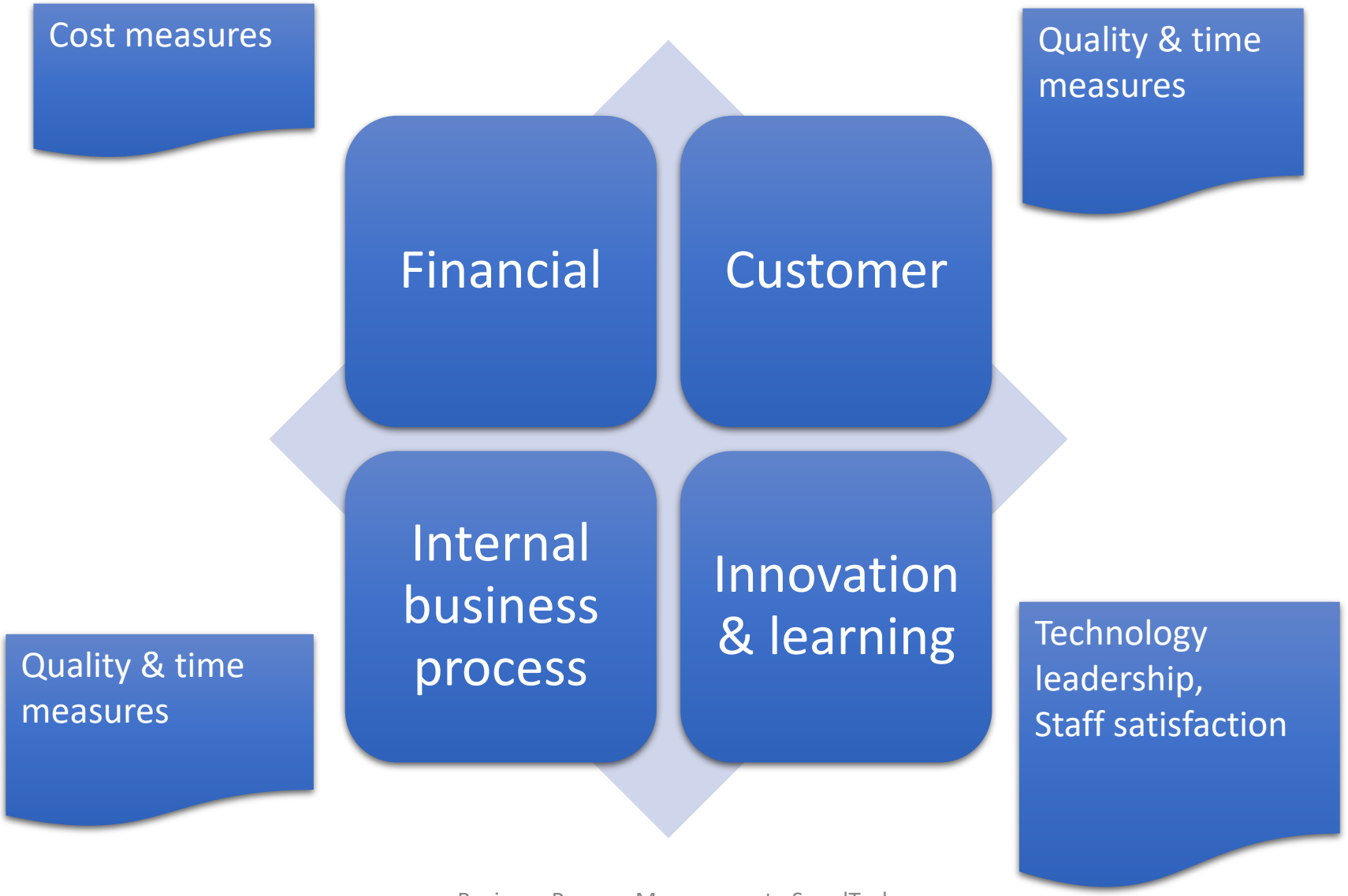
For each objective, identify variable(s) and aggregation method → performance measure

Variable: customer served in < 30 min.	Aggregation method: percentage	Measure: ST_{30} = % of customers served in < 30 min.

For each performance measure, define targets

$ST_{30} > 99\%$

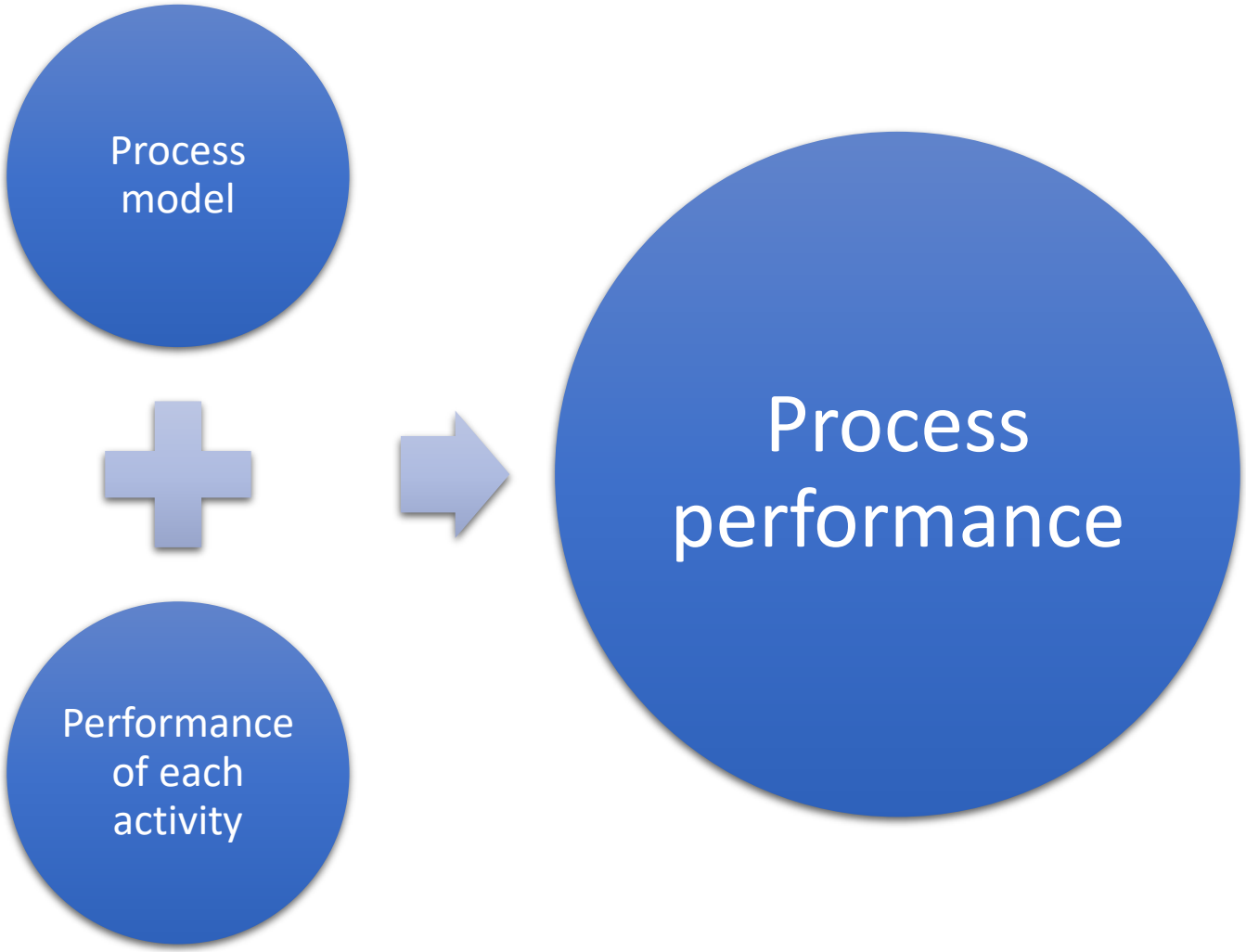
Balanced scorecard



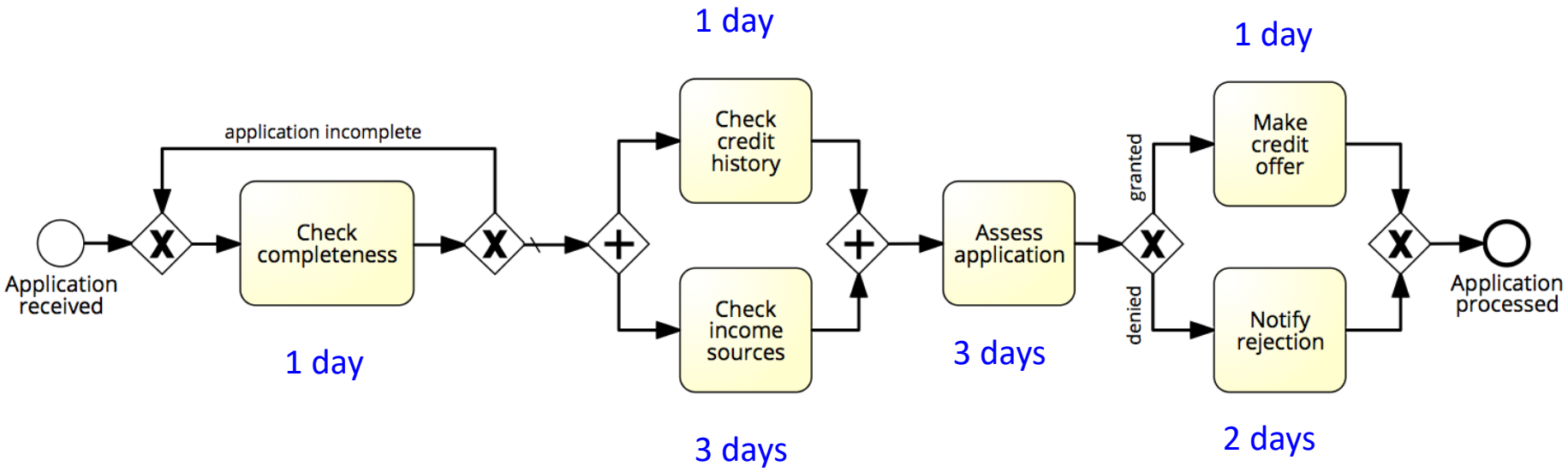
Flow analysis

Flow Analysis

Flow analysis



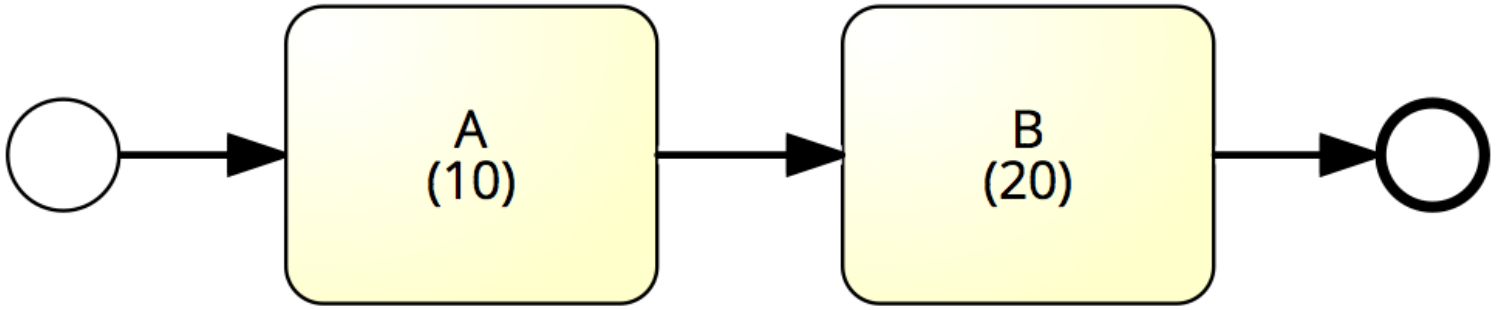
Flow analysis of cycle time



Cycle time = X days

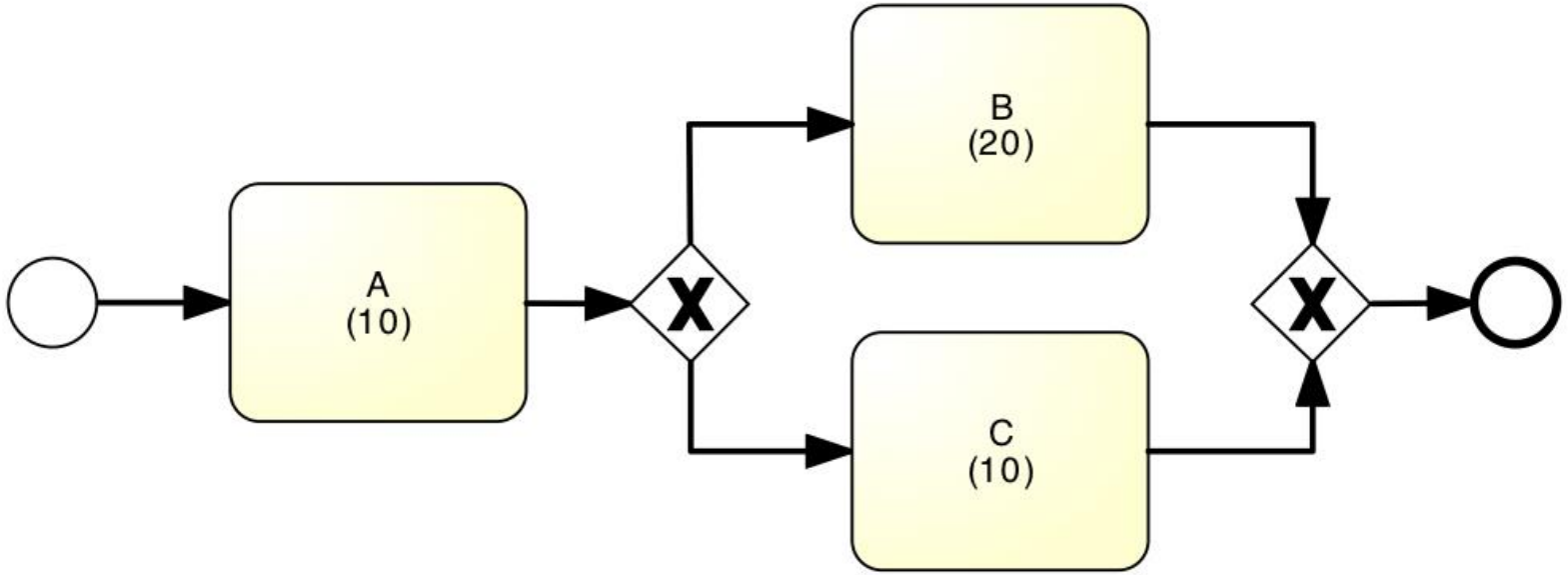
Sequence – Example

- What is the average cycle time?



Example: Alternative Paths

- What is the average cycle time?



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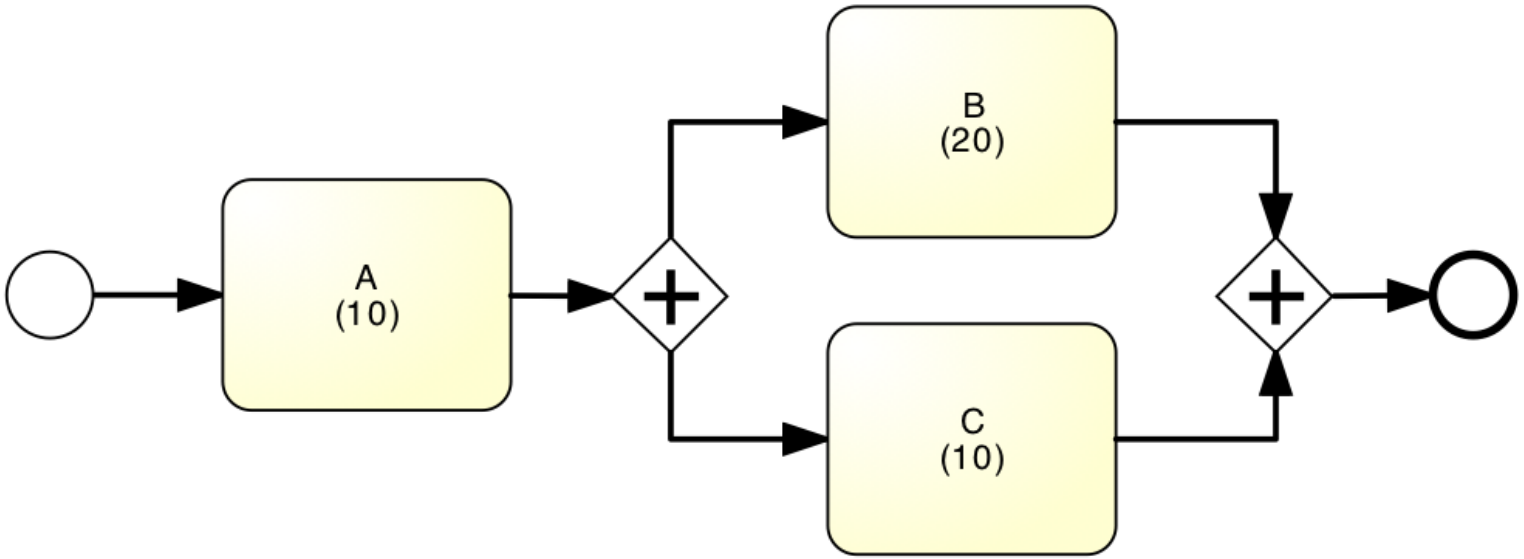
Example: Parallel paths

- What is the average cycle time?



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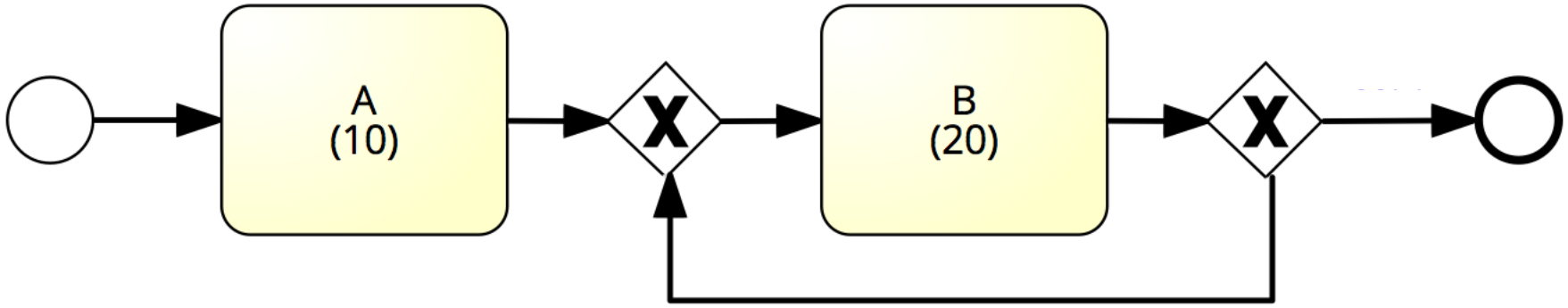
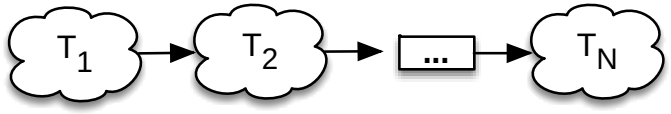
Example: Rework loop

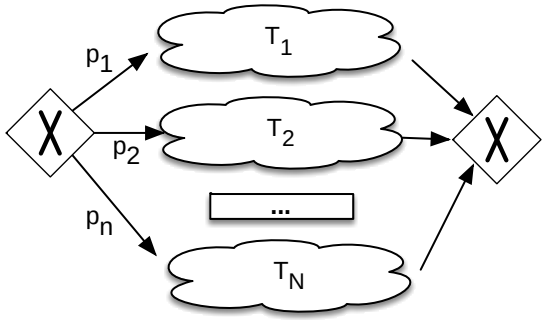
- What is the average cycle time?



Flow analysis equations for cycle time

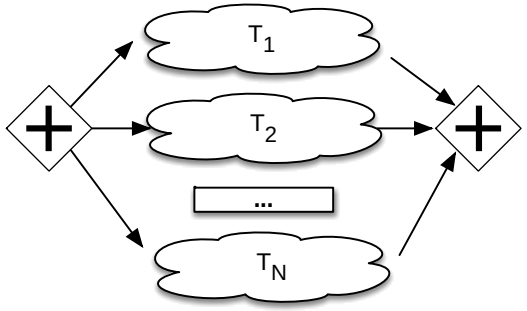


$$CT = \sum_{i=1}^{N} T_i = T_1 + T_2 + \cdots + T_N$$

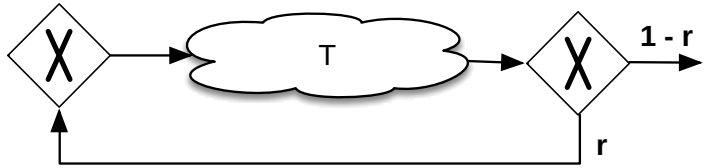


$$CT = \sum_{i=1}^{N} p_i \times T_i = p_1 \times T_1 + p_2 \times T_2 + \cdots + p_n \times T_N$$

where p = *branching probability*



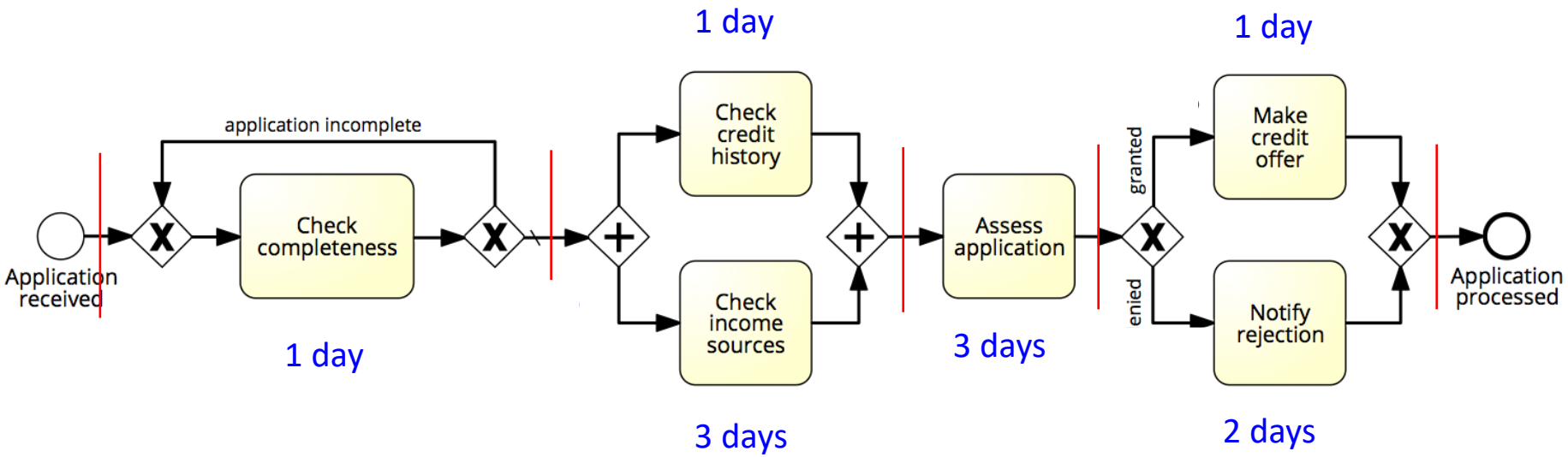
$$CT = \max(T_1, T_2, \ldots, T_N)$$



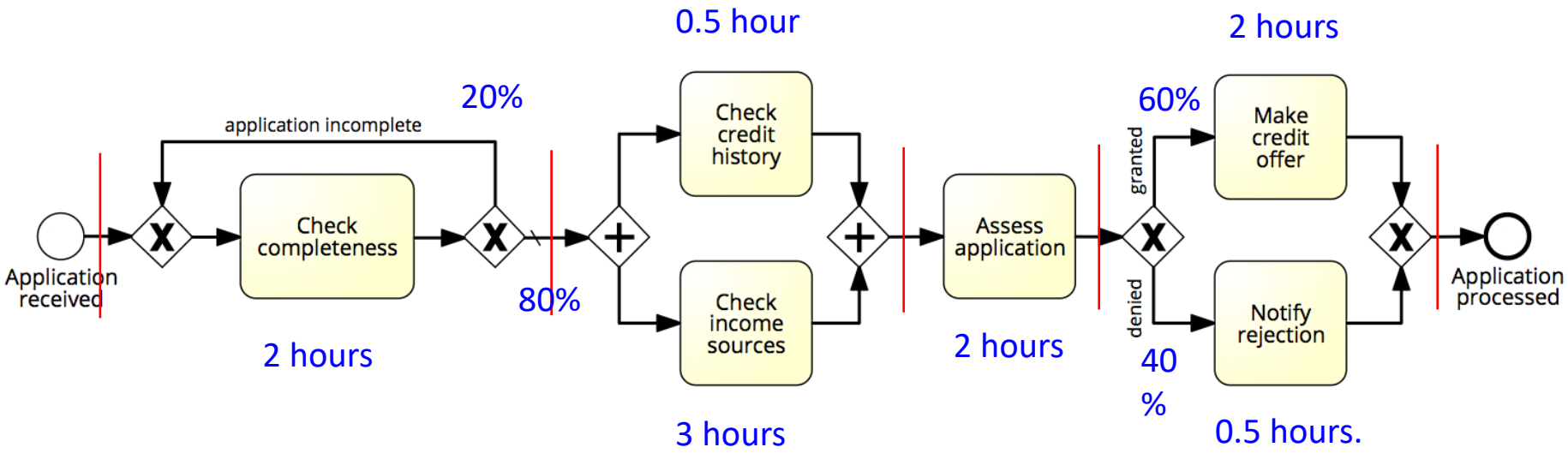
$$CT = \frac{T}{1 - r}$$

where r = *rework probability*

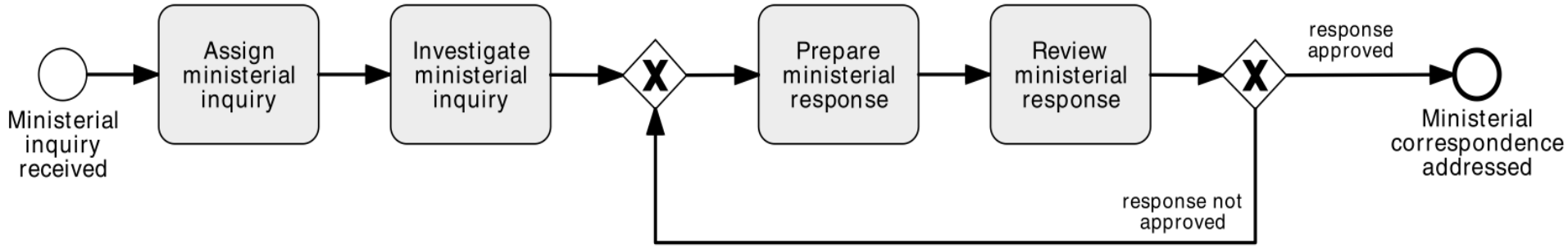
Flow analysis of cycle time



Flow analysis of processing time



Exercise: Calculate CTE of the following process



Activity	Cycle time	Processing time
Assign ministerial enquiry	2 days	30 mins
Investigate ministerial enquiry	8 days	12 hours
Prepare ministerial response	4 days	4 hours
Review ministerial response	4 days	2 hour

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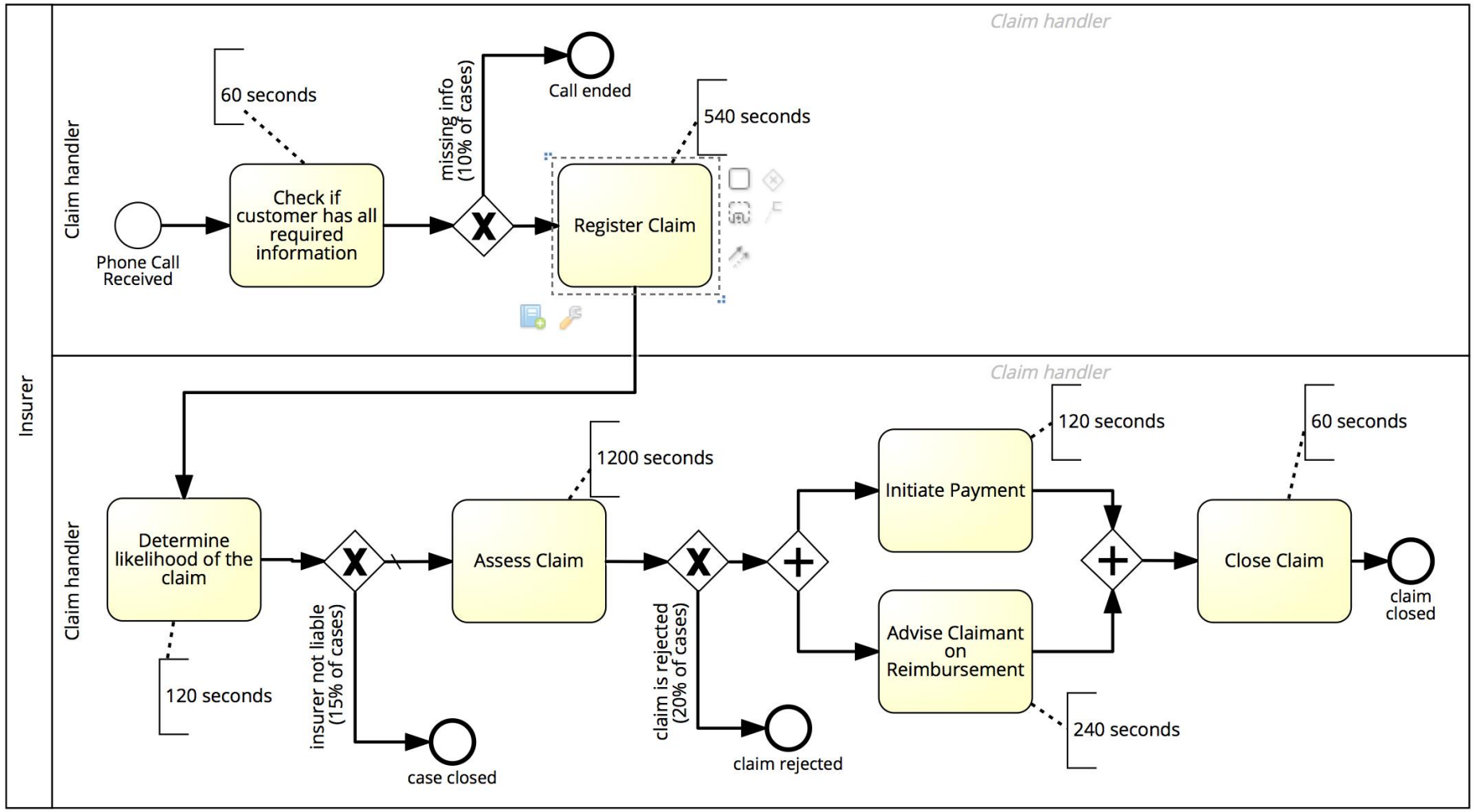
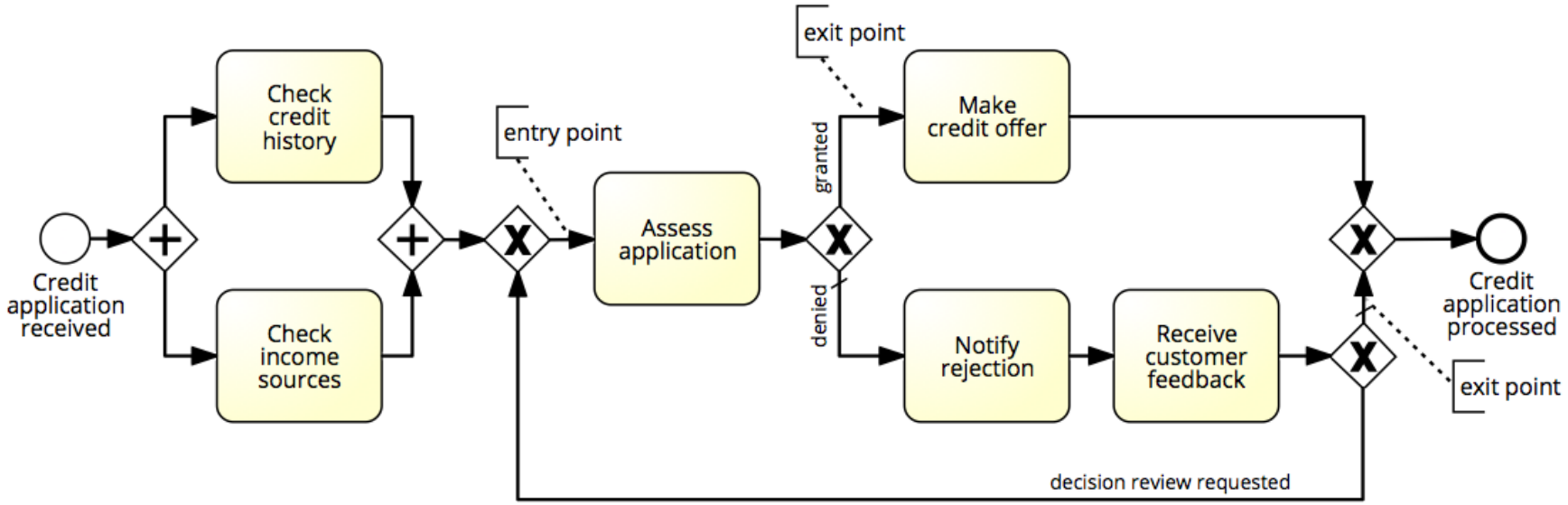
Exercise: Calculate TCT of the following process



Flow analysis: scope and limitations

- Flow analysis for cycle time calculation
- Other applications:
  - Calculating cost-per-process-instance
  - Calculating error rates at the process level
  - Estimating capacity requirements

Limitation 1: Not all Models are Structured



Limitation 2: Fixed arrival rate capacity

- Cycle time analysis does not consider:
  - The rate at which new process instances are created (arrival rate)
  - The number of available resources
- Higher arrival rate at fixed resource capacity
  ➔ high resource contention
  ➔ higher activity waiting times (longer queues)
  ➔ higher activity cycle time
  ➔ higher overall cycle time
- The slower you are, the more people have to queue up…
  - and vice-versa

Cycle Time & Work-In-Progress

- WIP = (average) Work-In-Process
  - Number of cases that are running (started but not yet completed)
  - E.g. # of active and unfilled orders in an order-to-cash process
- WIP is a form of waste (cf. 7 sources of waste)
- Little's Formula: $WIP = \lambda \cdot CT$
  - λ = arrival rate (number of new cases per time unit)
  - CT = cycle time
  - Little's law holds for any stable process:
    - Arrival rate (inflow rate) is approximately same as outflow rate of input units

Example (Customer Flow)

- The café Den Drippel in Ninove, Belgium, serves, on average, 60 customers per night. A typical night at Den Drippel is long, about 10 hours. At any point in time, there are, on average, 18 customers in the café. These customers are either enjoying their food and drinks, waiting to order, or waiting for their order to arrive.

  - How long does a customer spend inside the café?

Example 2 (Claims Flow)

- A branch office of an insurance company processes 10,000 claims per year. Average processing time is three weeks. Assume that the office works 50 weeks per year.
- We want to know how many claims are being processed at any given point?

Example 3 (Cash Flow)

- A steel company processes $400 million of iron ore per year. The cost of processing ore is $200 million per year. The average inventory is $100 million. The value of inventory includes both ore and processing cost.
- We want to know how long a dollar spends in the process.

Exercise

A fast-food restaurant receives on average 1200 customers per day (between 10:00 and 22:00). During peak times (12:00-15:00 and 18:00-21:00), the restaurant receives around 900 customers in total, and 90 customers can be found in the restaurant (on average) at a given point in time. At non-peak times, the restaurant receives 300 customers in total, and 30 customers can be found in the restaurant (on average) at a given point in time.

1. What is the average time that a customer spends in the restaurant during peak times?
2. What is the average time that a customer spends in the restaurant during non-peak times?

Exercise (cont.)

3. The restaurant plans to launch a marketing campaign to attract more customers. However, the restaurant's capacity is limited and becomes too full during peak times. What can the restaurant do to address this issue without investing in extending its building?

Next Week

Mid-term examination:

- 1 study case problem (half of points):
  - Includes activities from Process Discovery and Process Analysis.
  - You are only allowed to bring your own BPMN cheat sheet. Not printed out, but you have to draw and write by yourself (only the information contained in the cheat sheet is allowed)
- 4 direct questions and 1 multiple option question about all the content we learned.

Note:

- Bring calculator (not scientific, but a simple calculator)

Acknowledgements

- The content notes for this lecture feature content borrowed with or without modification from the following sources:
  - "Source: M. Dumas, M. La Rosa, J. Mendling and H. Reijers, *Fundamentals of Business Process Management*, 2nd edition, Springer, 2018".
  - Chapter 7