Business Process Management

Paolo Bottoni

Dipartimento
di Informatica

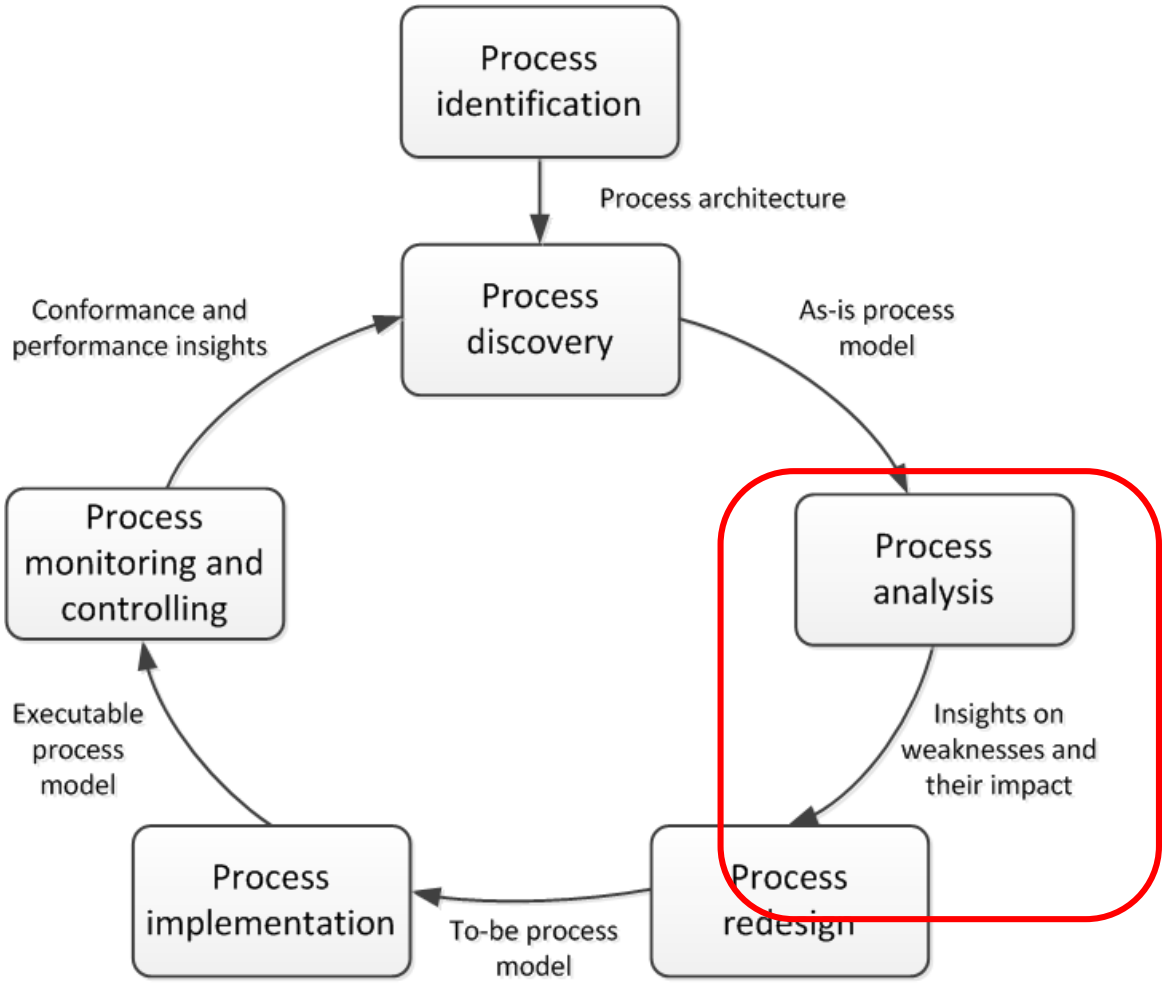
Sapienza
Università di Roma

Lecture 8: Quantitative Analysis

Adapted from the slides for the book :
Dumas, La Rosa, Mendling & Reijers: Fundamentals of Business Process Management, Springer 2013

http://courses.cs.ut.ee/2013/bpm/uploads/Main/ITlecture5.ppt

Business Process Analysis



Process Analysis Techniques

Qualitative analysis

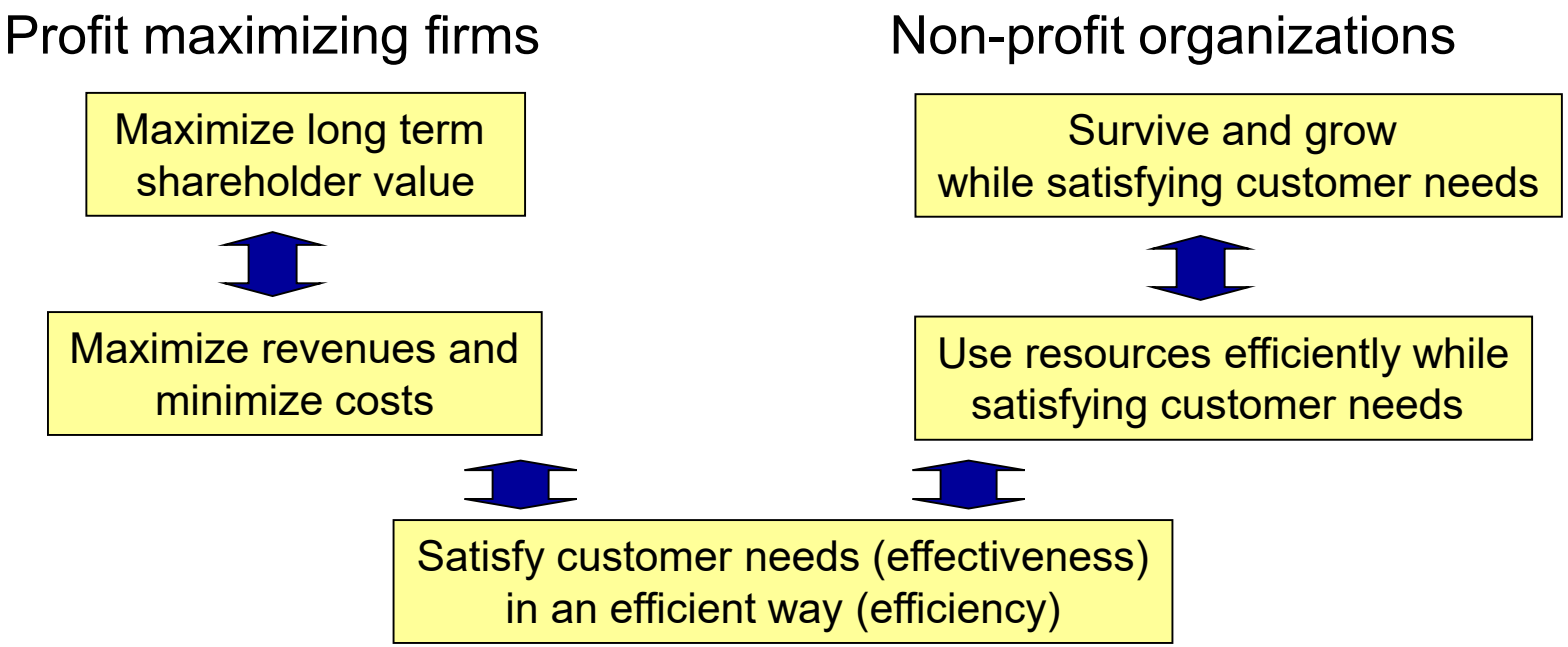
- Value-Added Analysis
- Root-Cause Analysis
- Pareto Analysis
- Issue Register

Quantitative Analysis

- Quantitative Flow Analysis
- Queuing Theory
- Process Simulation

Process Performance Measures

- Link the identified processes to measurable objectives
- Quantify the benefits of improvement



Inspired by a slide by Manuel Laguna & John Marklund

Fill in the blanks

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

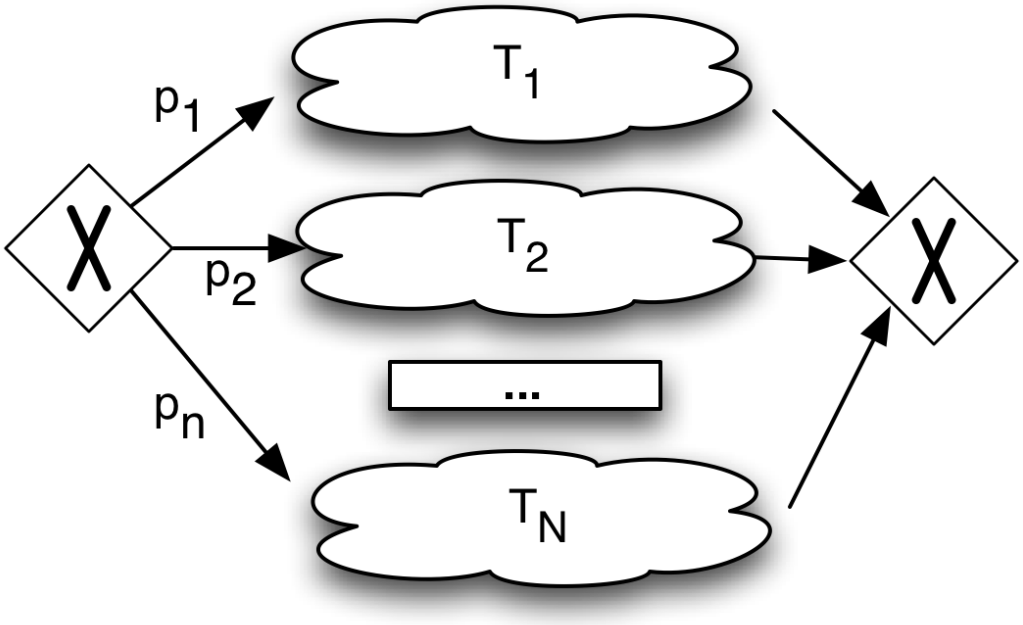
- F…
- B…
- C…

Process Performance Measures

Cycle Time Analysis

- Cycle time: Difference between a job's start and end time
- *Cycle time analysis*: the task of calculating the ***average*** cycle time for an entire process or process fragment
  - Assumes that the average activity times for all involved activities are available (activity time = waiting time + processing time)
- In the simplest case a process consists of a sequence of activities on a sequential path
  - The average cycle time is the sum of the average activity times
- … but in general we must be able to account for
  - Alternative paths (XOR splits)
  - Parallel paths (AND splits)
  - Rework (cycles)

Alternative Paths

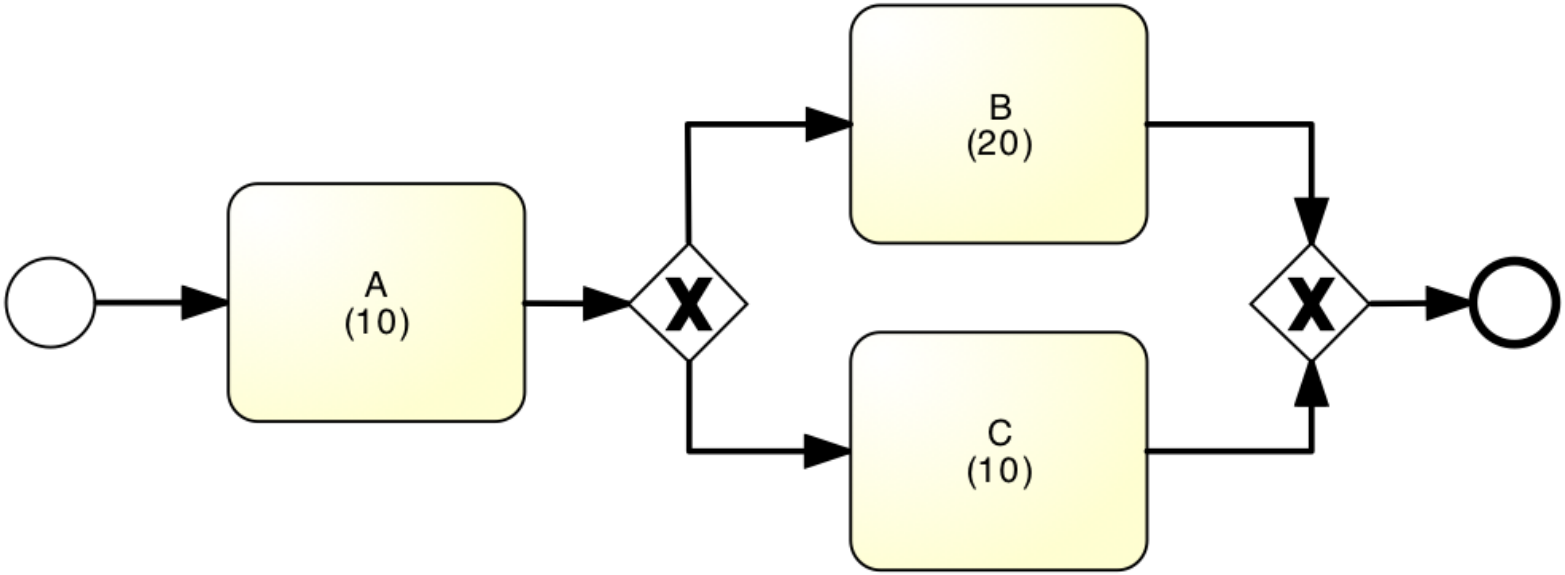


$$CT = p_1T_1 + p_2T_2 + \ldots + p_nT_n = \sum_{i=1}^{n} p_iT_i$$

Inspired by a slide by Manuel Laguna & John Marklund

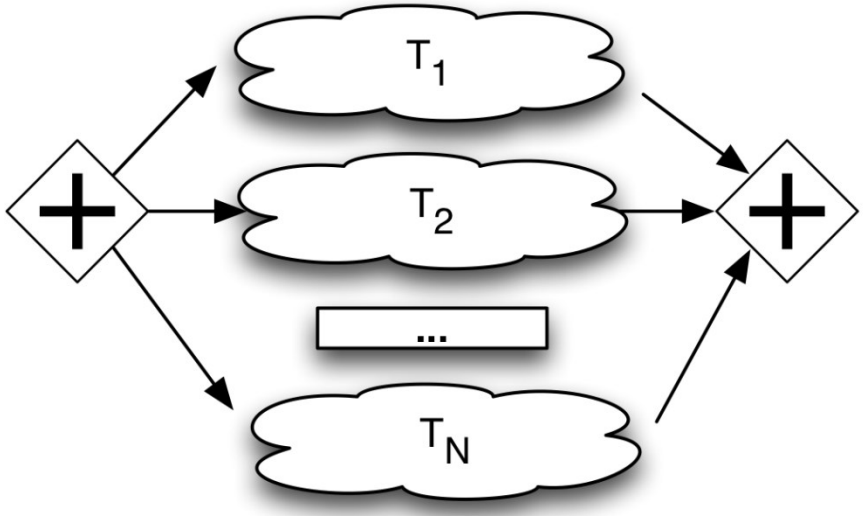
Alternative Paths – Example

- What is the average cycle time?



Parallel Paths

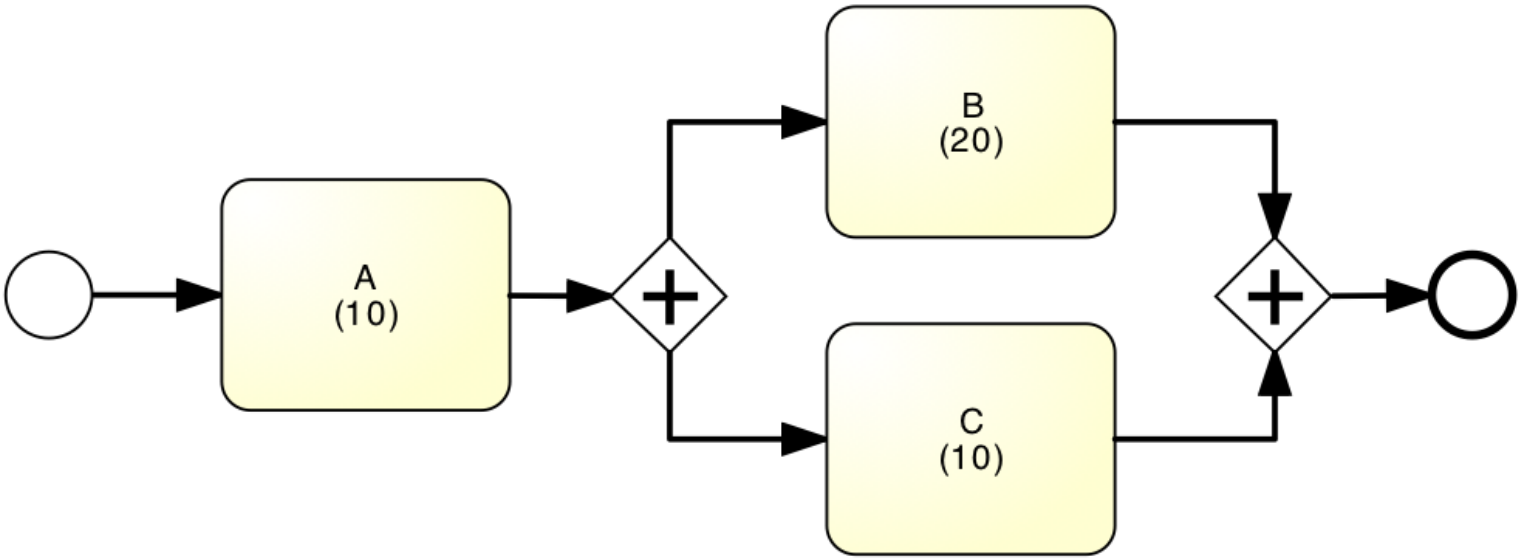
- If two activities related to the same job are done in parallel the contribution to the cycle time for the job is the maximum of the two activity times.



$$CT_{parallel} = Max\{T_1, T_2, \ldots, T_M\}$$

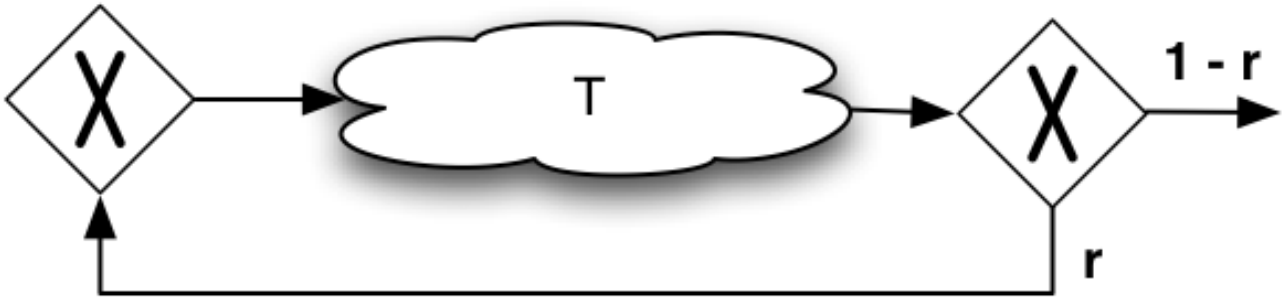
Inspired by a slide by Manuel Laguna & John Marklund

Parallel Paths – Example



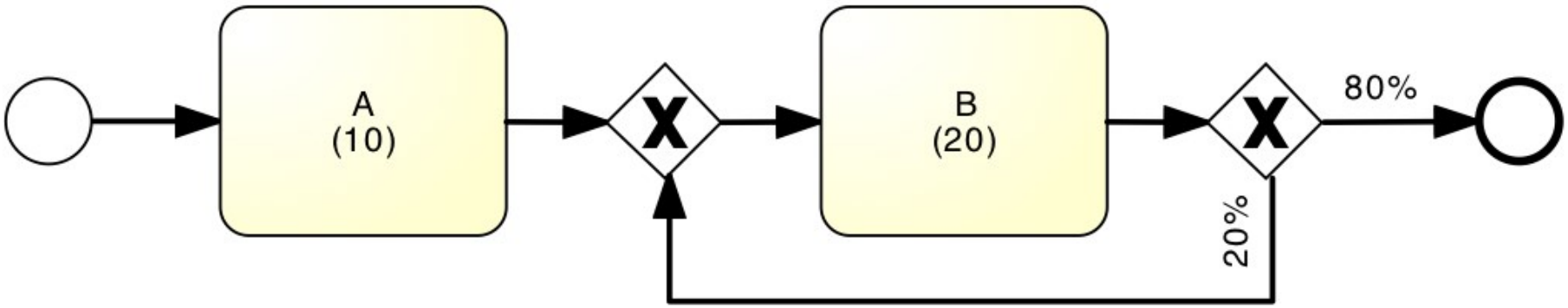
Rework

- Many processes include control or inspection points where if the job does not meet certain standard, it is sent back for rework



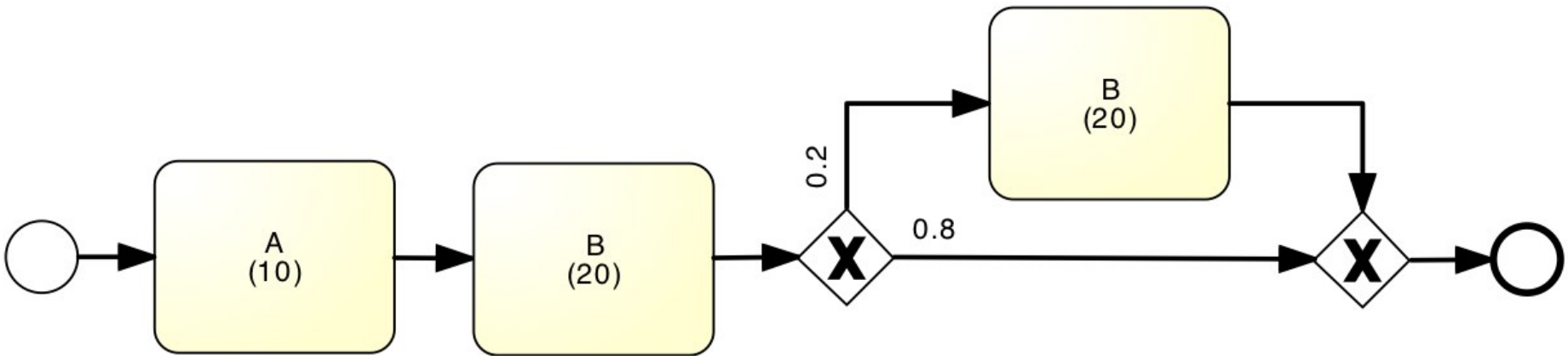
$$CT = T/(1-r)$$

Rework – Example



Rework At Most Once – Example

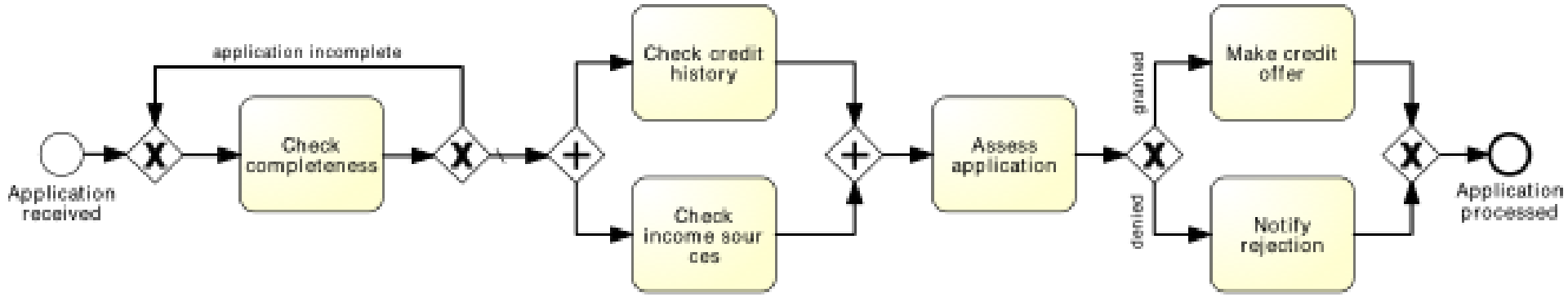
- What is the average cycle time?



Quick exercise

Calculate cycle time

Activity	*Cycle time*
Check completeness	1 day
Check credit history	1 day
Check income sources	3 days
Assess application	3 days
Make credit offer	1 day
Notify rejection	2 days



Cycle Time Efficiency

- Measured as the percentage of the total cycle time spent on value adding activities.

$$\text{Cycle Time Efficiency} = \frac{\text{Theoretical Cycle Time}}{\text{CT}}$$

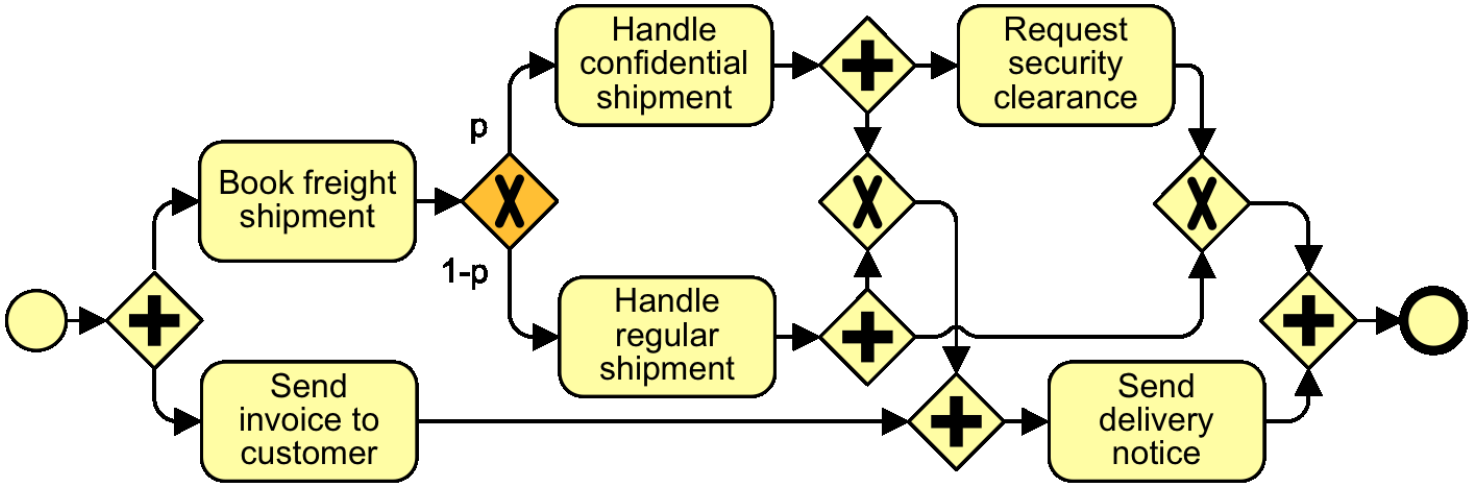
- CT = cycle time as defined before
- Theoretical Cycle Time (TCT) is the cycle time if we only counted value-adding activities and excluded any waiting time or handover time
  - Count only *processing times*

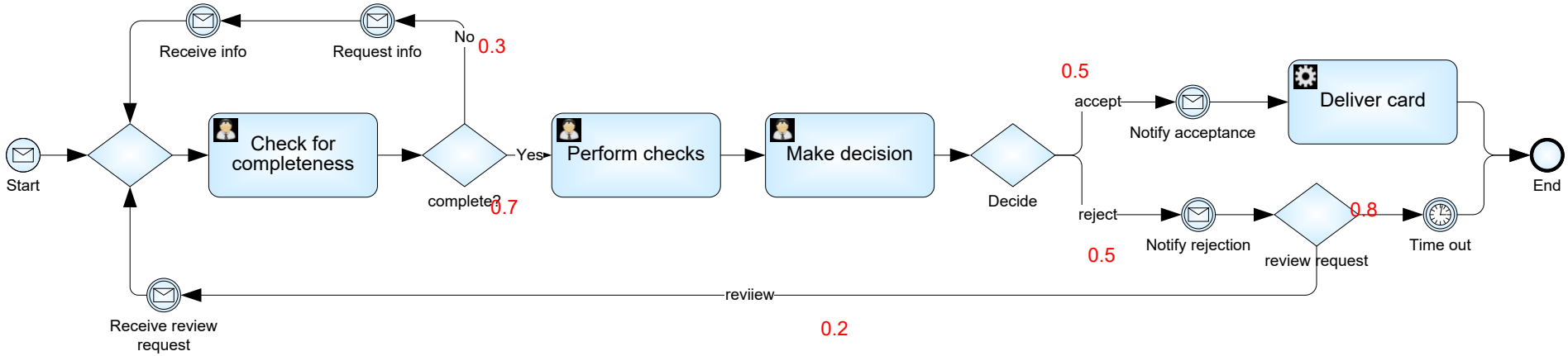
Inspired by a slide by Manuel Laguna & John Marklund

Flow Analysis

- The previous technique for cycle time analysis is only one example of what can be done using *flow analysis* techniques
- 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 load + fixed resource capacity

- Cycle time analysis does not consider waiting times due to resource contention
- Queuing analysis and simulation address these limitations and have a broader applicability

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+1 sources of waste)
- Little's Formula: WIP = $\lambda \cdot CT$
  - λ = arrival rate (number of new cases per time unit)
  - CT = cycle time

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?
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?