MTAT.03.231
Business Process Management (BPM)
(for Masters of IT)

Lecture 4: Quantitative Process Analysis

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Business Process Analysis Techniques

• Qualitative analysis
  – Added-Value Analysis
  – Root-Cause Analysis
  – Issue Register

• Quantitative Analysis
  – Cycle Time Analysis
  – Capacity Analysis
  – Queuing Theory
  – Process Simulation
  – Markovian Analysis
Added-Value Analysis

- Idea: classify activities into value-adding and non-value adding
  - Crucial in identifying waste and inefficiencies in existing processes

<table>
<thead>
<tr>
<th>Activity</th>
<th>Value-Adding</th>
<th>Non-Value Adding</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Handoff</td>
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<tr>
<td></td>
<td></td>
<td>Delay</td>
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<tr>
<td></td>
<td></td>
<td>Rework</td>
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<tr>
<td></td>
<td>Business Value Adding</td>
<td>Control</td>
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<tr>
<td></td>
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<td>Policy compliance</td>
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</tbody>
</table>
Added-Value Analysis

• Customer value-adding activities
  – Essential in order to meet customer expectations
  – Activities the customer would be willing to pay for
  – Involves doing the right things right
    – Performing the right activities
    – Doing them correctly, with high efficiency

• Business value adding activities
  – Control activities
  – Do not directly add customer value but are essential to conducting business

• Non-value adding activities
  – Activities the customer is not willing to pay for
Added-Value Analysis

- Elimination of non-value adding activities is a key first step in redesigning business processes
  - Often achieved through task or activity consolidation
- Task and activity consolidation reduces
  - Hand-offs
  - Need for control activities
  - Process complexity
Added-value analysis of claims handling process

Request additional information

Pay

Notify agent

Give instructions

File claim

Local independent agent

Forward claim

Claims processing center

Request quote

Provide quote

Approved glass vendor

Pay

Client
Existing claims process

1. Client notifies a local agent that she wishes to file a claim. She is given a claims form and is told to obtain a cost estimate from a local glass vendor.

2. When the claims form is completed the local agent verifies the information and forwards the claim to a regional processing center.

3. The processing center logs the date and time of the claim’s arrival. The data is entered into a computer-based system (for record keeping only) by a clerk. The claim is then placed in a hard copy file and passed on to a claims representative.

4. a) If the claims representative is satisfied with the claim it is passed along to several others in the processing chain and eventually a check is issued and sent to the client.
   b) If there are problems with the claim the representative mails it back to the client for necessary corrections.

5. When the client receives the check she can go to the local glass vendor and replace the glass.
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 single 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 loops
Alternative Paths

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

- What is the average cycle time?
Processes with Parallel Activities

• 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.

\[ CT_{\text{parallel}} = \text{Max}\{T_1, T_2, \ldots, T_M\} \]
Parallel Paths – Example

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

\[ CT = \frac{T}{1-r} \]
Rework – Example

• What is the average cycle time?
Rework At Most Once – Example

- What is the average cycle time?
Cycle Time Efficiency

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

\[
\text{Cycle Time Efficiency} = \frac{\text{Theoretical Cycle Time}}{\text{CT}}
\]

• Theoretical Cycle Time = the cycle time which we would have if only value adding activities were performed
  – That is if the activity times, which include waiting times, are replaced by the processing times
Cycle time Reduction

- Cycle time analysis provides valuable information about process performance
  - Helps to quantify efficiency problems and bottlenecks
  - Useful for assessing the effect of design changes
- Ways of reducing cycle times through process redesign
  1. Eliminate activities
  2. Reduce waiting time
  3. Eliminate or reduce rework
  4. Perform activities in parallel
  5. Move processing time to activities not on the critical path
Consider a process with three sequences or paths.

Example – Critical Activity Reduction

- By moving 2 minutes of activity time from path 2 to path 1, the cycle time is reduced by 2 minutes to $CT=45$ minutes.

### Sequence (Path) vs. Time required (minutes)

<table>
<thead>
<tr>
<th>Sequence (Path)</th>
<th>Time required (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A → B → E</td>
<td>12 + 14 + 15 = 41</td>
</tr>
<tr>
<td>2. A → C → E</td>
<td>12 + 20 + 15 = 47 = $CT$</td>
</tr>
<tr>
<td>3. A → D → E</td>
<td>12 + 18 + 15 = 45</td>
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</tbody>
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Flow Analysis

• The previous technique for cycle time analysis is only one example of what can be done using “flow analysis” techniques.

• Other applications include:
  – Calculating cost per-process-instance (cf. Textbook)
  – 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 over time
  - Number of jobs that have entered the process but not yet left it
- A long lasting trend in manufacturing has been to lower WIP by reducing batch sizes
  - The JIT philosophy
- Little’s Formula: General relationship between the average WIP, the throughput ($\lambda$) and Cycle time (CT)

$$\text{Little’s Formula: } \text{WIP} = \lambda \cdot \text{CT}$$

- Implications, everything else equal
  - Shorter cycle time $\Leftrightarrow$ lower WIP
  - If $\lambda$ increases $\Rightarrow$ to keep WIP at current levels CT must be reduced
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 (continued)

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?