

MSBA 7004

Operations Analytics

Class 2-1: Process Flow Analysis (I)
Capacity Rate, Flow Time, Bottleneck
2023

Definition: Arrival Rate

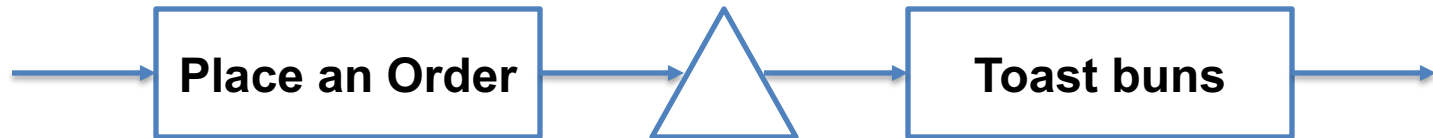
- Arrival Rate
 - The number of flow units (customers) that arrive in a unit of time
 - unit: # of customers/ unit time, e.g., 2 orders per hour
 - If *Arrival Rate* \geq Capacity,
then the process cannot handle all the jobs, and hence the manager needs to find ways to increase capacity
 - Primary reason we see queues (waiting)

Match supply and demand

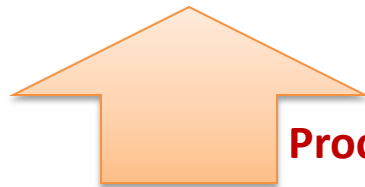
Bottleneck Characteristics

- The bottleneck is fully utilized while other resources are not utilized
 - Always working (100% of the available time)
- Shortening tasks of non-bottleneck resources decreases flow time but does not affect capacity rate
 - Reducing flow time improves response time

Processes may be *unbalanced*



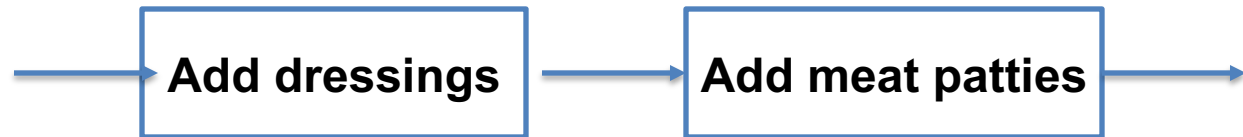
Flow Time	8 sec		10 sec
Capacity Rate	450/hour		360/hour



Process is "Blocked"

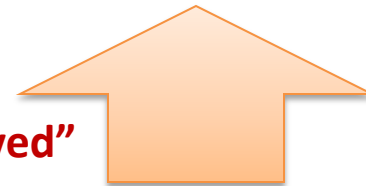
- When the next stage is busy, the order cannot be sent to the next stage after finishing the current stage, unless an inventory buffer is introduced

Another example



Flow Time	8 sec		6 sec
Capacity Rate	450/hour		600/hour

Process is "starved"



More Bottleneck Characteristics

- The bottleneck is fully utilized while other resources are not utilized
- Shortening tasks of non-bottleneck resources decreases flow time but does not affect capacity rate
 - Reducing flow time improves response time
- If a buffer is provided at some upstream stage to the bottleneck, inventory may build up at the buffer
- Inventory will not build up at the (immediately) downstream stages to the bottleneck even if buffers are provided

Summary of Bottleneck Characteristics

- Increasing capacity rate of bottleneck resource(s) increases process capacity rate only when the bottleneck is unique
 - With multiple bottlenecks (same capacity rate), we need to increase capacity rate for all of them to increase process capacity rate
- Two ways of increasing capacity rate of bottleneck resources:
 1. Increase number of bottlenecks' resources
 2. Reduce unit load of bottlenecks' task
- Reducing unit load on a non-bottleneck resource **reduces flow time** but does **not affect cycle time (or capacity rate)**

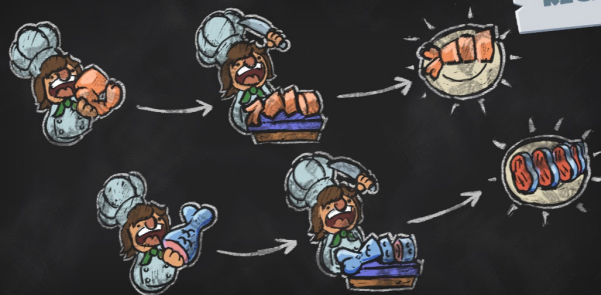
Process Analysis

- **Improving a process**
 - Throughput (Capacity)
 - Bottleneck Analysis
 - Levers for Improvement

- Flow Time (Responsiveness)
 - Critical Path Analysis
 - Improvement Levers

SASHIMI

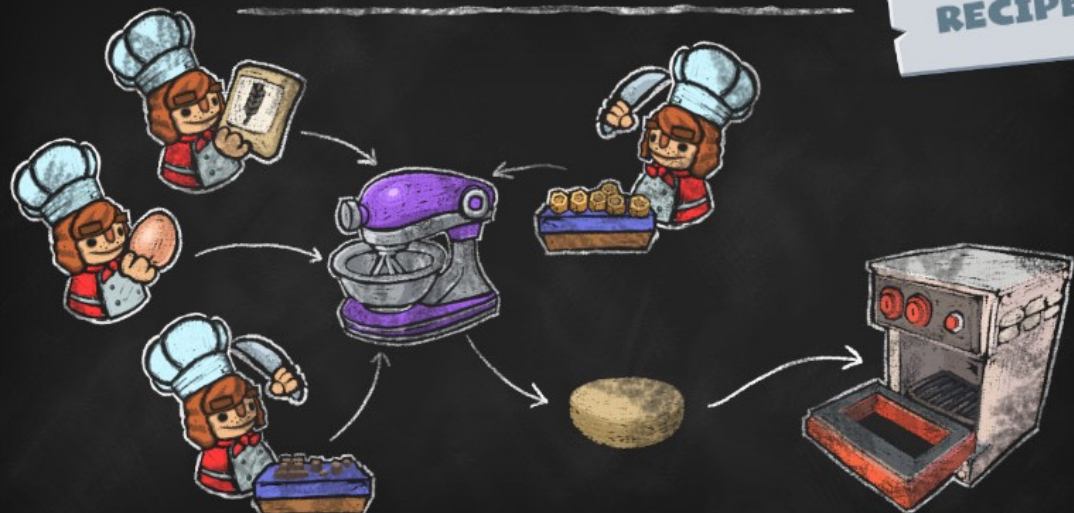
NEW
RECIPE



HOW TO MAKE SASHIMI!

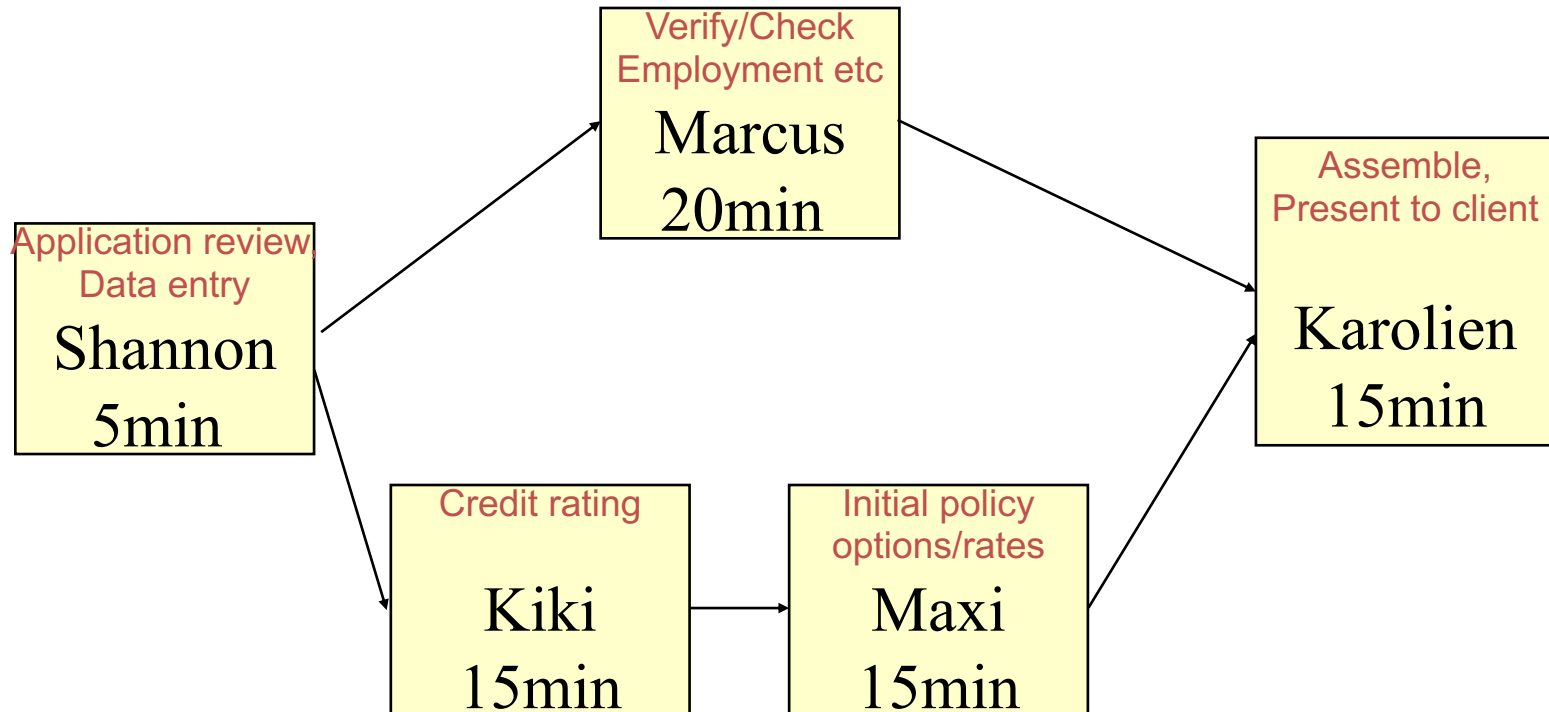
CAKE

NEW
RECIPE



MIX FLOUR AND EGG WITH CHOPPED HONEY, CARROT OR CHOCOLATE AND
BAKE THE LOT!

Analyzing Process Performance: Mortgage Application



- How to reduce flow time?

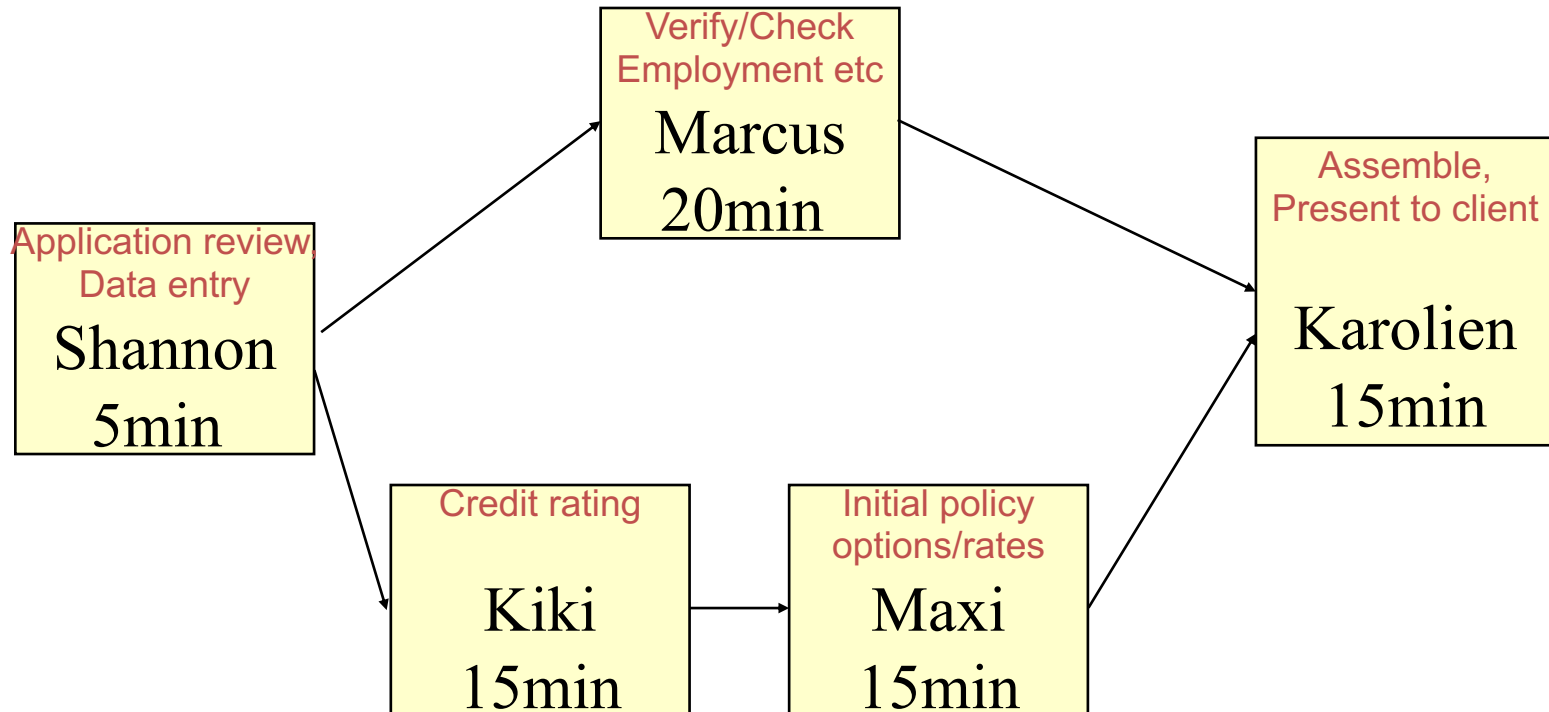
Improving Flow Time

- **Critical path:** The longest path in the process flowchart.
- **Critical activities:** Activities on a critical path.
- Flow time = Activity time + Waiting (buffer) time
- Theoretical flow time = Value-adding flow time (on the critical path)

Levers for Reducing Flow Time

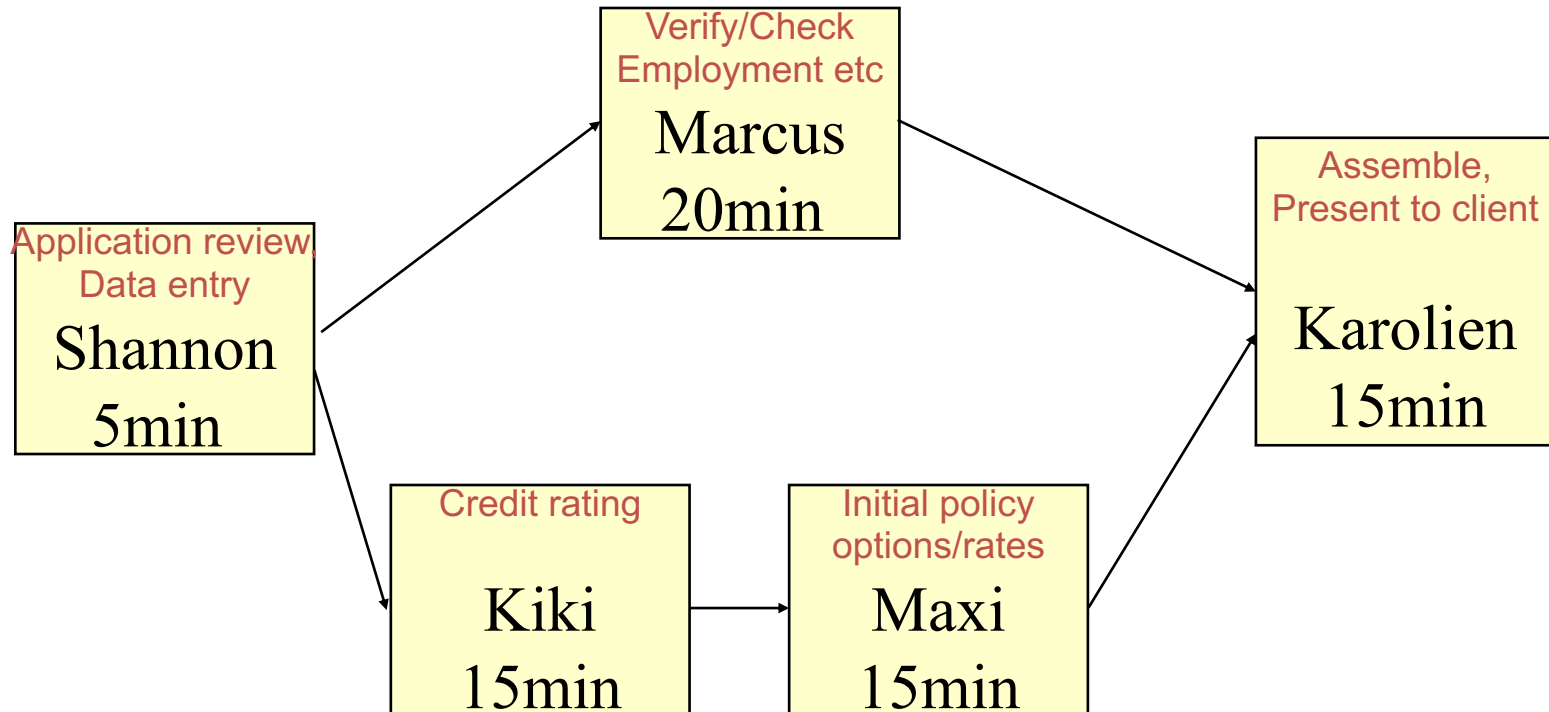
- Decrease the work content on the critical path (reducing activity time)
 - work faster (reduce flow time of critical activities)
 - move work content off the critical path
 - Rearrange the process
- Reduce waiting (buffer) time

Analyzing Process Performance: Mortgage Application



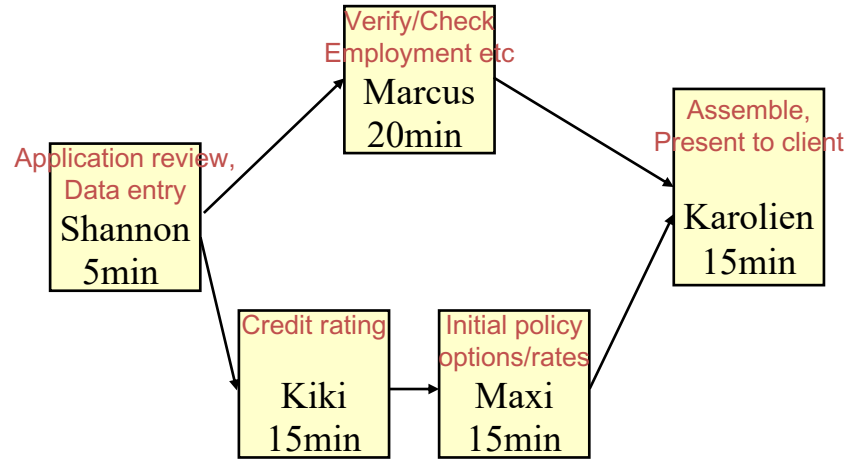
- How to reduce flow time?

Analyzing Process Performance: Mortgage Application



- How to increase capacity?

Mortgage Application



Resource	Unit Load (time/job)	Resource Capacity			Process Capacity
		Unit Capacity	# of units	Total Capacity	
Shannon	5min	12/hr	1	12/hr	3/hr
Marcus	20min	3/hr	1	3/hr	3/hr
Kiki	15min	4/hr	1	4/hr	3/hr
Maxi	15min	4/hr	1	4/hr	3/hr
Karolien	15min	4/hr	1	4/hr	3/hr

The bottleneck doesn't have to be on the critical path