Operations & Business Process Management

Prof. Apurva Jain

MSIS 503

Contents

Next

Where are we…(flow of the class)

What is the flow?: Flow-units, Resources, Activities,

What are the symptoms?: Cost, Time, Quality

Flow-units

How many flow-units?
-Forecasting
Ideas: Data-driven, Automate Expo. Smoothing, Simple software, Adjust for external vars., Error-tracking, Combine/Consensus

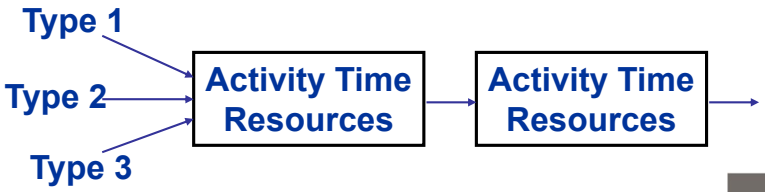
Resources & Activities

How many, where and what type of resources?
Ideas: locate bottleneck, add capacity, reallocate work or reassign resources, automate to cut service times and provide flexibility

How do we incorporate uncertainty?
Ideas: Measure & track variability, Use the Utilization-Wait graph to decide capacity, Mitigation ideas: incentive, information, standardization, automation.

What is the impact of a variety of flow units?

A variety of flow-units



How do we manage capacity in presence of a variety of flow-units?

Is this a good idea? →

ORACLE

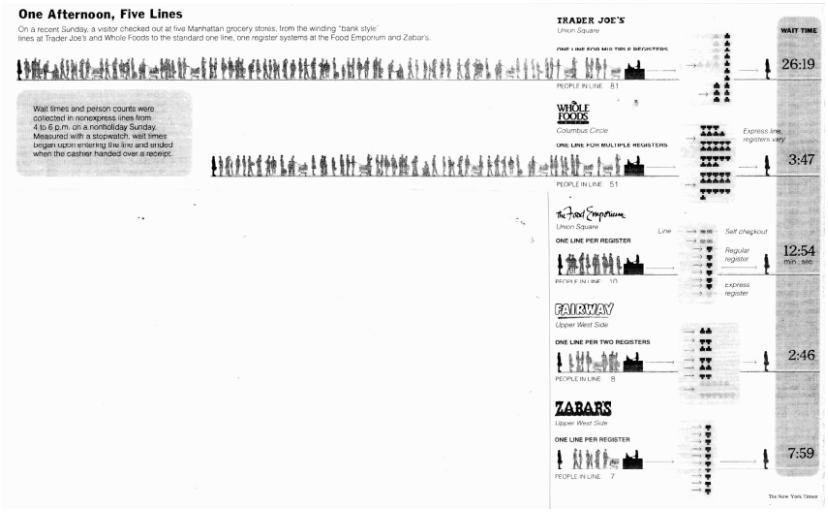
Oracle Fusion Cloud Service Global Price List
March 7, 2024
Software Investment Guide

	Monthly Subscription Price	Per Unit Price	Metric	Minimum	Part Number
Oracle Sales and Service Options					
Oracle Fusion Digital Customer Service Cloud Service		70.00	1000 Pooled Sessions	10	B96469
Cloud Priority Support for SaaS - Base Fee	1,250.00		Each	-	B86669

https://www.oracle.com/mx/a/ocom/docs/corporate/pricing/oracle-fusion-cloud-global-price-list.pdf

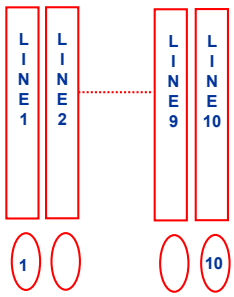
Pooling of Capacity

A long line for a shorter wait at the supermarket. ***NYT***



What conclusion can be drawn from data?

Pooling of Capacity: Benefits
A thought experiment



10 separate queues
For each queue:

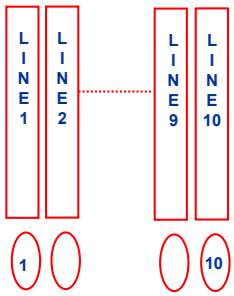
$arrival\ rate = 1 / \min,$

$service\ rate = 2 / \min,$

$resources = 1$

$\Rightarrow wait\ time = 0.5 \min$

Pooling of Capacity: Benefits
A thought experiment



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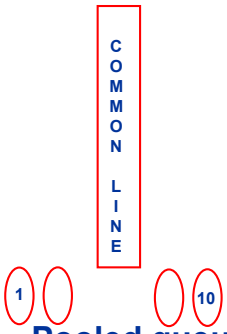


Pooled queue

$arrival\ rate = 10/\min,$

$service\ rate = 2/\min,$

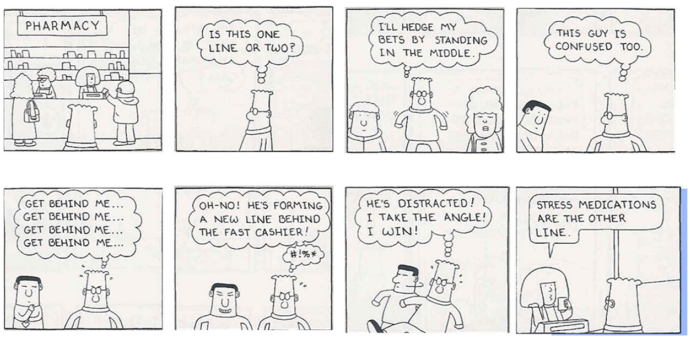
$resources = 10$

$\Rightarrow wait\ time =$ _____

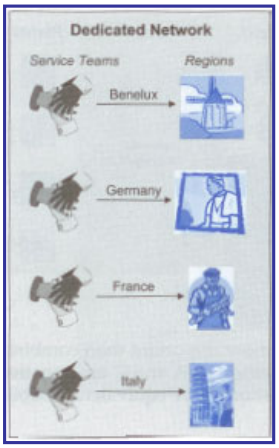
Sources of Pooling benefits are:

More effective resource utilization
Reduction in arrival variability

What are the costs of implementing pooling?

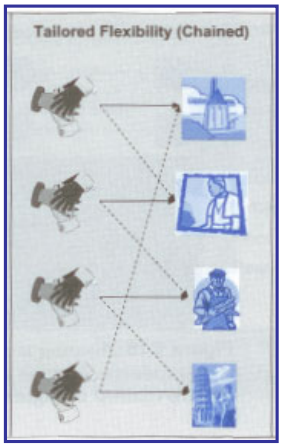


Pooling's cost: cross-functional training



No pooling has long waits.

Full pooling will reduce waits but requires multi-lingual operators (high cost).



"Some" pooling gets most of the benefit at low cost. This is called **Chained Pooling.**

Practice: Pool or not?

There is another branch of the firm that is double the size (twice the arrival rate, double resources). Should we pool?

Recall earlier question:

Enter Inputs here:		
	Arrival rate=	2.4
Capacity of one resource (service rate)=		3
	Number of resources=	1
	Utilization=	0.8
Coefficient of variation of arrivals Ca=		1
Coefficient of variation of service Cs=		1
Read Outputs here:		
	Waiting Time=	1.33333333
	Service Time=	0.33333333
	Total lead time=	1.66666667
	Number in waiting line=	3.2
	Number in system=	4

What if the need for cross-functional work across two branches increases average service time by 10% (or 12%)?

Practice: Pool or not? (continuing from earlier setup)

There is another branch of the firm that is double the size (twice the arrival rate, double resources). Should we pool?

Bigger branch current wait:
Change arrival rate to 4.8 and number of resources to 2.
Wait = 0.6030 hr
Average wait = (1/3)*1.3333 + (2/3)*(0.6030) = 0.8464 hr

After Pooling:
Change arrival rate to 7.2 and number of resources to 3.
Wait = 0.3694 hr → Pooling benefits avg. wait.

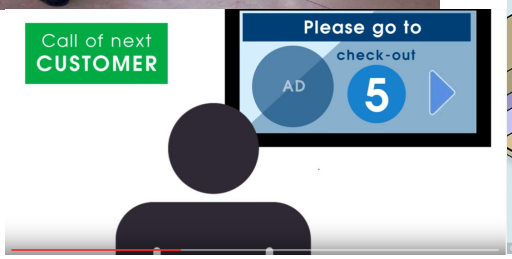
What if the need for cross-functional work across two branches increases average service time by 10% (or 12%)?

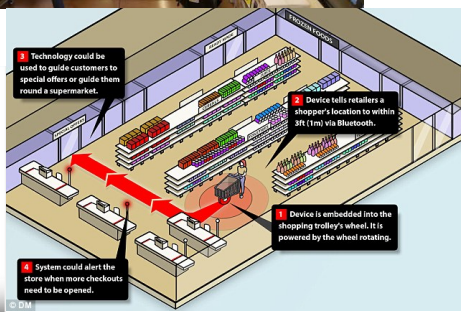
After Pooling:
Change arrival rate to 7.2 and number of resources to 3.
Change service time to 20*1.1=22 min; service rate = 60/22 per hr
Wait = 0.8062 hr → Pooling is good at 10% increase
OR 12% gives service time 22.4 min and wait 0.9789 hr
→ Pooling is not good at 12% increase

Key points and takeaways

- Capacity-Wait graph shows the impact of changing capacity on wait times and how this changes with variability. The exponential nature of the graph shows that little changes in capacity or variability can have huge impact on wait times.
- Given a target wait time, the graph and the spreadsheet model can be used to make capacity decisions.
- If a “cost of waiting” can be estimated, we can make capacity decisions by considering the trade-off between the cost of waiting and the cost of providing capacity.
- Pronto pizza problem provides an example of the above trade-off and a capacity decision in a setting with multiple stations.
- “Pooling” means that if there are different types of flow-units, a combined capacity can deliver smaller waiting times (grocery line).

Examples: Grocery line capacity management technologies





Operations & Business Process Management

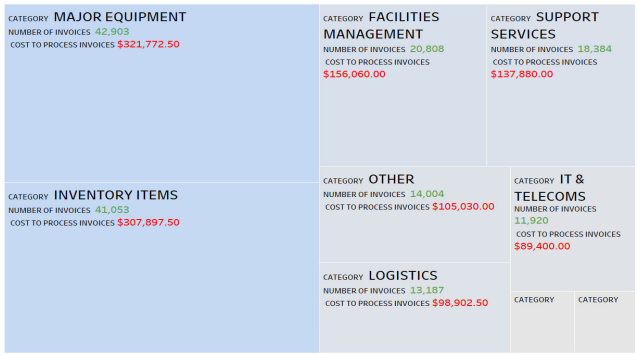
Prof. Apurva Jain
MSIS 503

Contents

Next

Too many invoices result in high administrative costs

280,405 invoices were issued in 2017 equivalent to $2.1M of procurement labor cost



Category, sum of Number of Records and sum of cost to process invoices. Color shows sum of Number of Records. Size shows sum of Number of Records. The marks are labeled by Category, sum of Number of Records and sum of cost to process invoices. The view is filtered on Category, which excludes Null and UNCLEAR.

Application: Baria

Why this case?

- A growing business sector

- Contemporary project-type business context

- An opportunity to show how our ideas are applicable in contexts beyond mfg., retail, etc.

Step-by-step approach for capacity decisions and improvements

Identify Flow
Balance Capacity
Mitigate Variability
Configure for Variety
Qualitative ideas + Quantitative evaluation

Baria: Identify Flow & Metrics

Interpret the flow

Flow-unit: Sales support requests, 4 sectors, 4 types
Four stations: data engineering, data analysis
proposal support (sector-specific), pricing
Arrival rate, service rates, number of resources are given
Ca and Cs can be estimated

Performance Measure: Time

Turnaround time
Do delays influence business?

Baria: Compute Turnaround Time

To compute turnaround time:

Focus on a busy quarter.

Start with a total combined unit count across sectors and types and use this to compute arrival rate at data engineering, data analysis and pricing.

Separate out total arrival rate into sector arrival rates at the proposal support station.

Service time of the combined unit at each station is the weighted average service time where weights reflect product-mix for that quarter.

Ca can be derived if data is available, Ca=1 is a very reasonable assumption.

To estimate Cs, we need a measure of the standard deviation of the combined unit.

Baria Capacity Decisions

Ideas for Improvements? Pros and Cons.

Baria Capacity Decisions

Cross-training can facilitate reallocation of resources to get closer to a Balanced flow. It can also allow for pooling resources across sectors. Can pooling work well in a real context?

Priority Policy

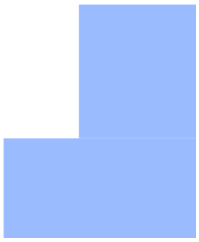
Baria should….

Practice FIFO (treat all types the same - First In First Out).

Prioritize NEWs over other types.

Prioritize RENEWALs over other types

I will explain my own plan.



Baria Priority Decision

In addition to sectors, flow-units are also different from each other based on their types: New Sale, Renewal, Expansion, Pilot. The resource capacity is already pooled on this dimension. An improvement idea may be to keep the capacity pooled but deliver differentiated service by prioritizing based in types. In order to decide which type gets priority, we should think about exactly how these types are different from each other.

New					
Renewal					

Key Points: Baria

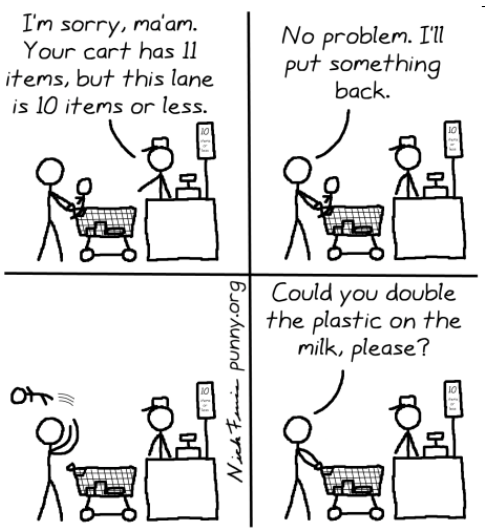
Identify flow:
Application of capacity analysis in a contemporary setting. Recognize predictable variability across quarters; unpredictable variability inside quarters.

Capacity decisions and improvements:
Bottleneck & Balance: Determine resources to add when and where.
Cross-train to makes it possible to shift resources and balance the flow.

Mitigate variability: Practice use of spreadsheet tool to estimate impact of capacity decisions on wait times. Pooling implementation issues.
Identify sources of variability and reduce.

Configure capacity for variety:
Rank flow-unit-types based on different factors and decide which one to prioritize.

A Moment of Reflection



How do you prioritize orders in your workflow?

Operations & Business Process Management

Prof. Apurva Jain
MSIS 503

Contents

Impact of variety on flow metrics

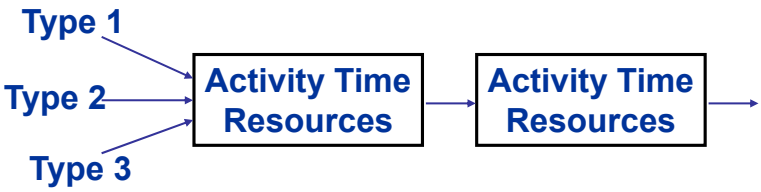
Variety → Variability, Slow on Learning Curve, Planning Complexity, Diseconomies of Scale → Higher Cost, Slower, Lower Quality

In other words,

Lower variety → Higher Volumes → Repetition → Cheaper, Better, Faster

But, variety is needed:
Customers want personalization
Resources dislike monotonous work

Variety: How are flow-units different?



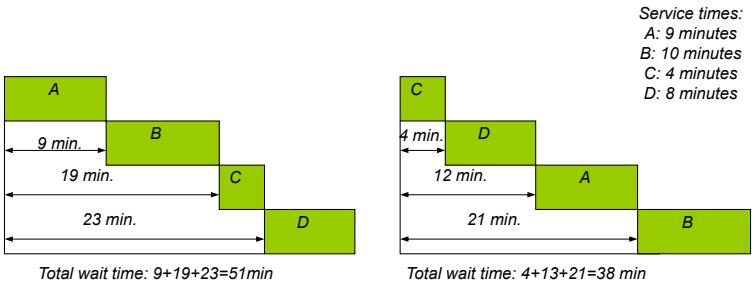
Different Waiting costs. Different revenue potentials. Different service times. Different service time variabilities. Different arrival variabilities.

How do we respond to variety in flow?

Demand Side Strategies	Supply Side Strategies
Admission Policies	Reduce Switching Costs
Pricing	Flexible Resources
Batching	Configure Capacity: Pool, Prioritize, Split

Simple priority rules

SPT: Shortest processing time first rule minimizes total wait.



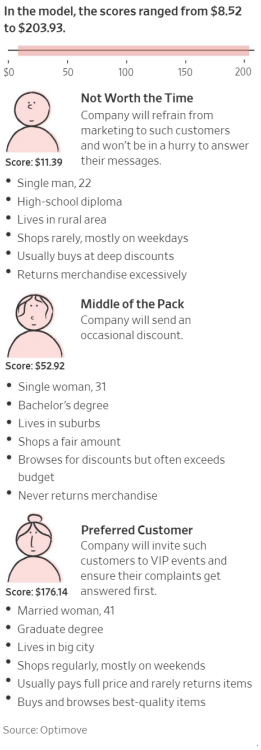
c-mu rule: Give priority to the class with the highest value of (cost of waiting divided by service time)

In dynamic priority, the class that gets priority can change over time.

On Hold for 45 Minutes? It Might Be Your Secret Customer Score.

Retailers, wireless carriers and others crunch data to determine what shoppers are worth for the long term—and how well to treat them

WSJ 11/1/2018

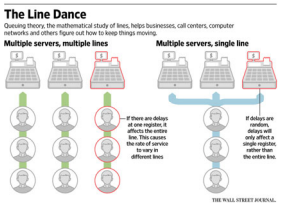


A simple framework for configuring capacity for variety

Differences in:
waiting costs, revenue potential, service times, arrival & service variabilities

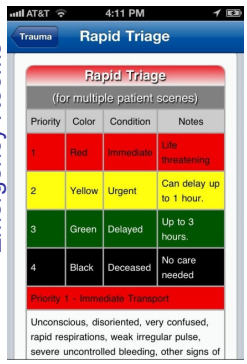
Similar Items → **Different Items**

Pool



Prioritize

Emergency Rooms



Split

Examples

SLATE News & Politics Culture Technology Business Human Interest Podcasts

THINKPIECES WERE THINKPOSTED

MONEYBOX

Online Ordering Is Ruining Lunch for the Rest of Us

BY HENRY GRABAR OCT 04, 2021 • 12:38 PM

Foolish and increasingly uncommon behavior. Greg Baker/Getty Images

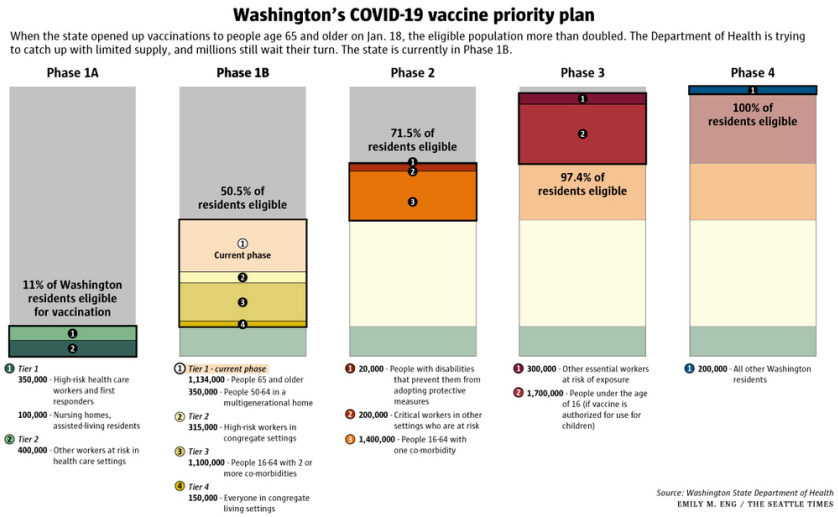
The road to lunch is splitting into two lanes, and one of them is moving faster than the other. At Shake Shack, for example, digital sales now represent 47 percent of all orders.

Ordering on the phone is even more popular at Chipotle. In the first quarter of this year, “digital orders” grew 133 percent over the prior three months and accounted for more than half of all sales at the chain. In the spring, even as COVID restrictions eased, the number of digital sales grew another 10.5 percent to nearly a billion dollars in digital burritos. That’s almost three times as many digital sales as the company did in the first quarter of 2020, before the pandemic.

Half the restaurant’s digital orders come from “order-ahead transactions,” many of which Most of those are placed less than 20 minutes in advance, Chipotle vice president of digital strategy and product Nicole West told me. Nearly all restaurants now have a second, hidden assembly line for digital orders, and Chipotle recently opened its first store, in Highland Falls, New York, that does not accept orders in person at all.

Examples

Examples



Key points & takeaways

Flow-units can differ from each other on two major dimensions:
Cost of waiting and Service burden

If flow-units are not very different from each other on the above dimensions, pooling with FCFS strategy is usually preferable over split capacity. There may be a one-time cost for cross-functional resource training but the benefits occur continuously.

If flow-units differ only on Service time dimension, SPT rule (shortest Processing or service time first) rule minimizes total wait.

If flow-units are also different on cost-of-waiting dimension, c-mu rule is shown to be effective.
c-mu rule: Give priority to the class with the highest value of
(cost of waiting divided by service time)

If flow-unit types differ significantly in above dimensions, a split-capacity strategy is practical.

In practice, cost-of-waiting may not be easy to measure. In addition, there may be other business differences between flow-units. Rank flow-units on each dimension and propose an overall ranking for determining which flow-unit gets priority.

Operations & Business Process Management

Prof. Apurva Jain

MSIS 503

Classifying flow-units based on their characteristics and prioritizing based on a simple index is effective in practice. If similar, pool and if too different, split the capacity.

Contents