

Creating Efficiencies in Last Mile Delivery through Workforce Management

Maciek Nowak

Associate Professor

Quinlan School of Business

Loyola University Chicago

Joint work with Karen Smilowitz, Northwestern University and Mike Hewitt, Loyola University



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What opportunities are there beyond reducing cost?

- Researchers are exploring customer service issues and how they relate to transportation cost
 - Time to rethink the models that we are using
- Introduce workforce management and its advantages
- Discuss new research looking to expand the customer service objectives
- Extend the planning horizon to achieve more efficiency
- Discuss general trends in workforce management

Workforce management

Key idea: Performance improves as drivers perform the same tasks multiple times (consistency)

Customer Familiarity

Reduce the cost per visit to a customer as the frequency of visits to that customer increases

If the customer set varies significantly by day, it may be advantageous to consider a more aggregate level

Region Familiarity

Reduce the cost per visit to a region as the frequency of visits to that region increases

Does workforce management matter and what does it cost?

“Many UPS drivers work the same route for 20 or 25 years. ...**UPS drivers form a real bond with customers**...A formal program that gathers sales leads from drivers generates volume of more than 60 million packages a year, largely because **drivers take tremendous ownership of their customers and routes.**

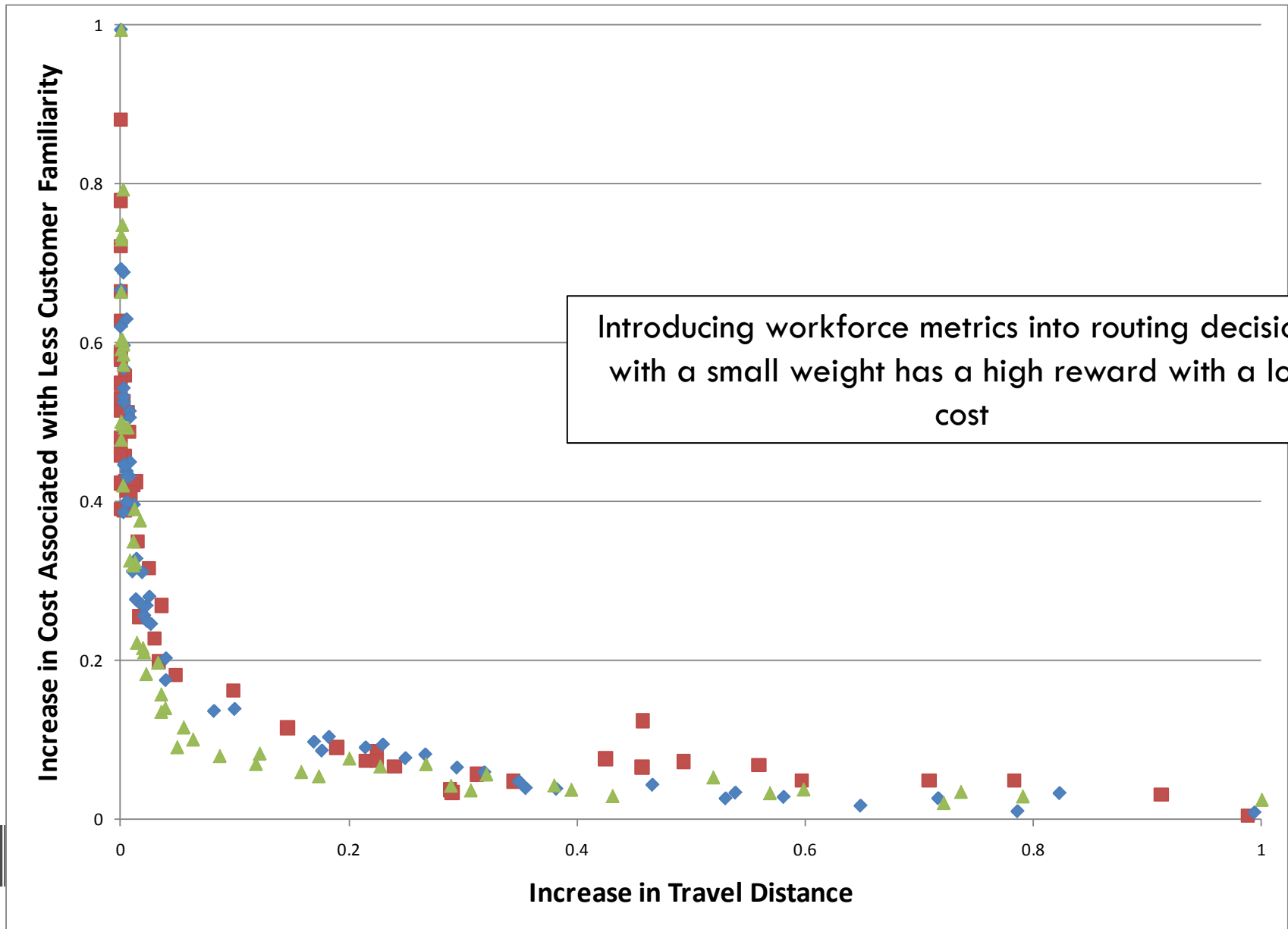
In contrast, a major competitor reserves the right to reconfigure some drivers' routes with five days' notice, meaning their customers, service area and earnings power can change quickly.”

- *UPS Corp. (2006)*

“While desirable to route the same drivers to the same customers each and every day, **that level of consistency can be inefficient.** As Hugh Gigante of *Appian* notes, “If we tell a customer that it costs them \$100 a day to keep the same drivers servicing the same customers, **most fleets will decide it isn't worth the cost.**”

- *Partyka and Hall (2010)*

Trade-off between customer familiarity and travel distance



Home health care delivery perspective

- Great benefit to patients and significant reduction in costs
- Considerable inefficiencies due to lack of funding and shortage of trained personnel
- Competing objectives make the problem interesting
 - Transportation cost/miles driven
 - Consistency: patient visited by same care provider at (roughly) same time of day - impacts quality of care
 - Work-load balancing: impacts care provider job satisfaction and retention
- There is no one home health care routing problem - different agencies are interested in optimizing different objectives

Continuity of care goals for schedules and routes

- A patient should be seen by the same nurse as often as possible
- A patient should always be seen at roughly the same time of day
 - Agencies quote patients a time window for each visit
 - We'll assume a fixed set of time windows we can assign to a patient (8 am - 9 am, 9 am - 10 am, etc.)
 - Our goal will be to always have a patient visited during the same time window
- **Consistency of time windows should increase both patient satisfaction and driver performance**

Instance from NY care provider

- 1414 patients spread over 45 zip codes
- Divided into five regions
- Days that service requested known a priori
 - From 1 to 5 days of service requested per week
- Several distributions tested

		Number of Days Service Requested				
		1	2	3	4	5
Percentage of customers	Instance					
	1	10	10	15	25	40
	2	0	0	35	55	10
	3	0	0	50	50	0
	4	0	0	40	40	20
5	0	0	45	45	10	

Achieving time consistency more difficult

Increase in consistency above minimum with 5% degradation in travel costs

<u>Customer distribution</u>	<u>Driver</u>	<u>Time Window</u>
0-0-50-50-0	0.1%	0.4%
0-0-35-55-10	0.4%	4.3%
0-0-40-40-20	0.5%	4.4%
0-0-45-45-10	1.2%	3.6%
10-10-15-25-40	0.0%	1.2%

Length of problem horizon may be too short

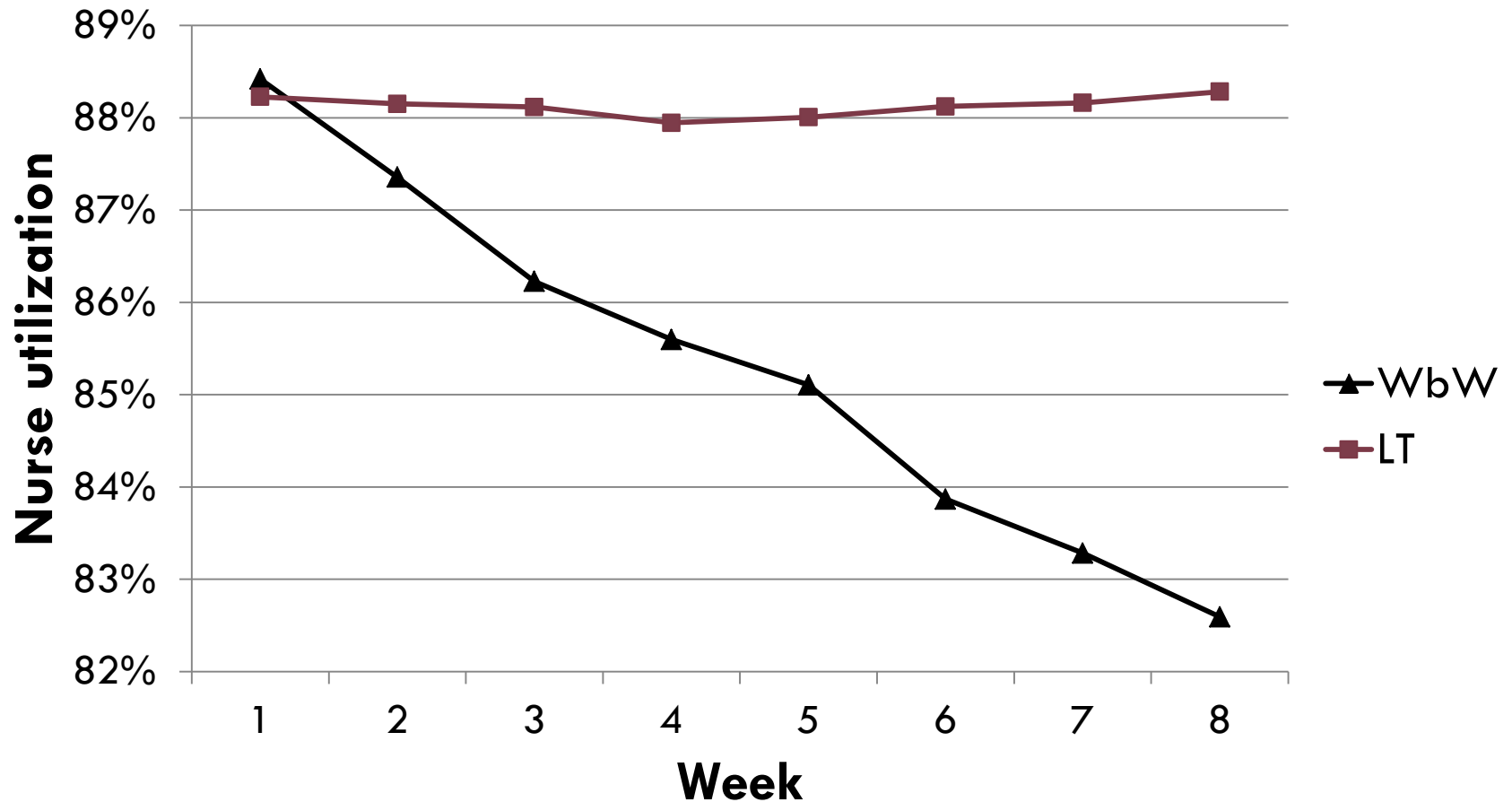
- Home health care relationships last considerably longer than one week
- Most providers only plan week-by-week, or even simply daily
- What happens when planning horizon extended to two to three months?
- Stochastic model designed so that data can be easily collected and applied
 - Simple predictions on number of expected customers
- **Extending planning horizon can help with staffing and reducing operational costs**

Problem instances

- Urban has patients dispersed over 5 mile radius, Rural-15 miles
- Patient visit requires one hour
- 200 patients with 70% likelihood that patient requests service on a day
- Number of patients requesting service is not constant each week

Instance	Begin/End	Geographic setting	Horizon
35U8	35	Urban	8 weeks
70U8	70	Urban	8 weeks
35R8	35	Rural	8 weeks
70R8	70	Rural	8 weeks
55U12	55	Urban	12 weeks
110U12	110	Urban	12 weeks
55R12	55	Rural	12 weeks
110R12	110	Rural	12 weeks

Nurse utilization remains constant with Long Term planning



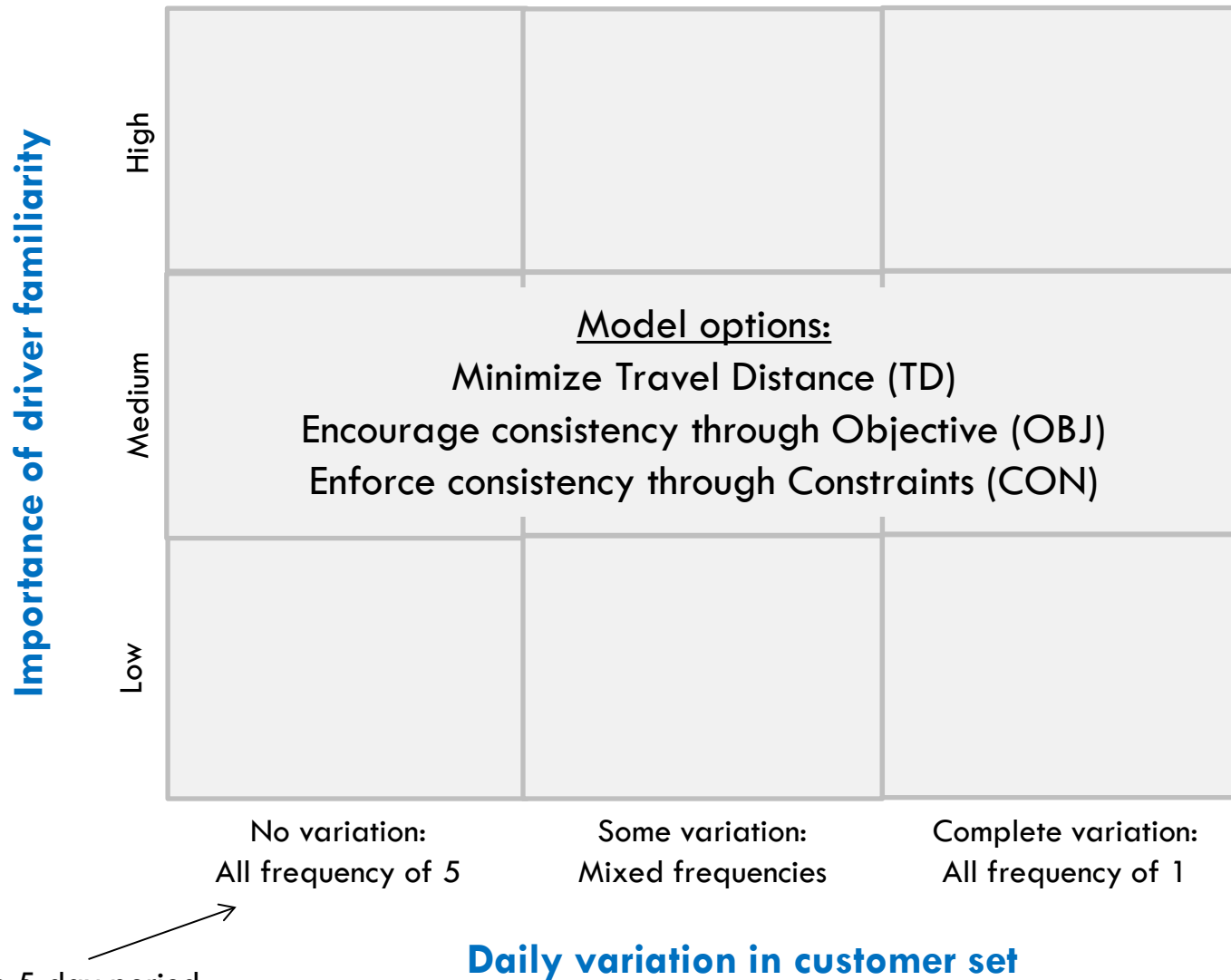
Number of nurses decreases

Instance	Week-by-Week		Long Term	
	Average	Standard deviation	Average	Standard deviation
35U8	31.0	2.8	26.5	1.6
70U8	39.6	6.7	33.0	2.8
35R8	36.8	2.8	28.9	3.2
70R8	46.6	6.5	34.3	5.1
55U12	36.1	3.8	28.2	1.8
110U12	50.4	9.1	40.1	3.5
55R12	41.1	4.7	32.0	4.2
110R12	54.8	8.8	40.5	5.7
Average	42.1	5.7	32.9	3.5

Travel time reduction over week-by-week model

Instance	Travel Time (Hours)	
	Week-by-Week	Long Term
35U8	669	611
70U8	848	800
35R8	1367	1190
70R8	1881	1602
55U12	1115	1051
110U12	1693	1577
55R12	2384	2166
110R12	2955	2695
Average	1614	1461

Matching models with industry

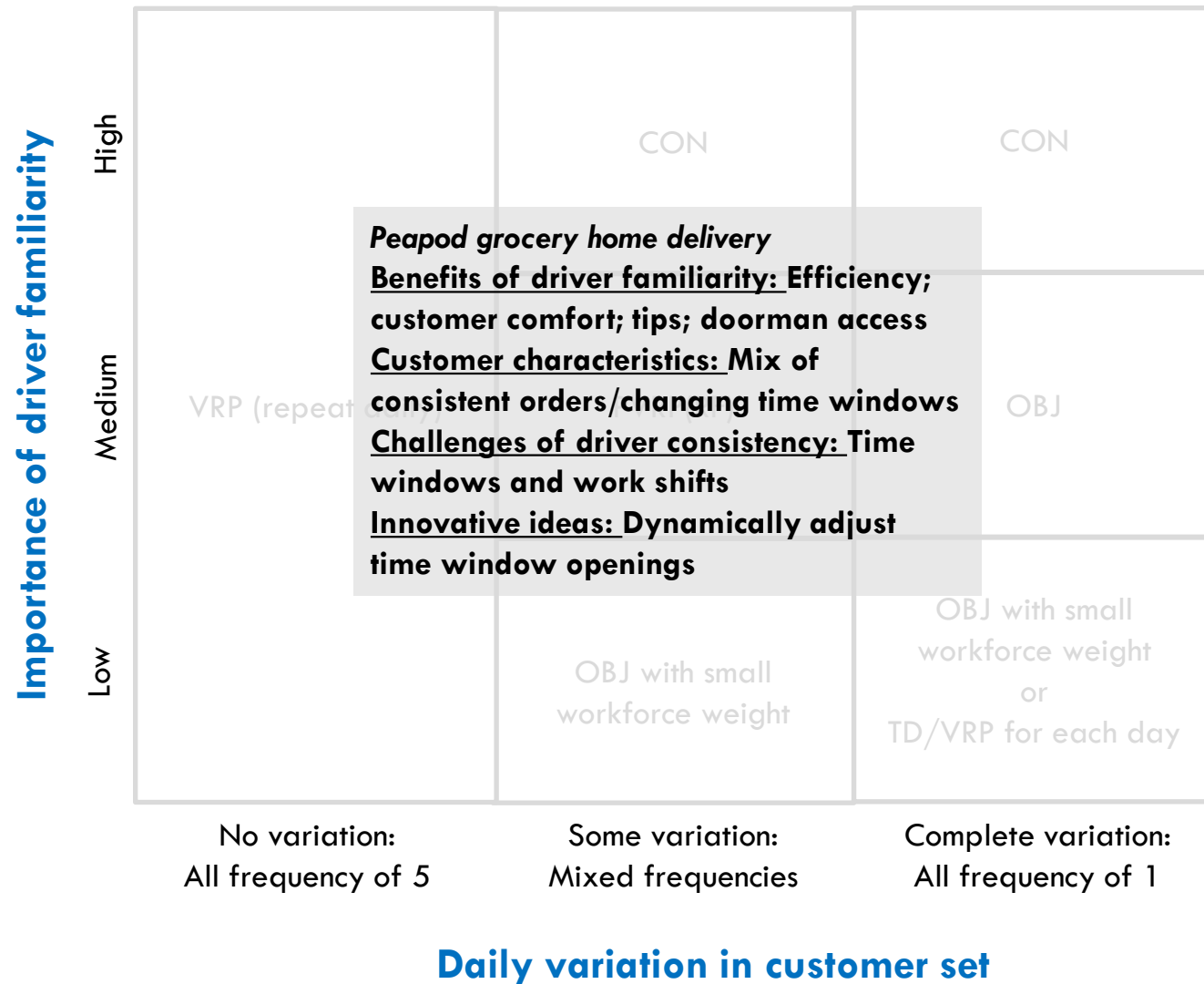


Matching models with industry

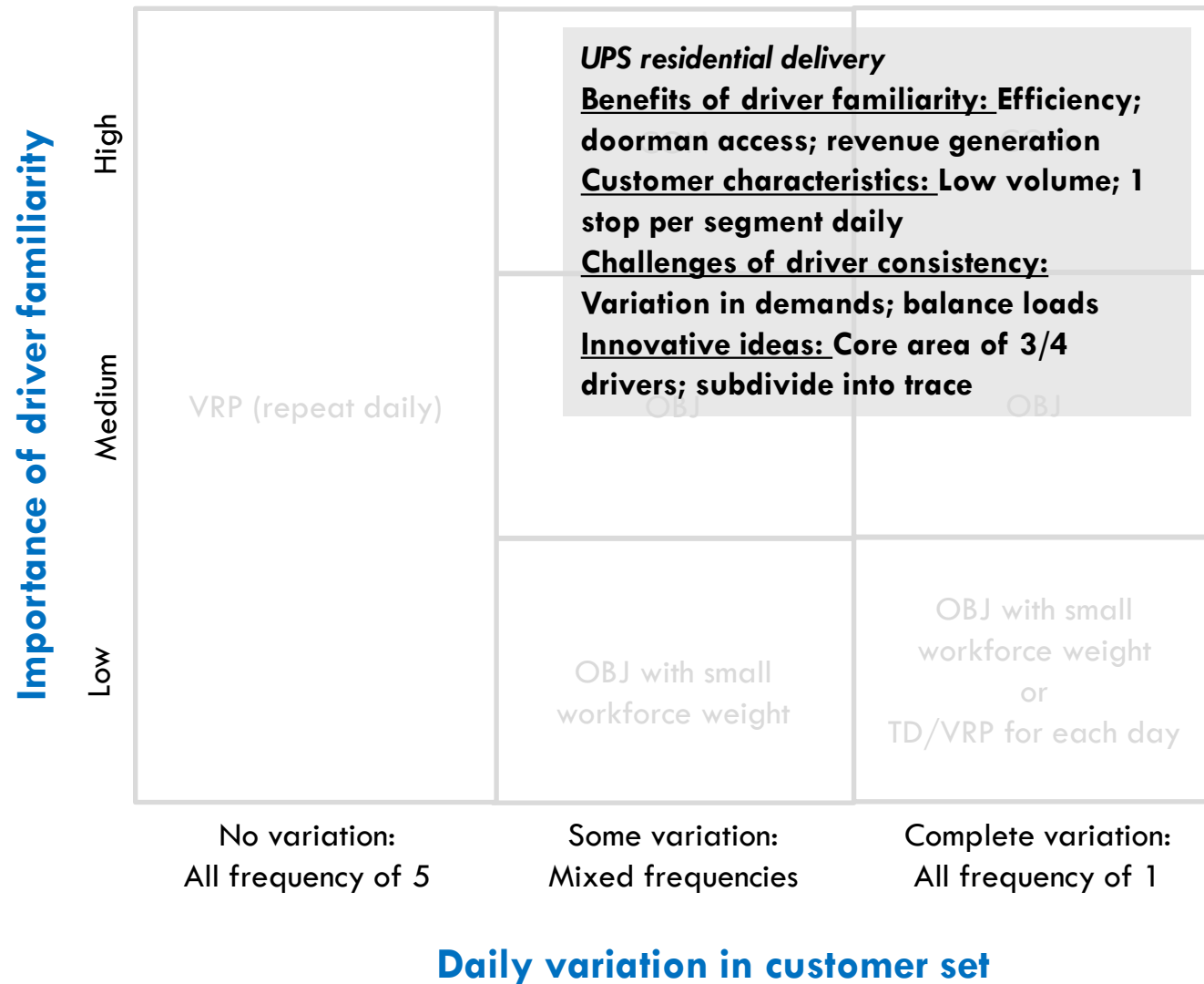
Importance of driver familiarity	High	CON	CON	
	Medium	OBJ	OBJ	
	Low	OBJ with small workforce weight	OBJ with small workforce weight or TD/VRP for each day	
		No variation: All frequency of 5	Some variation: Mixed frequencies	Complete variation: All frequency of 1

Daily variation in customer set

Matching models with industry: practitioner findings



Matching models with industry: practitioner findings



Matching software with models

Importance of driver familiarity

High		<p><u>Model:</u> Fixed territory PVRP</p> <p><u>Objective:</u> Min travel cost</p>	<p><u>Model:</u> Fixed territory PVRP (if region matters)</p> <p><u>Objective:</u> Min travel cost</p>
Medium	<p><u>Model:</u> VRP (repeat daily)</p> <p><u>Objective:</u> Min travel cost</p>	<p><u>Model:</u> PVRP</p> <p><u>Objective:</u> Min travel cost + workforce cost</p>	<p><u>Model:</u> PVRP (if region matters)</p> <p><u>Objective:</u> Min travel cost + workforce cost</p>
Low		<p><u>Model:</u> PVRP</p> <p><u>Objective:</u> Min travel cost (+ small workforce cost)</p>	<p><u>Model:</u> VRP (repeat daily)</p> <p><u>Objective:</u> Min travel cost</p>
	No variation: All frequency of 5	Some variation: Mixed frequencies	Complete variation: All frequency of 1

Daily variation in customer set

What are companies doing to shift within the grid?

Work around software - Peapod

Change software - UPS

Questions?