Supply Chain Analysis

Cheetah Running Shoes

Raymond A. Mason School of Business
WILLIAM & MARY

Kaitan Sun

Lindsay Carr

Craig Sorochuk

Jake Smith

Zoe Bai

Agenda

- **Case Overview**
- **Model**
- **Analysis & Results**
  - Q1: Does CRS have the right number of DCs in the best locations?
  - Q2: Does it ever make sense to use Next Day Air?
  - Q3: What is the tradeoff between customer service and cost?
  - Q4: Other Insights
- **Executive Summary**

Overview

Case Overview

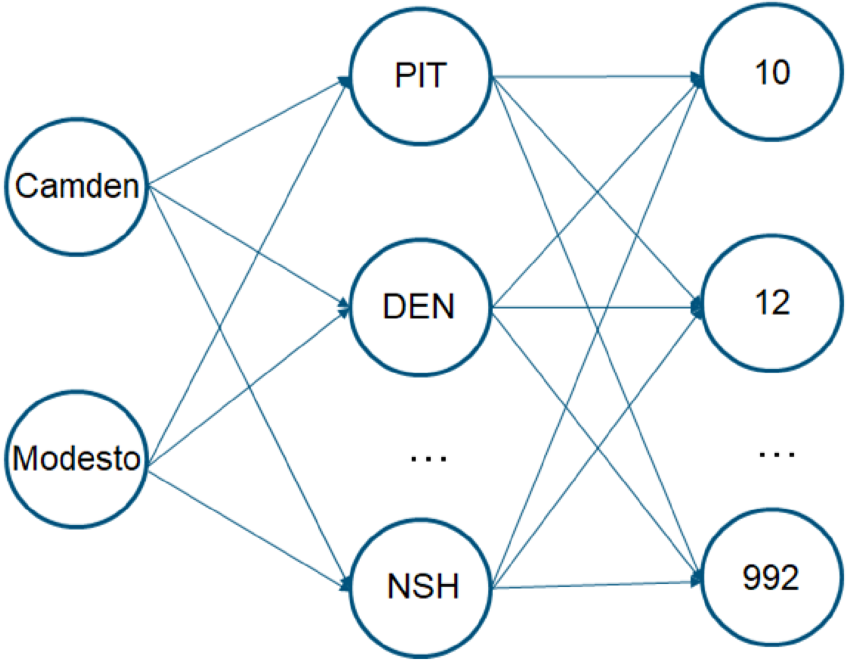
Current: 2 Plants, 2 Distribution Centers

15 Distribution Center Candidates

2 Plants

15 Distribution Centers

505 Customer Zones



Model

Optimization Model

Objective Function:

- Total Cost (inbound cost + handling cost + outbound cost)

Decision Variables:

- Plant → Distribution Center
- Distribution Center → Customer zone
- Distribution centers used

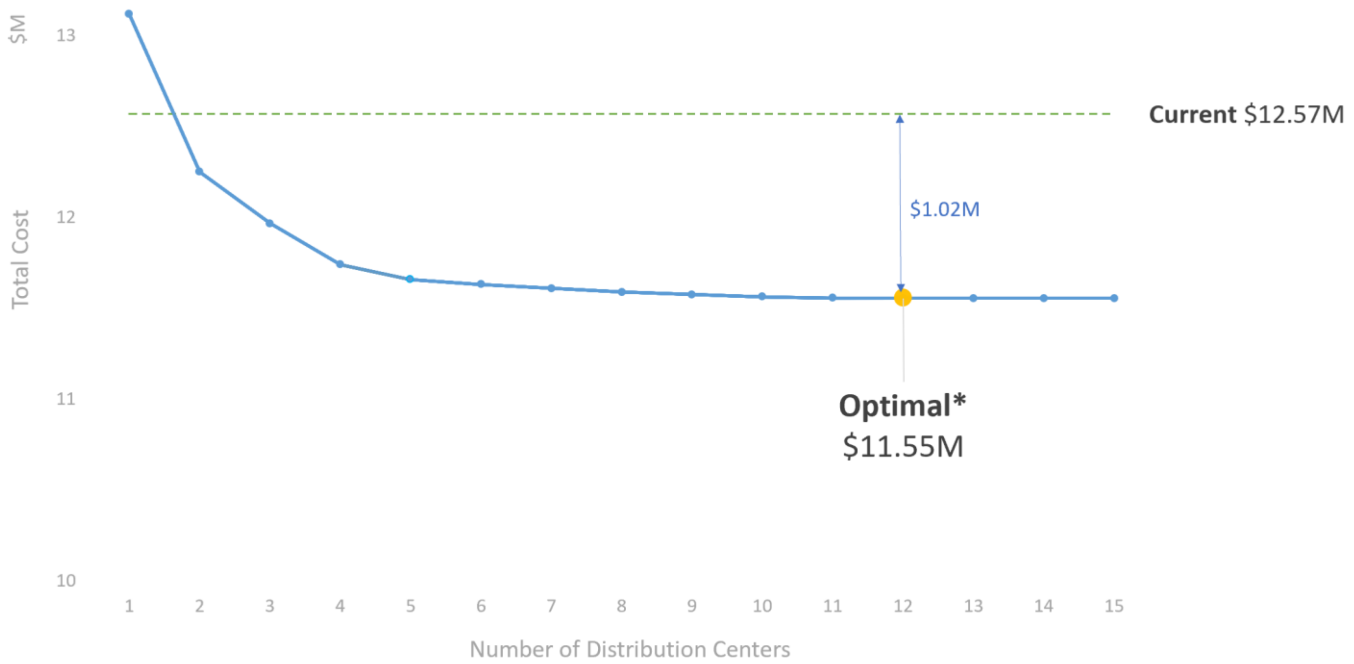
Special Constraints:

- Number of Distribution Centers (1 to 15)
- Customer Demand Satisfied
- Distribution Center inbound/outbound balance
- Plant capacity

Analysis & Results

Q1:
Does CRS have the right number of distribution centers and are they in the best locations?

Total Annual Cost



Distribution Center Selection

DCs \ # of DCs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Annual Cost Reduction (If Adding this DC)
Indianapolis																
Denver																$ 867,351
Dallas																$ 283,767
Greenville																$ 227,113
Pittsburgh																$ 82,247
Charleston																$ 26,489
Chicago																$ 22,834
Memphis																$ 19,549
Atlanta																$ 13,493
Charlotte																$ 11,718
Nashville																$ 6,920
Knoxville																$ 1,304
Chattanooga																$ -
Cincinnati																$ -
Louisville																$ -

Optimal 2-Distribution Center Solution

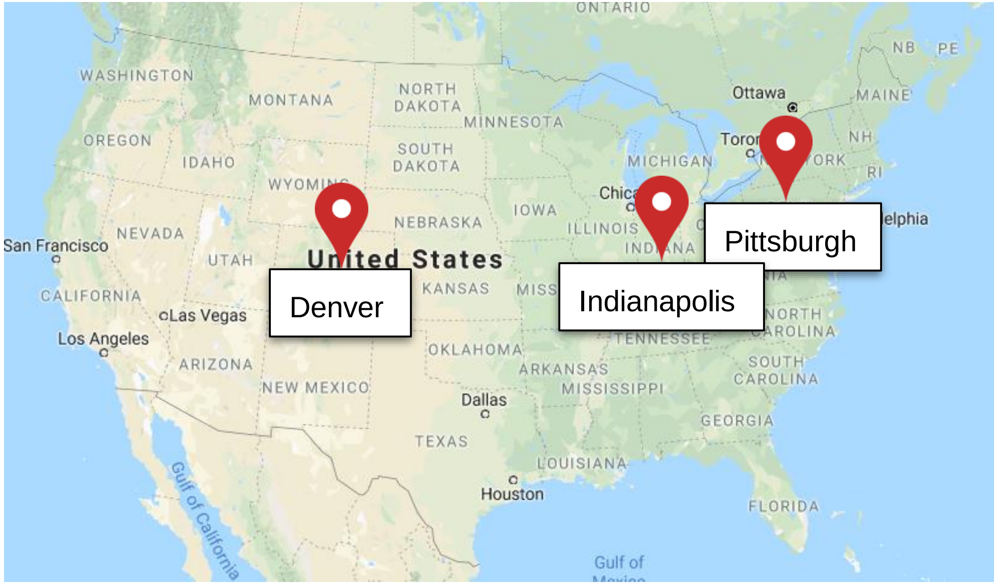
Current:

Denver & Pittsburgh

save $320,000

Optimal:

Denver & Indianapolis



Q2:
Does it ever make sense to use Next Day Air?

Air Delivery

Planned

- Revenue
  Set higher price for one-day delivery
- Responsiveness & Flexibility
  Supply customers quickly

Unplanned

- Unexpected delays on ground
  To meet customers' delivery expectation

Q3:
What is the tradeoff between customer service and cost?

Unplanned Air Delivery

- Every day of a planned ground transportation trip, there is a probability of delay **(5%)**
- We assume lost time on one day cannot be made up on a subsequent day (independence)
- The probability of unplanned air delivery:
    - 1-day trip: **5.0%**
    - 2-day trip: **9.8%**
    - 3-day trip: **14.3%**
    - 4-day trip: **18.5%**
    - 5-day trip: **22.6%**

Objective Function

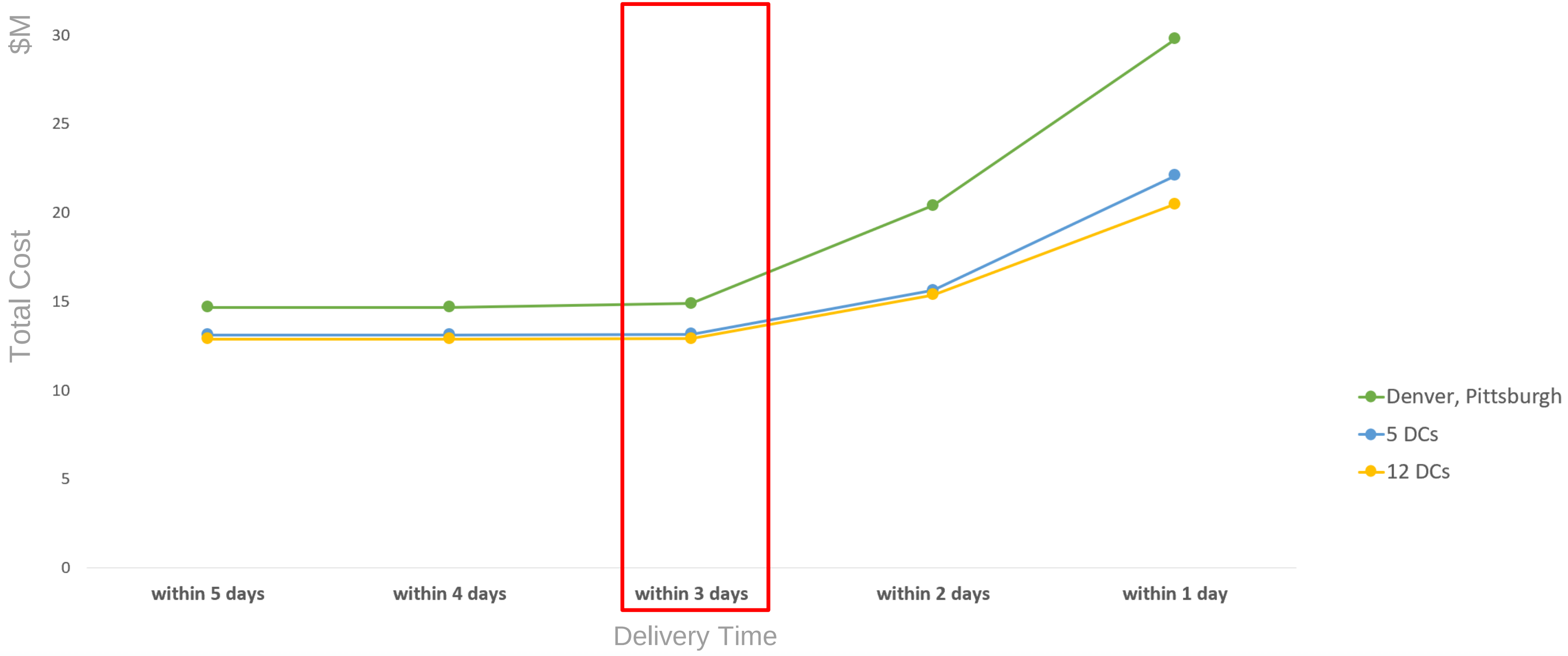
$$C_{Total} = \sum_{i}\sum_{j} d_{i,j}D_{i,j} + \sum_{j} e_j E_j + \sum_{j}\sum_{k} f_{j,k}F_{j,k}$$

$$E[C_{Total}] = \sum_{i}\sum_{j} d_{i,j}D_{i,j} + \sum_{j} e_j E_j + \overbrace{\sum_{j}\sum_{k}(1-\alpha_{j,k})f_{j,k}F_{j,k} + \sum_{j}\sum_{k} \alpha_{j,k}g_{j,k}F_{j,k}}$$

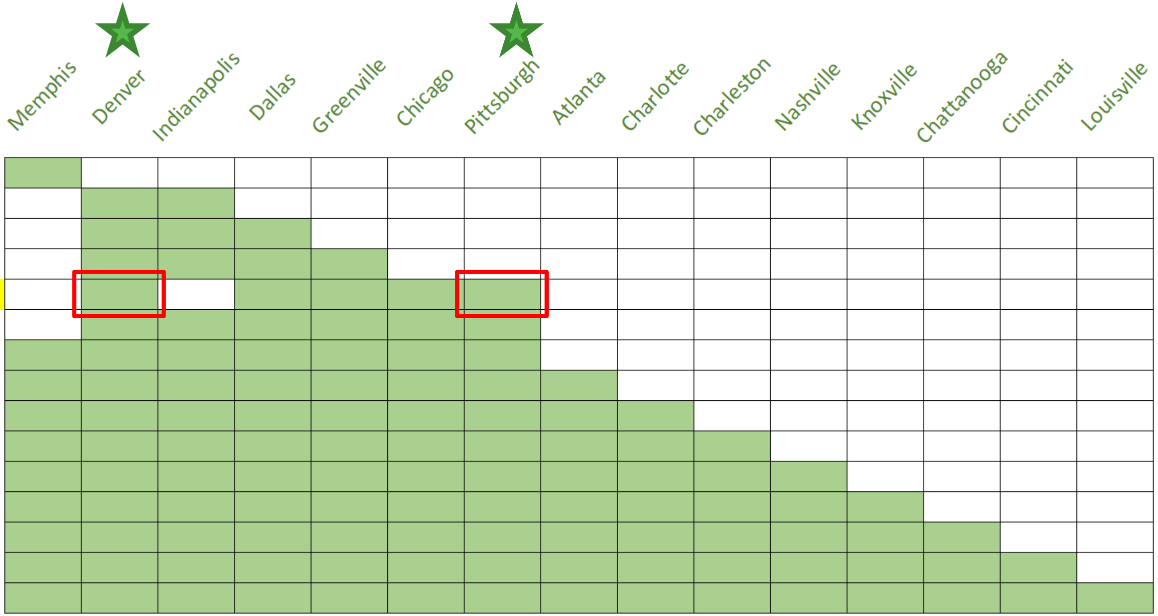
$$\alpha_{j,k} = \begin{cases} 1 & , days_{j,k} > days_{max} \\ 1 - 0.95^{days_{j,k}} & , days_{j,k} \leq days_{max} \end{cases}$$

$g_{j,k}$ = unit cost of air shipping from *j* to *k*

Expected Total Cost of Delivery Guarantees

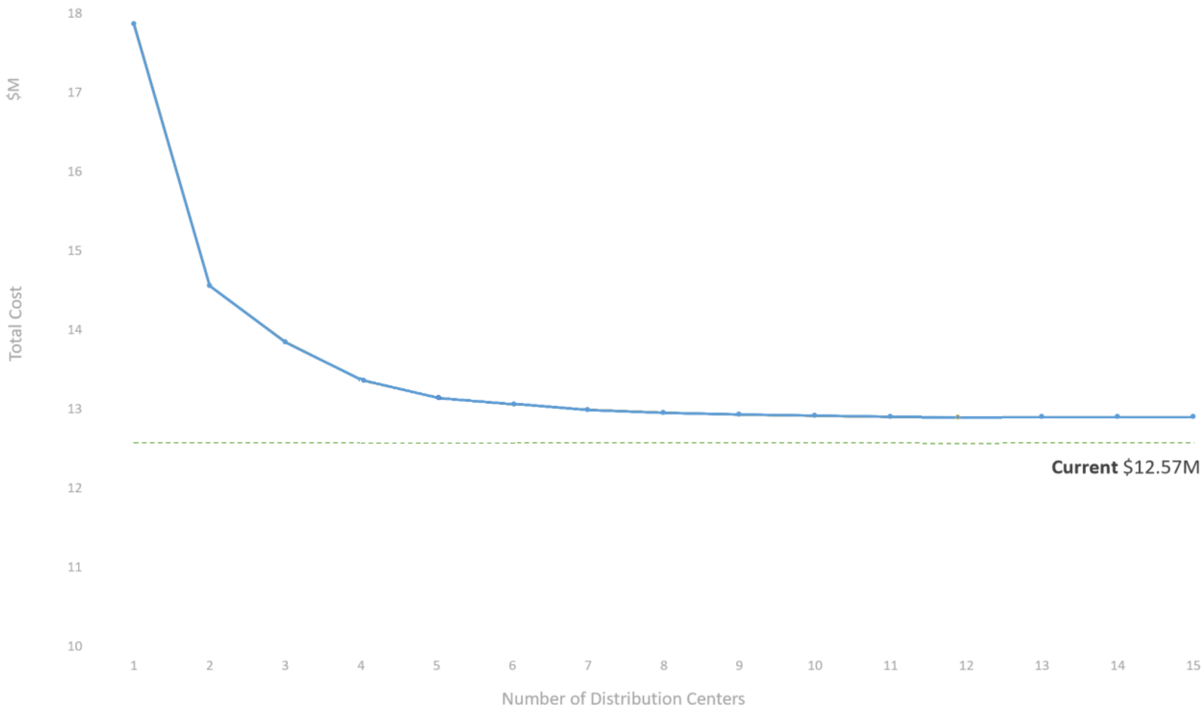


Customer Service and Cost Tradeoff



	Additional cost for "on time"guarantee $M	Guarantee cost / total cost with no air %
1 DC	4.74	36%
2 DCs	2.30	19%
3 DCs	1.88	16%
4 DCs	1.63	14%
5 DCs	1.49	13%
6 DCs	1.43	12%
7 DCs	1.38	12%
8 DCs	1.36	12%
9 DCs	1.35	12%
10 DCs	1.35	12%
11 DCs	1.34	12%
12 DCs	1.34	12%
13 DCs	1.34	12%
14 DCs	1.34	12%
15 DCs	1.34	12%

Customer Service and Cost Tradeoff



Other Insights

Other Insights

- Capacity > Demand
  - Capacity: **18.0M** pounds/year
  - Demand: **17.1M** pounds/year

- Unit Logistics Cost ($/pound)

	Denver & Pittsburgh	Recommended (5 DCs)	Optimal* (12 DCs)
Only ground	0.74	0.684	0.678
3-day “on time” guarantee (ground & air)	0.87	0.77	0.76

↑ 5%

Other Insights

- Position of plants and Distribution Centers

Executive Summary

Executive Summary

Q1: For DC candidates:

- Optimal number: 12
- Optimal 2: Denver & Indianapolis

Q2: Air transportation is used for planned and unplanned circumstances

Q3: For customer service: +$0.58M (5%)

- Delivery within 3 days
- With “on-time” guarantee
- From 5 DCs: Denver, Dallas, Greenville, Chicago, Pittsburgh

Q4: Other insights:

- An extra capacity of 0.9M pounds/year
- Strange DC & plant distribution