Logistics Final Project

Amanda Johnson, Milwinda Castillo, & Nick Morris

Approach

Strategic Plan → Already defined by the company (Qty and size of boats and ports).

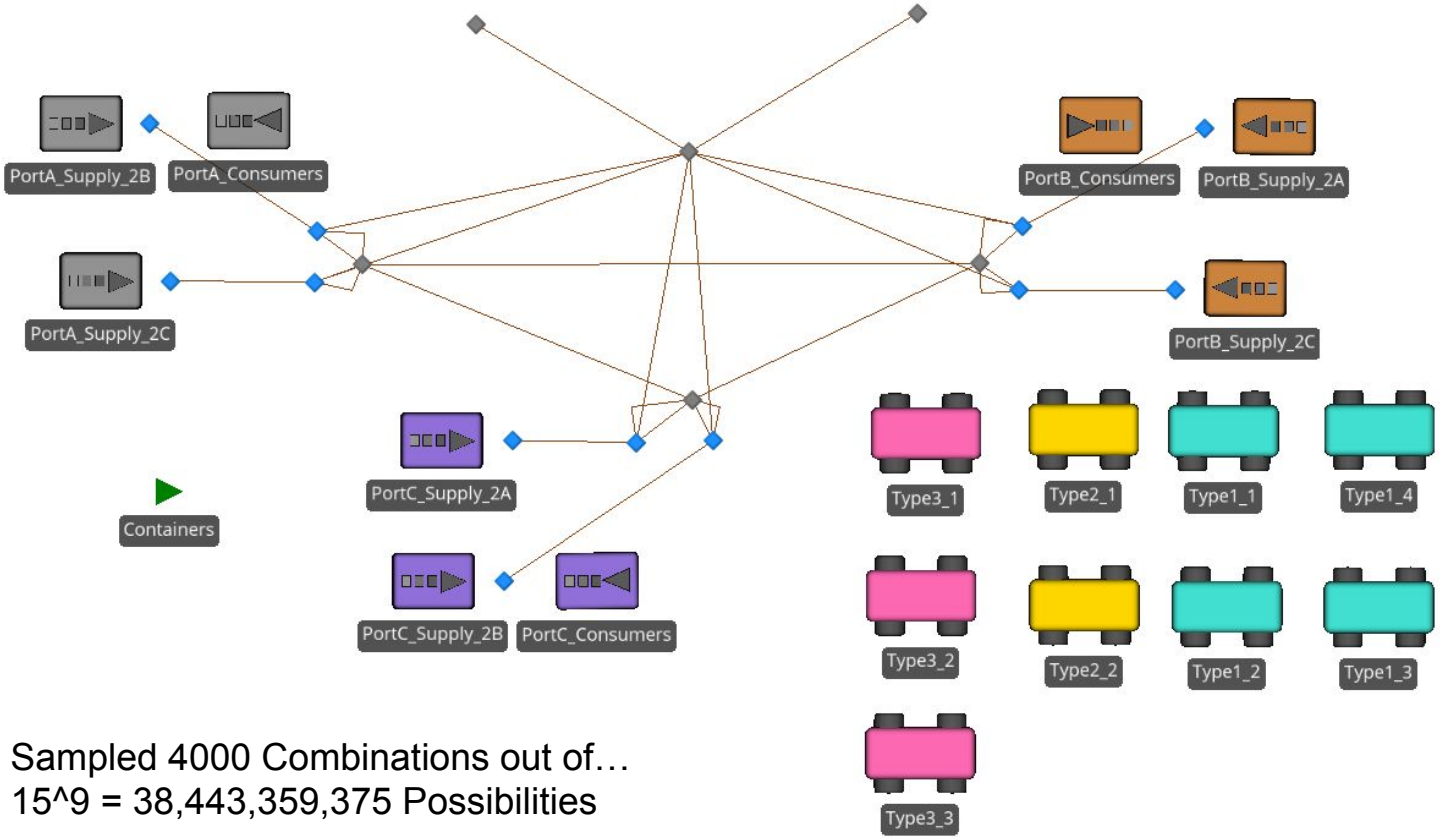
Tactical Plan → Boat assignment and routing.

Decision made to satisfy the aggregated demand in 6 month period
Method used: Simulation

Operational Plan → Full and empty containers planning (Ship, Buy, Lease, Sell)

Decision made in daily, weekly, monthly basis.
Method used: A Cost-Benefit Balancing Approach

Plan: Boats - Simulation



Sampled 4000 Combinations out of…
15^9 = 38,443,359,375 Possibilities

The 15 Routes

A → B
A → C
A → B → C
A → C → B
A → B → A → C

B → A
B → C
B → A → C
B → C → A
B → C → B → A

C → A
C → B
C → A → B
C → B → A
C → A → C → B

Plan: Boats - Routes

	boat 1	boat 2	boat 3	boat 4	boat 5	boat 6	boat 7	boat 8	boat 9
Route:	C_A	B_A	C_A	C_A	C_B	C_B	A_B	C_B	A_B
Depart:	-5	-3	-4	-4	-7	-7	-3	-7	-1
Capacity:	500	500	500	500	1200	1200	750	750	750

The majority of the routes include Port C.
This is due to...

Port	Demand
Port A:	6116
Port B:	7977
Port C:	17955

Plan: Containers

Methodology (Decision making process):

Steps

1. **Identify the consumer, producer and balanced ports.**
   AB → Balanced AC → Producer/Consumer BC → Producer Consumer

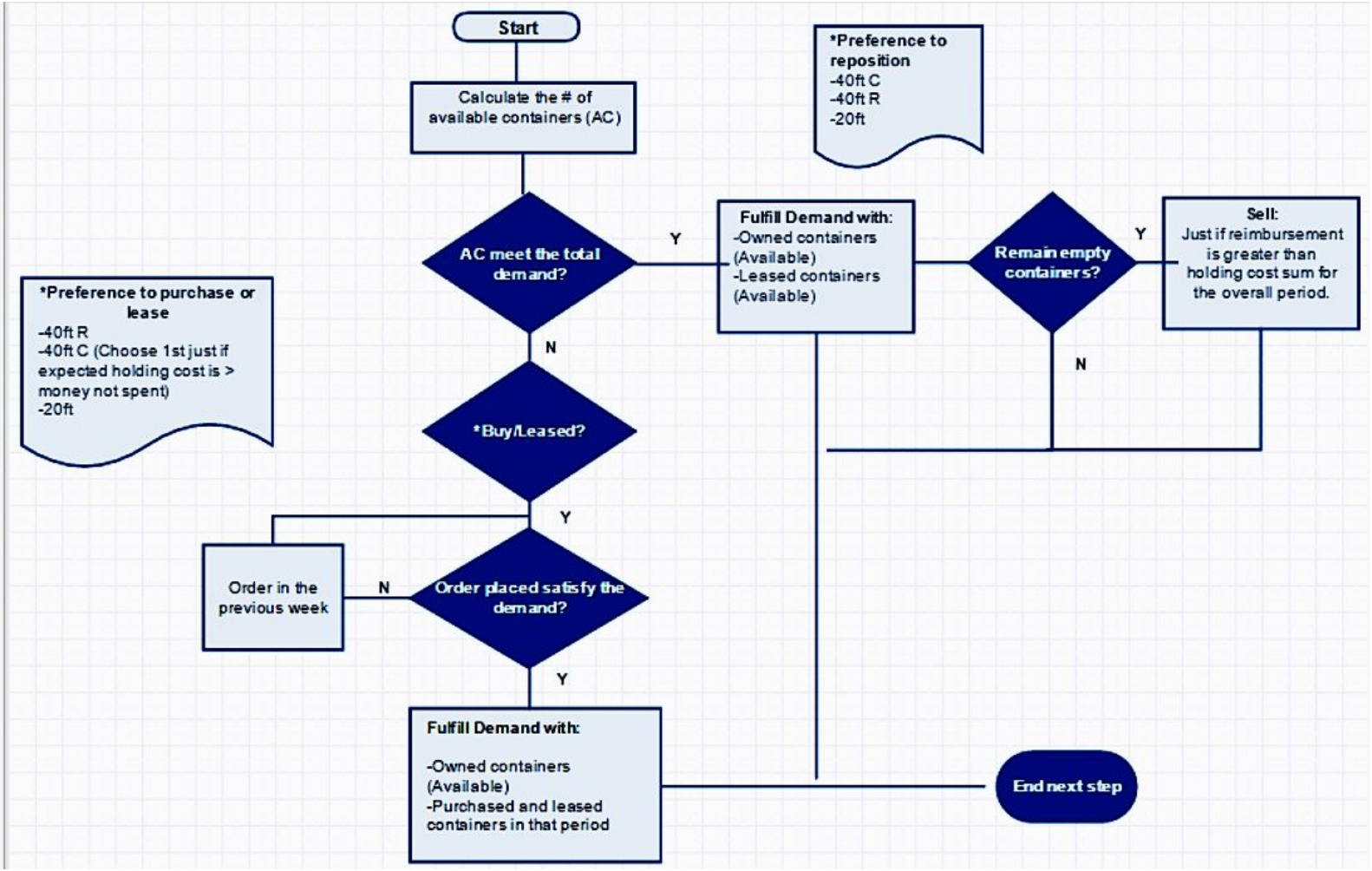
2. **Assign the empty containers to fulfill the demand based on the number of on-hand empty containers.** *The procedure of this step is Fig step 2.*

3. **Do step 2 for each of the ports in a given period.**

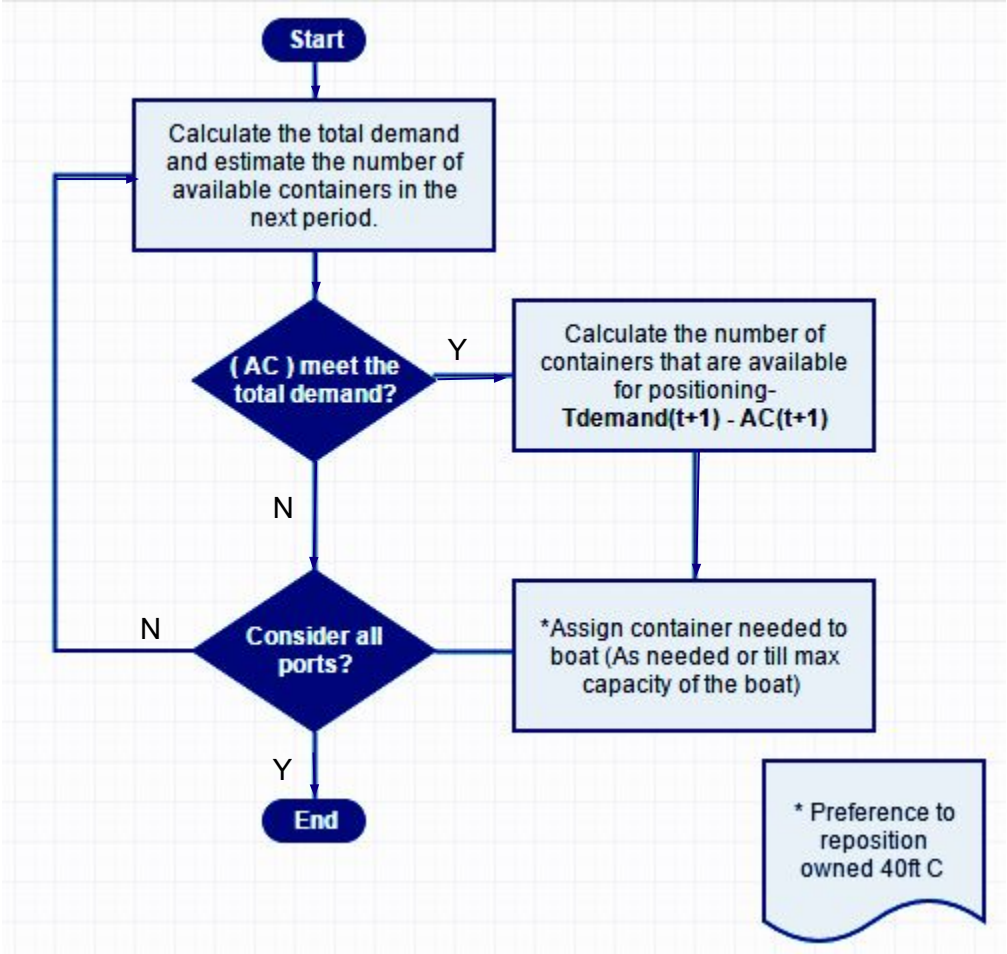
4. **Position empty containers in a given period for Produce/Consumer ports.** *The procedure of this step is Fig step 4.*

5. **Do from step 2 to step 4 for all the periods.**

Step 2.


Start
Calculate the # of available containers (AC)
*Preference to reposition
-40ft C
-40ft R
-20ft
AC meet the total demand?
Y
Fulfill Demand with:
-Owned containers (Available)
-Leased containers (Available)
Remain empty containers?
Y
Sell:
Just if reimbursement is greater than holding cost sum for the overall period.
N
*Preference to purchase or lease
-40ft R
-40ft C (Choose 1st just if expected holding cost is > money not spent)
-20ft
N
*Buy/Leased?
Y
Order in the previous week
N
Order placed satisfy the demand?
Y
Fulfill Demand with:
-Owned containers (Available)
-Purchased and leased containers in that period
End next step

Step 4.


Start
Calculate the total demand and estimate the number of available containers in the next period.
(AC) meet the total demand?
Y
Calculate the number of containers that are available for positioning- Tdemand(t+1) - AC(t+1)
N
Consider all ports?
N
*Assign container needed to boat (As needed or till max capacity of the boat)
Y
End
* Preference to reposition owned 40ft C

Plan: Containers

1. **Plan purchasing activities and delivery schedules based on the requirements.**

2. **Inventory system used to estimate the inventory level**

   Determine the quantity to keep in inventory to satisfy the demand (Minimizing the holding cost) in each port.

$$\underset{\text{(Full/Empty)}}{\text{Inventory}_{kpt}} = I_{t-1} + \text{Returned}_{kpt} + \text{Repositioned}_{kpt} + \text{Bought(Received)}_{kpt} + \text{Leased(Received)}_{kpt} - \text{Sold}_{kpt} - \text{Shipped}_{kpt}$$

K- Type of container
P- Port
T – Time period

Plan: Containers

Assumptions

1. Each port has enough container to satisfy the first shipment.
2. The average estimated length of stay per container at each port is 1 week
   $Returned_{kpt} = 80\% \ Shipped\_Full_{kpt-3}$
3. No lost sales allowed (Everything would be shipped)
4. Condition under which would be more cost effective:.
   - ***Buy or lease.***
     *Lease if the leasing cost * #weeks keep it is < purchase cost*
   - ***Sell .***
     Sell if holding cost sum > The expected Reimbursement (Purchase cost - selling price)

New Containers delivery lead times (weeks)			
	A	**B**	**C**
40 R	1	1	1
40 C	2	3	1
20R	1	1	1

40ft R	**Reimbursement** ($1800 -$1400) = $400	**Holding cost sum from (t→ t+1)** $80*(4) = 320	**Sell?** No
40ft R	**Leased =** $110* (52weeks)= $5720	$1800 /$110 per week = ~16 weeks	**Lease?** No

Plan: Coordinating Boats & Containers

Boat composition:

Capacity	500		500		1000 (500 x2)				3150 (1200x2 + 750)						750		750	
Route 2	boat 1		boat 2		boat 3		boat 4		boat 5		boat 6		boat8		boat 7		boat 9	
Route:	C_A	A_C	B_A	A_B	C_A	A_C	C_A	A_C	C_B	B_C	C_B	B_C	C_B	B_C	A_B	B_A	A_B	B_A
Full Loaded	100%	100%	100%	~100%	~50%	100%	~50%	100%	~ 50%	100%	~ 50%	100%	~ 50%	~50% - 100%	~70%	~70%	~35%	~35%
Empty					~50%		~50%							~50 - 100%				

Purchasing schedule:

- Leased = 0
- Sold= 0

Route 2																																		
Port A	Week	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
40 ft R (1 week lead time)	Ordered	300	300	300	300	300	300	300	300	300		117	300	300			300	300	300	300	300	300													
	Received		300	300	300	300	300	300	300	300	300		117	300	300			300	300	300	300	300	300												
Port B	Week	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
40 ft R (1 week lead time)	Ordered	300	300	300	300	300	300	300	300	300						34	300	300	300	300	300	300	300	300	300	300									
	Received		300	300	300	300	300	300	300	300	300						34	300	300	300	300	300	300	300	300	300	300								
Port C	Week	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
40 ft R (1 week lead time)	Ordered		200	400									372	400	400	400	400	400																
	Received			200	400									372	400	400	400	400	400																

Results - Cost / Service Level

Origin	Destination	Expected Aggregated demand	Shipped	Satisfaction
A	B	5235	5235	100.00%
	C	7328	7093	96.79%
B	A	4098	4098	100.00%
	C	10924	6300	57.67%
C	A	2018	2018	100.00%
	B	2823	2823	100.00%

System service level: **85.02%**

Cost	Value
Inventory	$12,687,325.00
Purchase	$21,284,400.00
Positioning	$8,410,306.00
Set up	$3,315,000.00
Total cost	$45,697,031.00

Limitations

Stage: Routing and Boat Assignments

1. The amount of route combinations evaluated in the simulation are an insignificant proportion of the total possible combinations.
2. The departures evaluated were limited to a boat leaving on time to make the first week forecast delivery, waiting one week, and waiting two weeks.
3. The simulation ignored information such as:
    a. Setup, Holding, and Handling Costs
    b. Purchased Container Lead Time
    c. Returned Containers from Customers
    d. Delayed Customers Pick Up's

    ... to evaluate which combination of routes provide generally high service levels.

Limitations

Stage: Container Limitations

1. Safety stock for the empty containers were not considered
2. Backorder cost was not considered

Further work:

1. Include a **(m, n)** policy to determine when should we import/export empty containers.
   - ***import*** *empty containers* ***up to "m"*** *when the number of empty containers in the port* ***is less than "m".***
   - ***or exporting*** *empty containers* ***down to "n"*** *when the number of empty containers* ***is larger than "n***"

Collapsible Containers

What makes them useful?

- They collapse when empty and can be stored in a smaller space:
  - Can ship 4 empty collapsible containers in the space of a single regular container
  - Holding costs at ports are about 5 times lower for collapsible than regular containers

What are the drawbacks?

- They are more complicated than regular containers:
  - Harder to handle and move onto and off of boats
    - Cost to move is about $30 more per container
  - More expensive to buy or lease
    - $1200 more per container to buy
    - $95 more per container per week to lease

Collapsible Containers

When are they useful?

- If containers sit empty in ports for a while:
  - Difference in cost to buy: $1200
  - Difference in cost to Hold empty:
    - Port A: -$55
    - Port B: -$115
    - Port C: -$75
  - Payback Periods
    - Port A: ~22 weeks
    - Port B: ~10 weeks
    - Port C: ~17 weeks

Collapsible Containers

What would make this Reasonable?

- The longest times that our containers sit:
  - Port A: ~9 weeks; 100 containers
  - Port B: ~10 weeks; 160 containers
  - Port C: ~13 weeks; 220 containers
    - Average Longest wait: ~11 weeks
- If 11 weeks were the payback period
  - Port A: $605→ $2405
  - Port B: $1265→ $3065
  - Port C: $825→ $2625
    - Average Price: $925→ $2725
      - Lowering the container price by $275 makes them reasonable

Collapsible Containers

When are they useful?

- If shipping containers is the most reasonable way to obtain them:

Port 1	Port 2	Max # Containers	Price Collapsible	Price Reg	Price Difference	# of Trips Needed (Regular)	# of Trips Needed (collapsible)	Room Left		
								Boat 1 (250)	Boat 2 (600)	Boat 3 (375)
A	B	35	$163,125.00	$164,200.00	$1,075.00	2	1	465	1165	715
A	B	71	$284,625.00	$285,520.00	$895.00	3	1	679		1054
A	B	107	$406,125.00	$406,840.00	$715.00	4	1	893		
A	C	35	$162,600.00	$163,500.00	$900.00	2	1	465	1165	715
A	C	71	$283,560.00	$284,100.00	$540.00	3	1	679		1054
A	C	107	$404,520.00	$404,700.00	$180.00	4	1	893		
B	A	47	$218,625.00	$219,640.00	$1,015.00	2	1	453	1153	703
B	A	95	$380,625.00	$381,400.00	$775.00	3	1	655		1030
B	A	143	$542,625.00	$543,160.00	$535.00	4	1	857		
B	C	47	$218,625.00	$219,640.00	$1,015.00	2	1	453	1153	703
B	C	95	$380,625.00	$381,400.00	$775.00	3	1	655		1030
B	C	143	$542,625.00	$543,160.00	$535.00	4	1	857		
C	A	59	$273,240.00	$273,900.00	$660.00	2	1	441	1141	691
C	A	119	$474,840.00	$474,900.00	$60.00	3	1	631		1006
C	A	178	$673,080.00	$673,800.00	$720.00	4	1	822		
C	B	59	$274,125.00	$275,080.00	$955.00	2	1	441	1141	691
C	B	119	$476,625.00	$477,280.00	$655.00	3	1	631		1006
C	B	179	$679,125.00	$679,480.00	$355.00	4	1	821		

  - Only ever reasonable if you are spreading across multiple ships

Collapsible Containers

What would make this Reasonable?

- The savings come from limiting the number of trips you need to make
  - To be cost effective, we would need to incentivise the use of smaller boats
    - Otherwise there is virtually no reason to spread the containers across multiple boats

Port 1	Port 2	Max # Containers	# of Trips Needed (Regular)	# of Trips Needed (collapsible)	Capacity if filling Ships	Max Capacity
A	B	35	2	1	18	34
A	B	71	3	1	24	70
A	B	107	4	1	27	106
A	C	35	2	1	18	34
A	C	71	3	1	24	70
A	C	107	4	1	27	106
B	A	47	2	1	24	46
B	A	95	3	1	32	94
B	A	143	4	1	36	142
B	C	47	2	1	24	46
B	C	95	3	1	32	94
B	C	143	4	1	36	142
C	A	59	2	1	30	58
C	A	119	3	1	40	118
C	A	178	4	1	45	177
C	B	59	2	1	30	58
C	B	119	3	1	40	118
C	B	179	4	1	45	178

Questions?