Supply Chain Planning Models under Possible Job Actions

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Ports of Los Angeles and Long Beach are keys to Economic Engine for Southern California

- 40% of nation’s overseas containerized imports come through the ports of Long Beach and Los Angeles
• West Coast Port Strike Continued into 2015.
• It continued to pose a logistical nightmare for retailers, keeping the bottlenecks in place that were carried forward into 2015.
Trading Partners

• 58% of Long Beach’s containerized imports come from China.
• 29% of our containerized export from Long Beach go to China.
Truckers striking three companies at the ports of Los Angeles and Long Beach agree to end their walkout. MSNBC -- July 12 2014
Container Traffic Through West Coast Ports

- 2002 Strike
- Peak of Financial Crisis
- 2014/2015 Labor Disputes

- Los Angeles (left)
- Long Beach (left)
- Los Angeles (unofficial, left)
- Oakland (right)

* Seasonally-adjusted.
Ports Gridlock Reshapes the Supply Chain

More cargo is being shifted away from congested West Coast trade routes

By
LAURA STEVENS and

PAUL ZIOBRO
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The labor dispute that caused months of gridlock at West Coast ports may be over, but the disruption is expected to redraw the trade routes that goods take to reach U.S. factories and store shelves.
Rerouted
Companies have increasingly shifted cargo to East Coast ports to avoid congestion at West Coast ports, despite the longer trips.

**East Coast routes**
- Via Indian/Atlantic oceans
- Via Panama Canal

**West Coast route**
- 25 days in transit
- 12 days
- 32 days

Sources: Maersk; Yang Ming
Marine Transport

THE WALL STREET JOURNAL.
Congestion over time, Los Angeles and Long Beach Harbors
22 October 2014 - 3 February 2015

Information Provided by:
Marine Exchange of Southern California
And Vessel Traffic Service of Los Angeles and Long Beach
POC: Capt. Kip Loutit, Executive Director

Total high: 25 ships
3 Feb 2015

Container Ship highs:
20 ships
24 Jan & 3 Feb 2015
Faced by companies with transportation plans through the ports of Los Angeles and Long Beach

PROBLEM
Alternatives

• Ship early, incur cost of storing inventories, costs of change of local production plans.
• Ship to (from) alternate ports, incur additional transportation costs.
• Ship air freight – 10 X more expensive

Assess all these in the light of uncertain future...
PROPOSED MODELING APPROACH
Scenario Tree

Period 0

Better outlook

No labor problem

25% slowdown

50% slowdown

Now

Worse outlook

No labor problem

25% slowdown

50% slowdown

Scenario Tree
For each node “on ship”

New Arrivals

Awaiting unloading on ships

Node s

Continue to await

Unloaded during this period
For each node “in inventory”

Node s

- Unloaded during this period
- Air shipment
- In inventory from the previous node
- Demand during node s
- In inventory for next node
New Arrivals

Awaiting unloading on ships

Unloaded during this period – subject to slowdown

Air Ship
    In inventory from the previous node

Demand during node s

Node s

Continue to await

In inventory for next node
Scenario Tree

Period 0

Better outlook

0.50

No labor problem

0.80

Worse outlook

0.50

25% slowdown

0.10

Now

0.50

50% slowdown

0.10

Scenario Tree

0.50

25% slowdown

0.25

25% slowdown

0.25

50% slowdown

0.25

50% slowdown

0.25

0.50

No labor problem

1

0.50

No labor problem

0.25

50% slowdown

0.25

50% slowdown

0.25

1

No labor problem

0.50

No labor problem

0.25

25% slowdown

0.25

25% slowdown

0.25

50% slowdown

0.25

50% slowdown

0.25
Parameters

- $V$ set of nodes in the scenario tree, indexed by $s$
- $a_k(s)$ kth parent of node $s$ [e.g., $a_1(3)=1$, $a_2(3)=0$, $a_0(3)=3$]
- $\tau(s)$=period for node $s$ [e.g., $\tau(3)=2$]
- $\gamma_s$=probability of node $s$ [e.g., $\gamma(3)=0.50 \times 0.20 = 0.10$]
- $\int_s$=slowdown at node $s$ [e.g., $\int(3)=0.25$]
- $\lambda(s)$=lead time for regular shipment for node $s$ [e.g., $\lambda(3)=0$, or $\lambda(4)=1$, or $\lambda(5)=2$]
- $D_t$= demand in period $t$
- $h$=inventory holding cost per unit per period
- $c$=extra shipment cost for airfreight (lead time=0)
Model

- Decision Variables

- $I_s = \text{ending inventory at node } s$

- $O_s = \text{awaiting unloading at the end of node } s$

- $P_s = \text{ocean shipments at node } s$

- $A_s = \text{air shipments at node } s$
New Arrivals

Awaiting unloading on ships

Unloaded during this period – subject to slowdown

Air Ship
In inventory from the previous node

Demand during node s

Continue to await

In inventory for next node
\[ \mathcal{H}_n \]

\[ P_{a_{\lambda(s)}} \]

\[ O_{a_1(s)} \rightarrow \text{Node } s \rightarrow O_s \]

\[ (1 - \sigma_s) \left[ O_{a_1(s)} + P_{a_{\lambda(s)}} \right] \]

\[ A_s \rightarrow \text{Node } s \rightarrow I_s \]

\[ I_{a_1(s)} \rightarrow \text{Node } s \rightarrow D_{\tau(s)} \]
Model

Min $\sum_{s \in V} \gamma_s (hi_s + cA_s)$

subject to:

$I_s = I_{a_1(s)} + (1 - \sigma_s) \left[ O_{a_1(s)} + P_{a_\lambda(s)} \right] + A_s - D_{\tau(s)}, \forall s \in V,$

$O_s = O_{a_1(s)} + P_{a_\lambda(s)} - (1 - \sigma_s) \left[ O_{a_1(s)} + P_{a_\lambda(s)} \right], \forall s \in V,$

$I_s, O_s, P_s, A_s \geq 0, \forall s \in V$
Min \{\text{Sum of \[\text{Prob} \times (\text{Inventory Holding + Air Ship Costs})\]\}} \\

Subject to: \\
(Awaiting unloading) + (New Arrivals) = \\
(Continue to await) + (Unloaded during this period) \\

(Air shipped) + (Inv. from previous period) + \\
(Unloaded during this period) = \\
(Demand) + (Ending inventory)
Acknowledgment

The original version of this formulation was proposed by Alper Sen, PhD, of Bilkent University, while visiting UC Berkeley during 2014-2015 Academic Year.

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This is a work in progress. We will appreciate any suggestions and comments.