A Strategic Empty Container Logistics Optimization in a Major Shipping Company

CSAV

INGENIERIA INDUSTRIAL UNIVERSIDAD DE CHILE
OVERVIEW

- CSAV and the Shipping Business
- The Empty Container Logistics Process
- The Optimization System and its Implementation
- Impact and Benefits
The Company

FERNANDO VALENZUELA
SENIOR VICE PRESIDENT OF OPERATIONS & LOGISTICS
STATEGIC PLAN

- Strengthen Capital Base and Asset Structure
- Improve Commercial & Operational Efficiency
7 REGIONAL OFFICES

New Jersey
Sao Paulo
Valparaiso
Barcelona
Hamburg
Mumbai
Hong Kong
CONTAINER FLEET

- 700,000 TEUs Dry & Reefer
- Valued at $2 billion

Dry Van 20 ft
Dimensions: 20' x 8' x 8'6"  
Tare Weight: 2,330 Ton  
Max. Load: 28,150 Ton

1 TEU  
Twenty-foot Equivalent Unit
CONTAINER TYPES

- Dry Van 20 ft
- Dry Van 40 ft
- High Cube 40 ft
- Flat Rack 20 ft
- Flat Rack 40 ft
- Reefer 40 ft
- Open Top 20 ft

Others:
- Reefer 20 ft
- Ventilated 20 ft
- Open Top 40 ft
- Reefer High Cube 40 ft
- ...
CONTAINER FLEET GROWTH

TEUs (for World fleet)

TEUs (for CSAV fleet)

- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011

6 million
38,000
26 million
730,000

CSAV
World
CSAV GLOBALIZATION

languages
regulations
viewpoints
cultures
customs
UNIVERSITY OF CHILE

- Forest Operations (Edelman Prize 1998)
- First in *Interfaces* Publications Ranking in Applied Operations Research Outside US
- School Meals Combinatorial Auctions (IFORS Prize 2002)
- Mine Planning
EMPTY CONTAINER LOGISTICS

- Complex Network
- Uncertainty
- Size
- Information Availability
2008 FINANCIAL CRISIS

- Sales Dropped 38%
- CSAV’s Market Value Fell 66%
- CSAV was in a Critical Situation

Strategic Change:

Excellence in Operations
Empty Container Logistics Problem

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INDUSTRIAL ENGINEERING DEPARTMENT
UNIVERSITY OF CHILE
EMPTY CONTAINER LOGISTICS CHALLENGES

- IMBALANCE
- UNCERTAINTY
- INFORMATION HANDLING AND SHARING
- COORDINATION OF INTERRELATED DECISIONS WORLDWIDE
CONTAINER IMBALANCE

Exports
Imports
EMPTY CONTAINER LOGISTICS CHALLENGES

- IMBALANCE
- UNCERTAINTY
- INFORMATION HANDLING AND SHARING
- COORDINATION OF INTERRELATED DECISIONS WORLDWIDE
UNCERTAINTY

- Demand
- Return of Empty Containers
- Travel Times
- Ships’ Capacity for Transporting Empty Containers
EMPTY CONTAINER LOGISTICS CHALLENGES

- IMBALANCE
- UNCERTAINTY
- INFORMATION HANDLING AND SHARING
- COORDINATION OF INTERRELATED DECISIONS WORLDWIDE
INFORMATION HANDLING

- 400,000 Container Activity Transactions per Day

- Timely Decisions need Accurate Information
EMPTY CONTAINER LOGISTICS CHALLENGES

- IMBALANCE
- UNCERTAINTY
- INFORMATION HANDLING AND SHARING
- COORDINATION OF INTERRELATED DECISIONS WORLDWIDE
2006 EMPTY CONTAINER LOGISTICS

- Imbalance
- Uncertainty
- Information
- Coordination

- High Quality Service

- High Levels of Stocks
  - Inefficient Repositioning
Solution and Methodology
EMPTY CONTAINER LOGISTICS OPTIMIZATION
FORECASTING MODULE

- Combination of 3 Methodologies:
  - Moving Average
  - Trended and Seasonal Time Series
  - Sales Force Forecasts (CFM)
1.5 Million Forecasts per Day

- Container Demand
- Space in Vessels for Empty Containers
- Container Client’s Returns
FORECAST ERROR AND SAFETY STOCK

Graph showing the relationship between service level and safety stock for different forecast standard deviations:

- **High Forecast Std. Dev.**
  - Service Level: 80%
  - Safety Stock: 77 TEU
  - Service Level: 95%
  - Safety Stock: 43 TEU
  - Service Level: 99%
  - Safety Stock: 28 TEU
  - Service Level: 99.99%
  - Safety Stock: Approx. 140 TEU

- **Medium Forecast Std. Dev.**
  - Service Level: 80%
  - Safety Stock: 77 TEU
  - Service Level: 95%
  - Safety Stock: 43 TEU
  - Service Level: 99%
  - Safety Stock: 28 TEU
  - Service Level: 99.99%
  - Safety Stock: Approx. 120 TEU

- **Low Forecast Std. Dev.**
  - Service Level: 80%
  - Safety Stock: 77 TEU
  - Service Level: 95%
  - Safety Stock: 43 TEU
  - Service Level: 99%
  - Safety Stock: 28 TEU
  - Service Level: 99.99%
  - Safety Stock: Approx. 100 TEU
Inventory = Expected (Demand & Return) + Safety Stock

\[ Z_\alpha \cdot \sigma_{\text{Forecast}} \]

\( \sigma_{\text{Forecast}} \) : Forecast Standard Deviation
\( z_\alpha \) : Safety Factor with a Service Level of \( \alpha \)%
Regional Offices

Web Interface

Safety Stocks

MC Network Flow Model

Inventory Model

Travel Times
Vessel Capacity
Expected Demand & Return
Standard Deviation

Forecasting Model

Container Positions

Local Forecasting

Historical Data

Transaction Database CSAV

ECO
MC NETWORK FLOW MODEL: MAIN DECISIONS

- Inventory Levels per Type, Location, and Day
- Empty Container Repositioning Flows
- When and Where to Lease & Return Containers
Minimize Empty Container Logistics Costs

Empty Container Cost Elements:

- Leasing
- Repositioning
- Storage
- Loading
- Discharge
Per Container Type, Location, and Day:
MC NETWORK FLOW MODEL: SAFETY STOCK

Uncertainty

Safety Stock
ECO

Transaction Database CSAV

MC Network Flow Model

Inventory Model

Forecasting Model

Travel Times
Vessel Capacity
Expected Demand & Return
Standard Deviation

Historical Data

Cleansing Module

Container Positions

Regional Offices

Web Interface

Safety Stocks

Local Forecasting

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MC NETWORK FLOW MODEL: RESOLUTION

- 3.7 Million Parameters, 1.2 Million Variables, and 600,000 Equations
- 3 Runs per Day
- Solution in 2 Hours:
  - Warm Starts
  - Size Reduction
- Integer Friendly
INFORMATION QUALITY IMPROVEMENTS

- Projects: Data Gathering, Reliability, and Transmission
- Company-Wide Improvements
- Example: Avg. Activity Tracking Time
  - Before: +48 Hours
  - Today: -24 Hours
The most difficult part was still to come...
COLLABORATIVE WEB INTERFACE
Implementation

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VICE PRESIDENT OF LOGISTICS AND GLOBAL OPERATIONAL PROCESSES
IMPLEMENTATION CHALLENGES

- Data Quality
- Different Processes
- Regional Structures
- Coordination
- Parameters
CSAV FREIGHT TRANSPORTATION

TEU

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

0 500,000 1,000,000 1,500,000 2,000,000 2,500,000 3,000,000 3,500,000
REGIONAL LOGISTICS

New Jersey
Sao Paulo
Valparaiso
Barcelona
Hamburg
Mumbai
Hong Kong
STEP 1 - PROTOTYPE DEVELOPMENT

- Development Sequence:
  - Prototype with Historical Data
  - Prototype for Chile
  - Prototype for Chile-Brazil
  - Global Prototype
Global Process for Empty Container Logistics:

- Weekly Coordination Meetings
- Best Practices in use of ECO
- Target Inventories
- Coordinated Flows
- System Validation
IMPLEMENTATION HISTORY

2006: Project Start

2007: Prototype in Chile & Brazil

2008: Global Prototype Validation

2009: Global Implementation Plan

Jan 2010: ECO Goes Live
GLOBAL LOGISTICS

New Jersey
Sao Paulo
Valparaiso
Barcelona
Hamburg
Mumbai
Hong Kong
Impacts & Benefits

FERNANDO VALENZUELA
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OPTIMIZATION

- Coordination
- Creativity
- Flexibility
INTEGRATION

Sales

Logistics
INFORMATION VALUE

Data + Intelligence = Efficiency
EMPTY TIME PER CONTAINER CYCLE (Days)

Average Empty Container Turnover Increased 60%

Data points:
- 2006: 35.0 days
- 2007: 41.2 days
- 2008: 40.6 days
- 2009: 47.2 days
- 2010: 27.3 days
CONTAINER CYCLES PER YEAR

Voyages per Year

2006: 4.4
2007: 4.1
2008: 4.1
2009: 3.8
2010: 4.8
REQUIRED DRY CONTAINERS FOR 2010 DEMAND

Without ECO Avg. 2006-2009: 722,450

With ECO 2010: 631,057

Avg. 2006-2009: 660,000

14.5%
EXCESS COST PER FULL VOYAGE RESPECT TO 2010

$ USD

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost Difference</th>
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<tbody>
<tr>
<td>2006</td>
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<td>2007</td>
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<tr>
<td>2008</td>
<td>$32</td>
</tr>
<tr>
<td>2009</td>
<td>$51</td>
</tr>
<tr>
<td>2010</td>
<td>Base Year</td>
</tr>
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Avg: +$35
SAVINGS 2010

Per Voyage Excess Cost 2006-2009: $35

Voyages 2010: 2.9 million

Total Savings: $35 \times 2.9 = $101 million

Estimated ECO Effect: 80%

Total ECO Savings: $81 million
CSAV NET INCOME

US$ million

2006 2007 2008 2009 2010

-58 117 -39 -669 170

ECO Impact

81
FUTURE SAVINGS

- 2010: $81 million
- 2011: $100 million
- 2012: $100 million
Testimony

ARTURO RICKE
CHIEF EXECUTIVE OFFICER